



# UNIVERSITY OF CALCUTTA

## Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

### List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
✓ 6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies ( General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE  
KOLKATA-700073  
The 4<sup>th</sup> June, 2018

*Paul*  
4/6/18  
(Dr. Santanu Paul)  
Deputy Registrar

**UNIVERSITY OF CALCUTTA**

**SYLLABUS**

**FOR**

**THREE-YEAR B.Sc. HONOURS COURSE**

**UNDER CHOICE BASED CREDIT SYSTEM**



**BOTANY**

**FOR SESSION 2018-2019**

**Core courses (CC-Total 14 courses to be studied in semesters. All theoretical papers i.e., BOT-A...TH are of 4 credits each and the respective practical papers i.e., BOT-A....P of 2 credits each)**

SEM I:

1. Phycology and Microbiology (BOT-A-CC-1-1-TH, BOT-A-CC-1-1-P)
2. Mycology and Phytopathology (BOT-A-CC-1-2-TH, BOT-A-CC-1-2-P)

SEM II

3. Plant anatomy (BOT-A-CC-2-3-TH, BOT-A-CC-2-3-P)
4. Archegoniate (BOT-A-CC-2-4-TH, BOT-A-CC-2-4-P)

SEM III

5. Palaeobotany and Palynology (BOT-A-CC-3-5-TH, BOT-A-CC-3-5-P)
6. Reproductive biology of Angiosperms (BOT-A-CC-3-6-TH, BOT-A-CC-3-6-P)
7. Plant systematic (BOT-A-CC-3-7-TH, BOT-A-CC-3-7-P)

SEM IV

8. Plant geography, Ecology and Evolution (BOT-A-CC-4-8-TH, BOT-A-CC-4-8-P)
9. Economic Botany (BOT-A-CC-4-9-TH, BOT-A-CC-4-9-P)
10. Genetics (BOT-A-CC-4-10-TH, BOT-A-CC-4-10-P)

SEM V

11. Cell and Molecular biology (BOT-A-CC-5-11-TH, BOT-A-CC-5-11-P)
12. Biochemistry (BOT-A-CC-5-12-TH, BOT-A-CC-5-12-P)

SEM VI

13. Plant Physiology (BOT-A-CC-6-13-TH, BOT-A-CC-6-13-P)
14. Plant Metabolism (BOT-A-CC-6-14-TH, BOT-A-CC-6-14-P)

**Skill enhancement courses (SEC- 2, two papers to be selected from the list taking 1 from SEC A in 3<sup>rd</sup> SEM and 1 from SEC B in 4<sup>th</sup> SEM. Both the papers of 2 credits each and theoretical only)**

SEC A (SEM III)

1. Applied Phycology, Mycology and Microbiology (BOT-A-SEC-A-3-1)
2. Biofertilizers (BOT-A-SEC-A-3-2)

SEC B (SEM IV)

3. Plant Breeding (BOT-A-SEC-B-4-3)
4. Mushroom Culture Technology (BOT-A-SEC-B-4-4)

**Discipline specific elective courses (DSE, four courses to be selected from the 2 groups (A & B). A student shall choose any one paper from each of Group- A and Group- B in 5<sup>th</sup> AND 6<sup>th</sup> SEM. Each course comprises of theoretical component of 4 credits and practical ones of 2 credits)**

DSE-A (Group- A)

SEM V

1. Biostatistics (BOT-A-DSE-A-5-1-TH, BOT-A-DSE-A-5-1-P)
2. Industrial and Environmental Biology (BOT-A-DSE-A-5-2-TH, BOT-A-DSE-A-5-2-P)

SEM VI

3. Medicinal and Ethnobotany (BOT-A-DSE-A-6-3-TH, BOT-A-DSE-A-6-3-P)
4. Stress Biology (BOT-A-DSE-A-6-4-TH, BOT-A-DSE-A-6-4-P)

DSE-B (Group-B)

SEM V

5. Plant Biotechnology (BOT-A-DSE-B-5-5-TH, BOT-A-DSE-B-5-5-P)
6. Horticultural practices and Post Harvest Technology (BOT-A-DSE-B-5-6-TH, BOT-A-DSE-B-5-6-P)

SEM VI

7. Research Methodology (BOT-A-DSE-B6-7-TH, BOT-A-DSE-B-6-7-P)
8. Natural resource management (BOT-A-DSE-B-6-8-TH, BOT-A-DSE-B-6-8-P)

**DISSERTATION/PROJECT: A Dissertation / Project may be given in lieu of a DSE. This is considered as a special course and will be of 6 credits. (Vide page 4 of CUS/268(CIR/18, dated 07.05.2018)). However, the details of the topics, modalities of evaluation etc. to be notified latter on.**

SEME STER	COURSE OPTED	COURSE NAME	CREDIT
I	Core Course 1- BOT-A-CC-1-1-TH	Phycology and microbiology	4
	Core Course 1- BOT-A-CC-1-1-P	Phycology and microbiology Practical	2
	Core Course 2- BOT-A-CC-1-2-TH	Mycology and phytopathology	4
	Core Course 2- BOT-A-CC-1-2-P	Mycology and phytopathology Practical	2
II	Core Course 3- BOT-A-CC-2-3-TH	Plant anatomy	4
	Core Course 3- BOT-A-CC-2-3-P	Plant anatomy Practical	2
	Core Course 4- BOT-A-CC-2-4-TH	Archegoniate	4
	Core Course 4- BOT-A-CC-2-4-P	Archegoniate Practical	2
III	Core Course 5- BOT-A-CC-3-5-TH	Palaeobotany and palynology	4
	Core Course 5- BOT-A-CC-3-5-P	Palaeobotany and palynology Practical	2
	Core Course 6- BOT-A-CC-3-6-TH	Reproductive biology of angiosperms	4
	Core Course 6- BOT-A-CC-3-6-P	Reproductive biology of angiosperms Practical	2
	Core Course 7- BOT-A-CC-3-7-TH	Plant systematics	4
	Core Course 7- BOT-A-CC-3-7-P	Plant systematics Practical	2
	SEC A – BOT-A-SEC-A-3-1/ BOT-A-SEC-A-3-2	Only <b>ONE</b> paper to be selected	2
IV	Core Course 8- BOT-A-CC-4-8-TH	Plant geography, ecology and evolution	4
	Core Course 8- BOT-A-CC-4-8-P	Plant geography, ecology and evolution Practical	2
	Core Course 9- BOT-A-CC-4-9-TH	Economic botany	4
	Core Course 9- BOT-A-CC-4-9-P	Economic botany Practical	2
	Core Course 10- BOT-A-CC-4-10-TH	Genetics	4
	Core Course 10- BOT-A-CC-4-10-P	Genetics Practical	2
	SEC B – BOT-A-SEC-B-4-3/ BOT-A-SEC-B-4-4	Only <b>ONE</b> paper to be selected	2
V	Core Course 11- BOT-A-CC-5-11-TH	Cell and molecular biology	4
	Core Course 11- BOT-A-CC-5-11-P	Cell and molecular biology Practical	2
	Core Course 12- BOT-A-CC-5-12-TH	Biochemistry	4
	Core Course 12- BOT-A-CC-5-12-P	Biochemistry Practical	2
	DSE A: BOT-A-DSE-A-5-1 & 2-TH & P	Only <b>ONE</b> paper to be selected from Group A	4 & 2
	DSE B: BOT-A-DSE-B-5-5 & 6-TH & P	Only <b>ONE</b> paper to be selected from Group B	4 & 2

VI	Core Course 13- BOT-A-CC-6-13-TH	Plant physiology	4
	Core Course 13- BOT-A-CC-6-13-P	Plant physiology practical	2
	Core Course 14- BOT-A-CC-6-14-TH	Plant metabolism	4
	Core Course 14- BOT-A-CC-6-14-P	Plant metabolism Practical	2
	DSE A: BOT-A-DSE-A-6-3&4-TH & P	Only <b>ONE</b> paper to be selected Group A	4 & 2
	DSE B: BOT-A-DSE-B-6-7&8 -TH & P	Only <b>ONE</b> paper to be selected Group B	4 & 2

# **C.U. B.Sc. BOTANY (HONOURS)**

## **SEMESTER I**

### **CORE COURSE 1**

#### **PHYCOLOGY AND MICROBIOLOGY (BOT-A-CC-1-1-TH)**

##### **THEORETICAL**

**(Credits 4, Lectures-60)**

### **PHYCOLOGY**

#### **1. General account :**

1.1. Thallus organization, Structure of algal cell, 1.2. Ultrastructure of Plastids and Flagella, 1.3. Origin and evolution of sex, 1.4. Life cycle patterns, 1.5. Significant contributions of important phycologists (Fritsch, Smith, R. N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar)

.....5 lectures

#### **2. Classification:**

2.1. Criteria and basis of Fritsch's classification  
2.2. Classification by Lee (2008) upto phylum with examples  
2.3. Salient features of Cyanobacteria, Rhodophyta, Chlorophyta , Charophyta, Bacillariophyta, Xanthophyta, Phaeophyta, Heterokantophyta.

.....5 lectures

#### **3. Cyanobacteria:**

3.1. Ultrastructure of cell, 3.2. Heterocyst - structure and function, 3.3. Ecology.

.....4 lectures

#### **4. Bacillariophyta:**

4.1. Cell structure, 4.2. Cell division, 4.3. Auxospore formation in Centrales and Pennales.

.....6 lectures

#### **5. Life History:**

5.1. *Chlamydomonas*, 5.2. *Oedogonium*, 5.3. *Chara*, 5.4. *Ectocarpus*, 5.5. *Polysiphonia*, 5.6. Evolutionary significance of *Prochloron*.

.....10 lectures

### **MICROBIOLOGY**

#### **1. Virus:**

1.1. Discovery, 1.2. Plant virus- types, 1.3. Transmission and translocation of Plant virus, 1.4. TMV-

Physicochemical characteristics and Multiplication, 1.5. One step growth curve, 1.6. Lytic cycle (T4 phage) and Lysogenic cycle (Lambda phage), Significance of lysogeny, 1.7. Viroids and Prions.

.....10 lectures

## **2. Bacteria:**

2.1. Discovery, 2.2. Distinguishing features of Archaea and Bacteria, 2.3. Characteristics of some major groups: Proteobacteria (Enterobacteria), Firmicutes, Mollicutes, Actinobacteria, Spirochaetes, Chlamydiae, 2.4. Bacterial growth curve and generation time, 2.5. Flagella (ultrastructure) & Pili, 2.6. Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria, 2.7. Bacterial genome and plasmid, 2.8. Endospore - formation, structure and function, 2.9. Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation– F- factor,  $F^+ \times F^-$ , Hfr  $\times F^-$ , concept of F', chromosome mobilization, (c) Transduction– Generalised and specialized.

.....20 lectures

## **PRACTICAL- PHYCOLOGY AND MICROBIOLOGY (BOT-A-CC-1-1-P) (Credits 2)**

1. Work out: Algae, Bacterial staining
2. Identification with reasons: (Algae and bacteria)
3. Classroom performance (Lab notebook, submission and permanent slides)
4. Viva- voce

### **ALGAE**

1. Work out of the following algae with reproductive structure (Free hand drawing and drawing under drawing prism with magnification): *Oedogonium*, *Chara*, *Ectocarpus*.
2. Study of (a) Permanent slides : *Gloeotrichia*, *Volvox*, *Vaucheria*, *Coleochaete*, *Polysiphonia*, Centric and Pennate diatom; (b) Macroscopic specimens : *Laminaria*, *Sargassum*.

### **MICROBIOLOGY**

1. Preparation of bacterial media – (a) Nutrient agar and nutrient broth, (b) Preparation of slants and pouring Petri-plates.



2. Sub-culturing of bacterial culture.
3. Gram staining from bacterial culture.
4. Microscopic examination of bacteria from natural habitat (curd) by simple staining.

### **FIELD WORK**

At least one local excursion to be conducted for study and collection of algae (only 5 from natural habitat) and another local excursion should be conducted to give an introductory idea about plant diversity (Collection not required).

### **CLASSROOM PERFORMANCE**

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.
2. Slides (permanent) prepared during practical classes.
3. Submission (5 algae collected from natural habitat and identified latter)

## **CORE COURSE 2 MYCOLOGY AND PHYTO-PATHOLOGY (BOT-A-CC-1-2-TH) THEORETICAL (Credits 4, Lectures 60)**

### **MYCOLOGY**

#### **1. General Account:**

1.1. Hyphal forms, 1.2. Fungal spore forms and mode of liberation, 1.3. Sexual reproduction and degeneration of sex, 1.4. Parasexuality and sexual compatibility, 1.5. Life cycle patterns.

.....6 lectures

#### **2. Classification:**

2.1. Classification of Fungi (Ainsworth, 1973) upto sub-division with diagnostic characters and examples. 2.2. General characteristics of Myxomycota, Oomycota, Zygomycota, Ascomycota, Basidiomycota, Deuteromycota.

.....6 lectures

#### **3. Life history:**

3.1. *Synchytrium*, 3.2. *Rhizopus*, 3.3. *Ascobolus*, 3.4. *Agaricus*.

.....10 lectures

#### **4. Mycorrhiza:**

4.1. Types with salient features, 4.2. Role in Agriculture & Forestry.

.....4 lectures

#### **5. Lichen:**

5.1. Types, 6.2. Reproduction, 6.3. Economic and ecological importance

.....4 lectures

### **PHYTO-PATHOLOGY**

#### **1. Terms and Definitions :**

1.1. Disease concept, 1.2. Symptoms, 1.3. Etiology & causal complex, 1.4. Primary and secondary inocula, 1.5. Infection, 1.6. Pathogenecity and pathogenesis, 1.7. Necrotroph and Biotroph, 1.8. Koch's Postulates, 1.9. Endemic, Epidemic, Pandemic and Sporadic disease, 1.10. Disease triangle, 1.11. Disease cycle (monocyclic, polycyclic and polyetic).

.....6 lectures

#### **2. Host – Parasite Interaction:**

2.1. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), 2.2. Pathotoxin (Definition, criteria and example), 2.3. Defense mechanism with special reference to Phytoalexin, 2.4. Resistance- Systemic acquired and Induced systemic.

.....6 lectures

#### **3. Plant Disease Management :**

3.1. Quarantine, 3.2. Chemical, 3.3. Biological, 3.4. Integrated.

.....8 lectures

#### **4. Symptoms , Causal organism, Disease cycle and Control measures of:**

4.1. Late blight of Potato, 4.2. Brown spot of rice, 4.3. Black stem rust of wheat, 4.4. Stem rot of jute.

.....10 lectures

### **PRACTICAL- MYCOLOGY AND PHYTO-PATHOLOGY (BOT-A-CC-1-2-P) (Credits 2)**

#### **MYCOLOGY**

1. Work out of the following fungi with reproductive structures (including microscopic measurement of Reproductive structures): *Rhizopus* (asexual), *Ascobolus*, *Agaricus*.

2. Study from permanent slides: Zygosporangium of *Rhizopus*, Conidia of *Fusarium*, Conidiophore of

*Penicillium*.

3. Morphological study of Fungi (fruit body of *Polyporus*, *Cyathus*), Lichens (fruticose and foliose).

### **PHYTO- PATHOLOGY**

1. Preparation of fungal media (PDA).

2. Sterilization process.

3. Isolation of pathogen from diseased leaf.

4. Inoculation of fruit and subculturing.

5. Identification : Pathological specimens of Brown spot of rice, Bacterial blight of rice , Loose smut of wheat, Stem rot of jute, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of *Puccinia graminis*.

### **FIELD WORK**

At least one local excursion to be conducted for study and collection of macrofungi (only 5).

### **CLASSROOM PERFORMANCE**

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes

2. Slides (permanent) prepared during practical classes.

3. Submission (5 Macro fungi)

## **SEMESTER- II**

### **CORE COURSE 3**

### **PLANT ANATOMY (BOT-A-CC-2-3-TH)**

**(Credits 4, Lectures 60)**

### **ANATOMY**

#### **1.Cell wall:**

1.1. Ultrastructure & Chemical constituents, 1.2. Plasmodesmata- ultrastructure, 1.3. Concept of Apoplast and Symplast, 1.4. Growth and Thickening of cell wall.

.....8 lectures

#### **2. Stomata:**

2.1. Types (Metcalfe and Chalk, Stebbins and Khush).

.....4 lectures

### **3. Stele:**

3.1 Leaf-trace and leaf-gap, 3.2. Stellar types & evolution

.....4 lectures

**4.Primary structure of stem and root-** Monocot and Dicot. Leaf- dorsiventral and isobilateral.

.....8 lectures

### **5. Secondary growth:**

5.1. Normal (intra- & extra-stelar), 5.2. Anomalous (stem of *Bignonia*, *Boerhavia*, *Tecoma*, *Dracaena* and root of *Tinospora*).

.....12 lectures

**6. Mechanical tissues and the Principles governing their distribution in plants.**

.....8 lectures

### **7. Developmental Anatomy:**

7.1. Organisation of shoot apex (Tunica–Corpus) and Root apex (Körper-Kappe), 7.2. Plastochrone.

.....8 lectures

### **8. Ecological Anatomy:**

Adaptive anatomical features of 8.1. Hydrophytes, 8.2. Xerophytes.

.....4 lectures

**9. Scope of plant anatomy: application in systematics, forensics and pharmacognosy.**

.....4 lectures

## **PRACTICAL- PLANT ANATOMY (BOT-A-CC-2-3-P)**

**(Credits 2)**

1.Workout on Plant Anatomy

2. Identification with reasons

3.Classroom performance: (Lab records, slides)

4. Viva

### **PLANT ANATOMY**

**1. Microscopic studies on:** Types of stomata, sclereids, raphides (*Colocasia*), cystolith (*Ficus* leaf) starch grains, aleurone grains, laticiferous ducts, oil glands.

2. Study of anatomical details through permanent slides/ temporary stained mounts- a) Root- Monocot and dicot, b) Stem- Monocot and dicot, c) Leaf- Monocot and dicot.
3. Study of anomalous secondary structure in stem of *Bignonia*, *Boerhaavia*, *Tecoma*, *Dracaena* and root of *Tinospora*
4. Study of adaptive anatomical features: Hydrophytes (*Nymphaea* – petiole) and Xerophytes (*Nerium* – leaf).

**CORE COURSE 4**  
**ARCHAEGONIATE (BOT-A-CC-2-4-TH)**  
**THEORITICAL**  
**(Credits 4, Lectures 60)**

**BRYOPHYTES**

**1. General Account :**

1.1. General characteristics and adaptations to land habit, 1.2. Classification (Strotler and Crandle Strotler, 2009) up to class with diagnostic characters and examples.

.....4 lectures

**2. Life History:** Gametophyte structure and Reproduction, Development and Structure of sporophyte, Spore dispersal in:

2.1. *Marchantia*, 2.2. *Anthoceros*, 2.3. *Funaria*.

.....6 lectures

**3. Phylogeny:**

3.1. Unifying features of archaegoniates; transition to land habit, 3.2. Origin of Alternation of Generations (Homologous and Antithetic theory), 3.3. Evolution of Sporophytes (Progressive and Regressive concept), 3.4. Origin of Bryophytes.

.....4 lectures

**4. Importance :**

Role of bryophytes in: 4.1. Plant succession, 4.2. Pollution Monitoring, 4.3. Economic importance of bryophytes with special reference to *Sphagnum*.

.....2 lectures

## PTERIDOPHYTES

### 1. General Account:

1.1. Colonisation and rise of early land plants, 1.2. Classification of vascular plants by Gifford & Foster (1989) upto division (Rhyniophyta to Filicophyta) with diagnostic characters and examples.

.....4 lectures

### 2. Life History:

Sporophyte structure, Reproduction and Structure of gametophyte in 2.1. *Psilotum*, 2.2. *Selaginella*, 2.3. *Equisetum*, 2.4. *Pteris*.

.....8 lectures

3. Telome concept and its significance in the origin of different groups of Pteridophytes.

.....4 lectures

4. Heterospory and Origin of Seed habit.

.....4 lectures

5. Economic importance as food, medicine and Agriculture.

.....2 lectures

## GYMNOSPERMS

1. Classification of vascular plants by Gifford & Foster (1989) upto division (Progymnospermophyta to Gnetophyta) with diagnostic characters and examples.

.....4 lectures

2. Progymnosperms :

Diagnostic characters of the group, 2.2. Vegetative and reproductive features of *Archeopteris*, 2.3. Phylogenetic importance.

.....6 lectures

3. Life History :

Distribution in India; Vegetative and Reproductive structure of sporophyte, Development of gametophyte in : 3.1. *Cycas* , 3.2. *Pinus* and 3.3. *Gnetum*.

.....8 lectures

4. Economic Importance with reference to Wood, Resins, Essential oils, and Drugs.

.....4 lectures

**PRACTICAL- ARCHAEGONIATE (BOT-A-CC-2-4-P)**  
**(Credits 2)**

1. Workout on Pteridophytes
2. Identification with reasons (Bryophytes, Pteridophytes and Gymnosperms)
3. Classroom performance: (Lab records, slides)
4. Field report
5. Viva

**BRYOPHYTES**

1. Morphological study of the plant body: Genera as mentioned in theoretical syllabus and *Riccia*, *Porella*.
2. Study from permanent slides : *Riccia* (V.S. of thallus with sporophyte), *Marchantia* (L.S. through gemma cup, antheridiophore , archegoniophore) , *Anthoceros* (L.S. of sporophyte) , *Funaria* (L.S. of capsule).

**PTERIDOPHYTES**

1. Morphological study of the sporophytic plant body: Genera as mentioned in the theoretical syllabus and *Lycopodium*, *Ophioglossum* and *Marsilea*.
2. Workout of the reproductive structures: *Selaginella*, *Equisetum*, *Pteris*.
3. Study from permanent slides: *Psilotum* (T.S. of synangium), *Lycopodium* (L.S. of strobilus), *Ophioglossum* (L.S. of spike), *Dryopteris* (gametophyte), *Marsilea* (L.S. of sporocarp).

**GYMNOSPERMS**

1. Morphological study: *Cycas* (microsporophyll and megasporophyll), *Pinus* (female and male cone), *Gnetum* (female and male cone).
2. Study from permanent slides: *Cycas* (L.S. of ovule), *Pinus* (L.S. of male and female cone), *Ginkgo* (L.S. of female strobilus), *Gnetum* (L.S. of male cone and ovule).

**FIELD STUDY**

Botanical excursion to familiarize the students with the natural habitats of these groups is desirable. No individual collection should be allowed. Students should submit only photographs in their field report.

**SEMESTER- III**  
**CORE COURSE-5**  
**PALAEOBOTANY AND PALYNOLOGY (BOT-A-CC-3-5-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

**PALAEOBOTANY & PALYNOLOGY**

**1. Geological time scale with dominant plant groups through ages.**

.....4 lectures

**2. Plant Fossil:**

2.1. Types: Body fossil (Micro- and Megafossils), Trace fossil, Chemical fossil, Index fossil, 2.2. Different modes of preservation (Schopf, 1975), 2.3. Conditions favouring fossilization, 2.4. Nomenclature and Reconstruction, 2.5. Principle of fossil dating (a brief idea), 2.6. Importance of fossil study.

.....12 lectures

**3. Fossil Pteridophytes:**

Structural features, Geological distribution and Evolutionary significance of 3.1. *Rhynia*, 3.2. *Lepidodendron* (Reconstructed), 3.3. *Calamites* (Reconstructed).

.....10 lectures

**4. Fossil gymnosperms:**

Structural features and Geological distribution of reconstructed genera: 4.1. *Lyginopteris*, 4.2. *Williamsonia*, 4.3. *Cordaites*.

.....10 lectures

**5. Indian Gondwana System** - Three fold division with major megafossil assemblages.

.....6 lectures

**6. Palynology:**

6.1. Spore and Pollen, 6.2. Pollen aperture types, 6.3. NPC classification (Erdtman). 6.4. Pollen wall- Sporopollenin, Stratification and Ornamentation (sculpturing).

.....10 lectures

**7. Applied Palynology:**

Basic concepts of: 7.1. Palaeopalynology, 7.2. Aeropalynology, 7.3. Forensic palynology, 7.4. Melissopalynology.

.....8 lectures



**PRACTICAL- PALAEOBOTANY AND PALYNOLOGY (BOT-A-CC-3-5-P)**  
**(Credits 2)**

1. Study from permanent preparations
2. Identification with reasons
3. Classroom performance: (Lab records)
4. Viva

**PALAEOBOTANY AND PALYNOLOGY**

1. Morphological study: *Ptilophyllum* and *Glossopteris* leaf fossils.
2. Study from permanent slides: T.S. of stem of *Rhynia*, *Lepidodendron*, *Calamites*, *Lyginopteris*, *Cordaites*.
3. Study of Pollen types (colpate, porate and colporate) from permanent slides.  
Slides may be prepared from specimens: Colpate (*Leonurus sibiricus*/ *Brassica* sp.), Porate (*Hibiscus rosa-sinensis*), Colporate (*Cassia sophera*/ *C. tora*).

**CLASSROOM PERFORMANCE**

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.

**CORE COURSE- 6**  
**REPRODUCTIVE BIOLOGY OF ANGIOSPERMS (BOT-A-CC-3-6-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

**MORPHOLOGY OF ANGIOSPERMS**

1. Inflorescence types with examples.  
.....8 lectures
2. Flower, induction of flowering, flower development- genetic and molecular aspects.  
.....14 lectures
3. Fruits and seeds - types with examples.  
.....8 lectures

## **EMBRYOLOGY**

### **1. Pre-fertilisation changes :**

- 1.1. Microsporogenesis and Microgametogenesis, 1.2. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic).

.....6 lectures

### **2. Fertilisation:**

- 2.1. Pollen germination, 2.2. Pollen tube- growth, entry into ovule and discharge, 2.3. Double fertilization.

.....6 lectures

### **3. Post-fertilization changes :**

- 3.1. Embryogenesis in Capsella, 3.2. Development of Endosperm (3 types).

.....10 lectures

### **4. Apomixis & Polyembryony:**

- 4.1. Apomixis- Apospory and Apogamy, 4.2. Polyembryony- different types.

.....8 lectures

## **PRACTICAL- REPRODUCTIVE BIOLOGY OF ANGIOSPERMS (BOT-A-CC-3-6-P)**

**(Credits 2)**

1. Identification with reasons (Morphology)
2. Classroom performance: (Lab records)
3. Field Records (Field note book/ project work)
4. Viva

### **REPRODUCTIVE BIOLOGY OF ANGIOSPERMS**

1. Inflorescence types- study from fresh/ preserved specimens
2. Flowers- study of different types from fresh/ preserved specimens
3. Fruits- study from different types from fresh/preserved specimens
4. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous)
5. Field study desirable
6. A project supported along with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits.

### **CLASSROOM PERFORMANCE**

Same as above.

**CORE COURSE- 7**  
**PLANT SYSTEMATICS (BOT-A-CC-3-7-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

**TAXONOMY OF ANGIOSPERMS**

**1. Introduction:**

1.1. Components of Systematic: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases - Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega- taxonomy.

.....6 lectures

**2. Nomenclature:**

Type method, Publication, Rank of taxa, Rules of priority, Retention and rejection of names, Author Citation, Effective and valid publication, Elementary knowledge of ICN- Principles.

.....6 lectures

**3. Systems of classification:**

Broad outline of Bentham & Hooker (1862-1883), Cronquist (1988), Takhtajan (1991) - system of classification with merits and demerits. Brief reference of angiosperm phylogeny group (APG III) classification.

3.1. Systematics in Practice: Herbaria and Botanical Gardens – their role in teaching and research; important Herbaria and Botanical Gardens of India and world (3 each); 3.2. Dichotomous keys – indented and bracketed.

.....20 lectures

**4. Phenetics and Cladistics:**

Brief idea on Phenetics, Numerical taxonomy- methods and significance; Cladistics- construction of dendrogram and primary analysis; Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy.

.....8 lectures

**5. Data sources in Taxonomy:**

Supportive evidences from: 5.1. Phytochemistry, 5.2. Cytology, 5.3. Palynology and 5.4. Molecular biology data (Protein and Nucleic acid homology).

.....8 lectures

6. Diagnostic features, Systematic position (Bentham & Hooker and Cronquist), Economically important plants (parts used and uses) of the following families:

6.1. Monocotyledons: Alismataceae, Gramineae (Poaceae), Cyperaceae, Palmae (Arecaceae), Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Orchidaceae.

6.2. Dicotyledons: Nymphaeaceae, Magnoliaceae, Leguminosae (subfamilies), Polygonaceae, Euphorbiaceae, Malvaceae, Umbelliferae (Apiaceae), Labiatae (Lamiaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Compositae (Asteraceae).

.....12 lectures

### **PRACTICAL- PLANT SYSTEMATICS (BOT-A-CC-3-7-P)** **(Credits 2)**

1. Workout on Angiosperms
2. Spot Identification
3. Classroom performance: (Lab records)
4. Field Records (Field note book, Herbarium specimens)
5. Viva

### **ANGIOSPERMS**

1. Work out, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants and systematic position according to Bentham Hooker system of classification from the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.
2. Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided).

### **FIELD WORK**

At least three excursions including one excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and Central National Herbarium (CNH).

### **FIELD RECORDS**

1. Field Note Book (authenticated) with field notes on the plants of the area of excursion and

voucher specimen book.

**2. Herbarium specimen: Preparation of 25 angiospermic specimens (identified with author citation, voucher number and arranged following Bentham & Hooker's system of classification) to be submitted during examination.**

## **CLASSROOM PERFORMANCE**

Same as above.

**SEMESTER IV  
CORE COURSE-8  
PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION (BOT-A-CC-4-8-TH)  
THEORETICAL  
(Credits 4, Lectures 60)**

### **PLANT GEOGRAPHY**

#### **1. Phytogeographical regions:**

1.1. Phytogeographical regions of India (Chatterjee 1960); 1.2. Dominant flora of Eastern Himalaya, Western Himalaya and Sunderban.

.....8 lectures

#### **2. Endemism:**

2.1 Endemic types and Factors; 2.2. Age & Area hypothesis and Epibiotic theory; 2.3. Endemism in Indian flora.

.....6 lectures

### **ECOLOGY**

#### **1. Preliminary idea on:**

1.1. Habitat and Niche, 1.2. Ecotone and edge-effect, 1.3. Microclimate, 1.4. Ecads, ecotype and ecoclines, 1.5. Carrying capacity.

.....4 lectures

#### **2. Community ecology:**

2.1. Community- Characteristics and diversity, 2.2. Ecological succession –Primary and secondary, Seral stages (with reference to Hydrosere), autogenic and allogenic succession.

.....6 lectures

3.1. Plant indicators (metallophytes); 3.2. Phytoremediation.

.....4 lectures

#### **4. Conservation of Biodiversity:**

4.1. Level of Biodiversity: genetic, species & ecosystem diversity, 4.2. Biodiversity hot spots- criteria,

Indian hotspots, 4.3. *In-situ* and *ex-situ* conservation, 4.4. Seed-banks, 4.5. Cryopreservation  
.....16 lectures

## **EVOLUTION**

1.1 Introduction, 1.2. Theories of evolution: Natural selection, Group selection, Neutral theory of molecular evolution, 1.3. Phyletic gradualism, Punctuated equilibrium and Stasis  
.....6 lectures

2.1 Brief idea on: Stabilizing directional, disruptive and sexual selection; Speciation: Sympatric and allopatric speciation; Coevolution, Adaptive radiation, Reproductive isolation  
.....4 lectures

3.1. Simplified phylogeny of bacteria, algae, fungi, bryophyte, pteridophyte and gymnosperm, 3.2. Phylogenetic tree.  
.....6 lectures

## **PRACTICAL- PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION (BOT-A-CC-4-8-P) (Credits 2)**

1. Workout on ecological parameters
2. Classroom performance: (Lab records)
3. Field Records (Field note book of phytogeographical study and ecological study)
4. Viva

## **PLANT GEOGRAPHY**

1. Field visit- at least one long excursion at different phytogeographical region of India.
2. Study of local flora and submission of a project report highlighting phytogeographical characteristics of the region.

## **ECOLOGY**

1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/ field visit).
2. Comparative anatomical studies of leaves from polluted and less polluted areas.
3. Measurement of dissolved O<sub>2</sub> by azide modification of Winkler's method.
4. Comparison of free CO<sub>2</sub> from different sources.

**CORE COURSE- 9**  
**ECONOMIC BOTANY (BOT-A-CC-4-9-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

1. Origin of cultivated crops: Concepts of centre of origin, their importance with reference to Vavilov's work. Examples of major plant introductions; crop domestication and loss of genetic diversity; evolution of new crops/ varieties, importance of germplasm diversity.  
.....6 lectures
2. Cereals: Rice and wheat (origin, morphology, processing and uses).  
.....6 lectures
3. Legumes: Origin, morphology and uses of gram and mung bean. Importance to man and environment.  
.....6 lectures
4. Sugar and starches: Morphology and processing of sugarcane, products and byproducts of sugarcane industry. Potato- morphology, propagation and uses.  
.....5 lectures
5. Spices: Listing of important spices, their family and part used.  
.....6 lectures
6. Beverages: Tea (morphology, processing and uses).  
.....5 lectures
7. Oil and fats: General description, classification, extraction, their uses and health implications of mustard, soybean, coconut (Botanical name, family and uses). Essential oils- general account, extraction methods, comparison with fatty oils and their uses.  
.....10 lectures
8. Drug-yielding plants: Therapeutic and habit forming drugs with special reference to Cinchona, Digitalis, Papavar, Cannabis and Tobacco (morphology, processing, uses and health hazards).  
.....8 lectures
9. Timber: general account with special reference to Sal and Teak.  
.....4 lectures
10. Fibers: Cotton and Jute (Morphology, extraction and uses).  
.....4 lectures

**PRACTICAL- ECONOMIC BOTANY (BOT-A-CC-4-9-P)**  
**(Credits 2)**

1. Workout, micro-chemical tests
2. Identification- T.S./L.S. of permanent slides

3. Classroom performance: (Lab records, permanent slides)

4. Field visit desirable to give an idea about cultivation of any crop (viz. rice, jute, mustard, tea, potato)

5. Field record of the visit, properly authenticated by escorting teacher

### **ECONOMIC BOTANY**

1. Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests)
2. Legume: Soybean, ground nut (habit, fruit, seed structure, micro-chemical tests)
3. Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch grains, micro-chemical tests.
4. Tea- tea leaves, tests for tannin
5. Mustard- plant specimen, seeds, tests for fat in crushed seeds
6. Habit sketch of *Digitalis*, *Papaver* and *Cannabis*.
7. Sal, Teak- section of young stem.
8. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fibre following maceration technique.

**CORE COURSE 10**  
**GENETICS (BOT-A-CC-4-10-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

1. Introduction: Mendelian genetics and its extension

.....6 lectures

2. Linkage, Crossing over and Gene Mapping:

2.1. Complete and incomplete linkage (example), linked gene does not assort independently (example), linkage group, 2.2. Crossing over, crossing over produces recombination (example), detection of crossing over (McClintock's experiment), and 2.3. Molecular mechanism of crossing over (Holliday model), 2.4. Gene mapping with three point test cross, detection of middle gene in three point test cross, calculation of recombination frequencies, 2.5. Co-efficient of coincidence and



interference, mapping function, 2.6. Problems on gene mapping, 2.7. Molecular mapping – ISH, FISH (brief idea).

.....16 lectures

**3. Epistasis and Polygenic inheritance in plants.**

.....4 lectures

**4. Aneuploidy and Polyploidy:** Types, examples, meiotic behaviour and importance of: 4.1. Aneuploidy, 4.2. Polyploidy, 4.3. Speciation and evolution through polyploidy.

.....8 lectures

**5. Chromosomal aberration:** Types and meiotic behaviour of: 5.1. Deletion, 5.2. Duplication, 5.3. Translocation, and 5.4. Inversion.

.....6 lectures

**6. Mutation :**

6.1. Point mutation-Transition, Transversion and Frame shift mutation, 6.2. Molecular mechanisms (tautomerisation, alkylation, deamination, base analogue incorporation, dimerisation), 6.3. DNA repair (brief idea).

.....8 lectures

**7. Structural organisation of Gene:**

7.1. One Gene—one polypeptide concept, 7.2. Split gene, 7.3. Overlapping gene, 7.4. Repetitive DNA-tandem and interspersed, 7.5. Transposon (Ac-Ds system), 7.6. Homoeotic gene in plants (ABCE Quartet model of flowering).

.....12 lectures

### **PRACTICAL- GENETICS (BOT-A-CC-4-10-P)**

**(Credits 2)**

1. Genetics
2. Identification
3. Classroom performance (Laboratory Records and slides)
- 4 Viva- voce

### **GENETICS**

- 1. Introduction to chromosome preparation:** Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides.
- 2. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa*.**
- 3. Study of mitotic chromosome:** Metaphase chromosome preparation, free hand drawing under high power objective, drawing with drawing prism under oil immersion lens, determination of  $2n$  number, and comment on chromosome morphology of the following specimens from root tips:

*Allium cepa*, *Aloe vera*, *Lens esculenta*.

4. Study of chromosomal aberrations developed due to exposure to any two pollutants/ pesticides etc.
5. Study of meiotic chromosome: Smear preparation of meiotic cells, identification of different stages and free hand drawing of the following specimens from flower buds: *Allium cepa* and *Setcreasea* sp.
6. Identification from permanent slides : Meiosis – (i) normal stages (ii) abnormal stages – laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*); Mitosis – (i) normal stages, (ii) abnormal stages- early separation, late separation, multipolarity, sticky bridge, laggard, fragmentation, (ii) pollen mitosis.

## **SEMESTER V**

### **CORE COURSE- 11**

#### **CELL AND MOLECULAR BIOLOGY (BOT-A-CC-5-11-TH)**

#### **THEORETICAL**

**(Credits 4, Lectures 60)**

### **CELL BIOLOGY**

#### **1. Origin and Evolution of Cells:**

1.1. Evolution of nucleic acid (from PNA to DNA), Concept of RNA world, Ribozymes, First cell, 1.2. Origin of eukaryotic cell (endosymbiotic theory), 1.3. Small RNA- riboswitch, RNA interference, si RNA, mi RNA- brief idea, 1.4. Organellar DNA (cp- and mt- DNA).

.....6 lectures

#### **2. Nucleus and Chromosome:**

2.1. Nuclear envelope, Nuclear lamina and Nuclear pore complex, 2.2. Nucleolus-ultrastructure and ribosome biogenesis, 2.3. Chromatin ultrastructure and DNA packaging in eukaryotic chromosome, 2.4. Centromere: types, structure and function.

.....6 lectures

#### **3. Cell cycle and its regulation:**

3.1. Kinetochore and spindle apparatus-structural organization and functions, 3.2. Microtubules-structure, organization and function, 3.3. Mechanism of cell cycle control in Yeast (checkpoints and role of MPF), Apoptosis (Brief idea).

.....6 lectures

### **MOLECULAR BIOLOGY**

## **1. DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes):**

1.1. Central Dogma, 1.2. Semiconservative DNA replication – mechanism, enzymes involved in DNA replication- DNA polymerase, DNA gyrase, Helicase, Ligase, primase and other accessory proteins, 1.3. Eukaryotic replication with special reference to replication licensing factor, assembly of new nucleosome, replication at the end chromosome telomere, telomerase concept, 1.4. Fidelity of DNA replication- prokaryote: nucleotide selection, proof reading, mismatch repair; eukaryote: through selection of error prone DNA polymerase, 1.5. Transcription, 1.6 RNA processing, 1.7. Aminoacylation of tRNA, 1.8. Translation.

.....20 lectures

## **2. Gene Regulation:**

2.1 Concept of Lac-operon, 2.2. Positive and negative control.

.....4 lectures

## **3. Genetic Code:**

3.1 Properties-evidences & exceptions, 3.2. Decipherance of codon (Binding technique).

.....4 lectures

## **4. Recombinant DNA Technology:**

4.1. Restriction endonuclease, - types and roles, 4.2. Vector (plasmid pBR 322), 4.3. Marker gene, 4.4. Steps of cloning technique, 4.5. PCR and its application, 4.6. Genomic DNA and cDNA library.

.....10 lectures

5. Development and causes of Cancer (in general and brief), tumor suppressor gene and oncogene.

.....4 lectures

## **PRACTICAL- CELL BIOLOGY (BOT-A-CC-5-11-P) (Credits 2)**

1. Work out
2. Identification
3. Classroom performance (Laboratory Records and slides)
4. Preparation of models/charts
5. Viva-voce

## **CELL BIOLOGY**

1. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo*/*Crinum*
2. Measurement of cell size by the technique of micrometry.
3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains)
4. Cytochemical staining of DNA- Pyronine-methyl green staining.

5. Estimation of DNA content through DPA staining.
6. Estimation of RNA through orcinol method.
7. Study of nucleolus through hematoxylin/ orcin staining and determination of nucleolar frequency.
8. Preparation of models/ charts: rolling circle, theta replication, semi-discontinuous replication, prokaryotic RNA polymerase and eukaryotic RNA polymerase II, assembly of spliceosome machinery, splicing mechanism in group I and group II introns, ribozyme and alternative splicing.

**CORE COURSE- 12**  
**BIOCHEMISTRY (BOT-A-CC-5-12-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

**1. Biochemical Foundations:**

1.1. Covalent and non-covalent bonds; hydrogen bond; Van der Waal's forces; 1.2. Structure and properties of water; 1.3. pH and buffer ( inorganic and organic ); 1.4. Henderson-Hasselbalch equation; 1.5. Isoelectric point.

.....6 lectures

**2. Molecules of life:**

2.1. Nucleic Acids – structure of nucleosides and nucleotides ; oligo- and poly nucleotides , B & Z form of DNA, RNA- different forms; nucleotide derivatives (ATP, NADP), 2.2. Proteins – structure and classification of amino acids; primary, secondary, tertiary and quaternary structure of proteins; 2.3. Carbohydrates - structure of mono-, di- and polysaccharide; stereoisomers, enantiomers and epimers; 2.4. Lipids - structure of simple lipid and compound lipid (phospholipids and glycolipids), fatty acids- saturated and unsaturated.

.....24 lectures

**3. Energy flow and enzymology:**

3.1. Bioenergetics-Thermodynamic principles; free energy; energy rich bonds- phosphoryl group transfer and ATP; redox potentials and Biological redox reactions, 3.2. Enzymes – classification and nomenclature (IUBMB); Co-factors and co-enzymes; isozymes, 3.3. Mechanism of enzyme action; enzyme inhibition; 3.4. Enzyme kinetics (Michaelis- Menten equation) and simple problems.

.....18 lectures

**4. Cell membrane:**

4.1. Membrane chemistry, 4.2. Membrane transport (uniport, symport, antiport), mechanism of ion

uptake.

.....6 lectures

**5. Phosphorylation:** ATP Synthesis- Chemiosmotic model, Oxidative and Photophosphorylation- Mechanism and differences.

.....6 lectures

**PRACTICAL- BIOCHEMISTRY (BOT-A-CC-5-12-P)**  
**(Credits 2)**

1. Workout on Plant Biochemistry (Quantitative & Qualitative)
2. Classroom performance (Laboratory Records and slides)
3. Viva

**PLANT BIOCHEMISTRY**

**Qualitative:**

1. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples.
2. Detection of carbohydrate and protein from plant samples.
3. Detection of the nature of carbohydrate – glucose, fructose , sucrose and starch from laboratory samples.
4. Detection of Ca, Mg, Fe, S from plant ash sample.

**Quantitative:**

1. Preparation of solutions and buffers.
2. Estimation of amino-nitrogen by formol titration method (glycine) .
3. Estimation of glucose by Benedicts quantitative reagent.
4. Estimation of titratable acidity from lemon.
5. Estimation of catalase activity in plant samples and effect of substrate, enzyme concentration and pH on enzyme activity.
6. Estimation of urease activity in plant samples.
7. Colorimetric estimation of protein by Folin phenol reagent.

**SEMESTER VI**  
**CORE COURSE-13**  
**PLANT PHYSIOLOGY (BOT-A-CC-6-13-TH)**  
**THEORETICAL (Credits 4, Lectures 60)**

**1. Plant-water relations:**

1.1 Concept of water potential, components of water potential in plant system, 1.2. Soil-plant-Atmosphere continuum concept, Cavitation in xylem and embolism, 1.3. Stomatal physiology-mechanism of opening and closing, Role of carbon di-oxide, potassium ion, abscisic acid and blue light in stomatal movement, Antitranspirants.

.....6 lectures

**2. Mineral nutrition:** essential and beneficial elements, macro- and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

.....6 lectures

**3. Organic Translocation:**

3.1. Phloem sap, P-protein, 3.2. Phloem loading and unloading, 3.3. Mass-flow (pressure flow) hypothesis and its critical evaluation.

.....6 lectures

**4. Plant Growth Regulators:**

4.1. Physiological roles of Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene, 4.2. Chemical nature – IAA, GA<sub>3</sub>, Kinetin, 4.3. Biosynthesis and bioassay of IAA, 4.4. Mode of action of IAA, 4.5. Brassinosteroids and Polyamines as PGRs (brief idea).

.....18 lectures

**5. Photomorphogenesis:**

5.1. Concept of photomorphogenesis, 5.2. Photoperiodism and plant types, 5.3. Perception of photoperiodic stimulus, 5.4. Critical day length, concept of light monitoring, 5.5. Phytochrome, cryptochrome and phototropins- chemical nature and role in photomorphogenesis, 5.6. Role of GA in flowering, 5.7. Vernalisation – role of low temperature in flowering, 5.8. Concept of biological clock and biorhythm.

.....12 lectures

**6. Seed dormancy:** 6.1. Types, Causes and Methods of breaking seed dormancy, 6.2. Biochemistry of seed germination.

.....6 lectures

**7. Physiology of Senescence and Ageing.**

.....6 lectures

**PRACTICAL- PLANT PHYSIOLOGY (BOT-A-CC-6-13-P)**  
**(Credits 2)**

1. Plant Physiology
2. Classroom performance (Laboratory records)
3. Viva- voce

**PLANT PHYSIOLOGY**

1. Determination of loss of water per stoma per hour.
2. Relationship between transpiration and evaporation.
3. Measurement of osmotic pressure of storage tissue by weighing method.
4. Measurement of osmotic pressure of *Rhoeo* leaf by plasmolytic method.
5. Effect of temperature on absorption of water by storage tissue and determination of  $Q_{10}$ .
6. Rate of imbibition of water by starchy, proteinaceous and fatty seeds and effect of seed coat.
7. To study the phenomenon of seed germination (effect of light).
8. To study the induction of amylase activity in germinating grains.
9. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA bioassay)

**CORE COURSE 14**  
**PLANT METABOLISM (BOT-A-CC-6-14-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

1. Concept of metabolism: Introduction, Anabolic and catabolic metabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and isozymes)

.....4 lectures

**2. Photosynthesis:**

2.1. Chemical structure of chlorophyll a and b, absorption and action spectra, biological significance of carotenoid pigments, 2.2. Red drop and Emerson effect, Components of photosystems (light harvesting complex), photochemical reaction centres, Cyclic and noncyclic electron transport, Water splitting mechanism, 2.3. Calvin cycle – Biochemical reactions & stoichiometry, 2.4. HSK Pathway– three variants of the pathway, 2.5. Photosynthetic efficiency of  $C_3$  and  $C_4$  plants and crop

productivity, 2.6. Photorespiration – mechanism and significance, 2.7. Crassulacean Acid Metabolism– mechanism and ecological significance.

.....16 lectures

### **3. Respiration:**

3.1. EMP pathway, regulation and its anabolic role, 3.2. Conversion of Pyruvic acid to Acetyl CoA, 3.3. TCA-cycle and its amphibolic role, 3.4. Oxidative pentose phosphate pathway and its significance, 3.5. Mitochondrial electron transport system, uncouplers, 3.6. Oxidation of cytosolic  $\text{NADH} + \text{H}^+$ , 3.7. Stoichiometry of glucose oxidation (aerobic).

.....12 lectures

### **4. Nitrogen Metabolism:**

4.1. Assimilation of nitrate by plants, 4.2. Biochemistry of dinitrogen fixation in Rhizobium, 4.3. General principle of amino acid biosynthesis (including GS and GOGAT enzyme system).

.....10 lectures

### **5. Lipid metabolism:**

5.1. synthesis and breakdown of triglycerides,  $\beta$ -oxidation, glyoxalate cycle, gluconeogenesis and its role in mobilization of the lipids during seed germinations,  $\alpha$ - oxidation.

.....8 lectures

6. Mechanism of signal transduction: receptor-ligand interactions, second messenger concept, calcium-calmodulin, G protein, MAP-kinase cascade.

.....10 lectures

## **PRACTICAL- PLANT METABOLISM (BOT-A-CC-6-14-P)** **(Credits 2)**

1. Workout on Plant metabolism
2. Classroom performance (Laboratory Records)
3. Viva

### **PLANT METABOLISM**

1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography.
2. Separation of plastidial pigments by solvent and paper chromatography.
3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method.



4. Effect of  $\text{HCO}_3$  concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting).
5. Measurement of oxygen uptake by respiring tissue (per g/hr.)
- 6.. Determination of the RQ of germinating seeds.
7. Test of seed viability by TTC method.

### **SKILL ENHANCEMENT COURSE- ELECTIVE (SEC)**

#### **SEC-A**

#### **APPLIED PHYCOLOGY, MYCOLOGY AND MICROBIOLOGY (BOT-A-SEC-A-3-1)**

##### **THEORETICAL**

**(Credits 2, Lectures 30)**

#### **APPLIED PHYCOLOGY**

1. Algae as food and source of phycocolloid (Agar-agar, Algin, Carrageenan), 2. Diatomite, 3. Algal toxin, 4. Algal Biotechnology – potential of microalgae for SCP,  $\beta$ -carotene, Biodiesel, bioplastics from algae.

.....10 lectures

#### **APPLIED MYCOLOGY**

1. Fungi as food, 2. Cheese and Ethanol- Industrial production (brief outline), 3. Fungal sources and uses of Enzyme (Cellulase), Amino acid (Tryptophan), Vitamin (Riboflavin), Antibiotic (Griseofulvin), Pharmaceuticals (Cyclosporin-A). 4. Aflatoxin

.....10 lectures

#### **APPLIED MICROBIOLOGY**

1. Industrial Production of Vinegar and Streptomycin (brief outline), 2. Microbial sources and uses of Enzyme (Amylase, Protease), Amino acid (Glutamic acid, Lysine), Polysaccharides (Dextran), 3. Use of microbes as Biofertilizer and Biopesticides, 3.4. Use of microbes in mineral processing.

.....10 lectures

### **BIOFERTILIZERS (BOT-A-SEC-A-3-2)**

#### **THEORETICAL**

**(Credits 2, Lectures 30)**

1. General account about the microbes used as biofertilizers- *Rhizobium*- isolation, identification, mass multiplication, carrier based inoculants, actinorrhizal symbiosis.
2. *Azospirillum*: isolation and mass multiplication- carrier based inoculants, associative effect of different microorganisms.

.....4 lectures

.....4 lectures

3. **Azotobacter:** classification, characteristics- crop response to *Azetobacter* inoculants, maintenance and mass multiplication.  
.....4 lectures
4. Cyanobacteria (Blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation. Factors affecting growth, blue green algae and *Azolla* in rice cultivation.  
.....4 lectures
5. *Mycorrhizal* association, types of mycorrhizal association, phosphorus nutrition, growth and yield- colonisation of VAM – isolation and inoculum production of VAM and its influence on growth and yield of crop plants.  
.....8 lectures
6. **Organic farming-** green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and industrial wastes- biocompost making methods, types and methods of vermicomposting- field application.  
.....6 lectures

**SEC-B**  
**PLANT BREEDING (BOT-A-SEC-B-4-3)**  
**THEORITICAL**  
**(Credits 2, Lectures 30)**

1. **Plant breeding:** introduction and objectives, breeding systems- modes of reproduction in crop plants, important achievements and undesirable consequence of plant breeding.  
.....4 lectures
2. **Methods of crop improvement:** Introduction- centres of origin and domestication of crop plants, plant genetics resources; acclimatization, selection methods- for self pollination, cross pollinated and vegetatively propagated plants, hybridization- for self, cross and vegetatively propagated plants, procedure, advantages and limitations.  
.....6 lectures
3. Maintenance of germplasm, 3.1. Mass selections and Pure line selection, 3.2. Back cross method.  
.....6 lectures
4. Heterosis and hybrid seed production, 4.1. Male sterility and its use in plant breeding.  
.....2 lectures
5. Inbreeding and inbreeding depression, effect of outcrossing- a very brief idea.  
.....4 lectures
6. Molecular Breeding (use of DNA markers in plant breeding).  
.....2 lectures
7. Role of mutations, polyploidy, distant hybridization and role of biotechnology in crop improvements.  
.....6 lectures

## MUSHROOM CULTURE TECHNOLOGY (BOT-A-SEC-B-4-4)

### THEORETICAL

(Credits 2, Lecture 30)

1. Introduction, nutritional and medicinal value of edible mushrooms; poisonous mushrooms, types of edible mushrooms available in India- *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

.....5 lectures

2. **Cultivation technology:** infrastructure: substrates (locally available), polythene bags, vessels, inoculation hook, inoculation loop, low cost stoves, sieves, culture racks, mushroom unit (thatched house), water sprayer, tray, small polythene bag. Pure culture: medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation- paddy straw, sugarcane trash, maize straw, banana leaves,. Factors affecting the mushroom bed preparation- low cost technology, composting technology in mushroom production.

.....12 lectures

3. **Storage and nutrition:** short term storage (Refrigeration- upto 24 hours), long term storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition- proteins- amino acids, mineral elements nutrition- carbohydrates, crude fibre content- vitamins.

.....8 lectures

4. **Food preparation:** type of foods prepared from mushroom. Research centres- National level and regional level. Cost benefit ratio- marketing in India and abroad. Export value.

.....5 lectures

## DISCIPLINE SPECIFIC ELECTIVE COURSES

### DSE-A

#### BIOSTATISTICS (BOT-A-DSE-A-5-1-TH)

### THEORETICAL

(Credits 4, Lectures 60)

1. **Biostatistics:** Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics.

.....12 lectures

2. **Biometry:** Data, Sample, Population, Random sampling, Frequency distribution- definition only.

.....12 lectures

3. **Central tendency**– Arithmetic Mean, Mode and Median; Measurement of dispersion–

Coefficient of variation, Standard Deviation, Standard error of Mean.

.....10 lectures

- 4. Test of significance:** chi- square test for goodness of fit.

.....6 lectures

- 5. Probability-** multiplicative and additive rules of probability: application and importance.

.....6 lectures

- 6. Measurement of gene frequency:** Hardy-Weinberg equilibrium- conditions applied for its implications (simple problems to calculate genotypic and allelic frequencies).

.....14 lectures

### **PRACTICAL- BIOSTATISTICS (BOT-A-DSE-A-5-1-P)**

**(Credits 2)**

1. Workout
2. Classroom performance (Laboratory Records)
3. Viva

### **BIOSTATISTICS**

1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size).
2. Calculation of correlation coefficient values and finding out the probability.
3. Determination of goodness of fit in Mendellian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance.
4. Calculation of 'F' value and finding out the probability value for the F value
5. Basic idea of computer programme for statistical analysis of correlation coefficient, 't' test, standard error, standard deviation.

### **INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY (BOT-A-DSE-A-5-2-TH)**

#### **THEORETICAL**

**(Credits 4, Lectures 60)**

1. Scope of microbes in industry and environment.

.....6 lectures

2. Bioreactors/ Fermenters and fermentation process: solid- state and liquid-state (stationary and submerged) fermentations; batch and continuous fermentations. Components of a typical

bioreactors, types of bioreactors- laboratory, pilot scale and production fermenters. Constantly stirred fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air- lift Fermenter.

.....12 lectures

3. Microbial production of industrial products: microorganisms involved, media, fermentation conditions, down stream processing and uses; filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, liophilisation, spray drying, hands on microbial fermentations for the production and estimation of enzymes amylase or lipase activity, organic acids (citric or glutamic acid), alcohol (ethanol) and antibiotic (Penicillin).

.....12 lectures

4. Microbial enzymes of industrial interest and enzyme immobilization: microorganisms for industrial applications. Methods of immobilization, advantages and applications of immobilization, large scale application of immobilized enzymes (glucose isomerase and penicillin acylase).

.....8 lectures

5. Microbes and quality of environment: distribution of microbes in air, isolation of microorganisms from soil, air and water.

.....8 lectures

6. Microbial flora of water: water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD of water samples. Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

.....8 lectures

7. Microbes in agriculture and remediation of contaminated soils: biological fixation, mycorrhizae, bioremediation of contaminated soils, isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

.....8 lectures

### **PRACTICAL- INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY (BOT-A-DSE-A-5-2-P)** **(Credits 2)**

1. Workout
2. Classroom performance (Laboratory Records)
3. Viva

### **INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY**

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Preparation of slant, stab and pouring petriplate.

4. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

**MEDICINAL AND ETHNOBOTANY (BOT-A-DSE-A-6-3-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

**1. Medicinal botany:** History, scope and importance of medicinal plant, a brief idea about indigenous medicinal sciences- ayurveda, siddha and unani. Polyherbal formulations.

.....14 lectures

**2. Pharmacognosy-** General account :

2.1 Pharmacognosy and its importance in modern medicine, 2.2 Crude drugs, 2.3 Classification of drugs- chemical and pharmacological, 2.4 Drug evaluation– organoleptic, microscopic, chemical, physical and biological, 2.5. Major pharmacological groups of plant drugs and their uses.

.....12 lectures

**3. Secondary metabolites:**

3.1 Definition of secondary metabolites and difference with primary metabolites , 3.2 Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis (outlines only), 3.3 Major types–terpenoids, phenolics, flavonoids, alkaloids and their protective action against pathogenic microbes and herbivores.

.....14 lectures

**4. Pharmacologically active constituents:**

Source plants (one example) parts used and uses of: 3.1 Steroids (Solasodin, Diosgenin, Digitoxin), 3.2 Tannin (Catechin), 3.3 Resins (Gingerol, Curcuminoids), 3.4 Alkaloids (Quinine, Atropine. Pilocarpine, Strychnine, Reserpine, Vinblastine), 3.5. Phenols (Sennocide and Capsaicin).

.....4 lectures

**5. Ethnobotany and folk medicine:** Definition, methods of study, application, Indian scenario, national interacts, Palaeo-ethnobotany, folk medicines in ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India, application of natural products to certain diseases- Jaudice, cardiac, infertility, diabetics, blood pressure and skin diseases.

.....16 lectures

**PRACTICAL- MEDICINAL AND ETHNOBOTANY (BOT-A-DSE-A-6-3-P)**  
**(Credits 2)**

1. Workout and chemical tests

2. Classroom performance (Laboratory Records)
3. Viva

### **MEDICINAL AND ETHNOBOTANY**

1. Chemical tests for (a) Tannin (*Camellia sinensis* / *Terminalia chebula* ), (b) Alkaloid ( *Catharanthus roseus*) .
2. Powder microscopy – *Zingiber* and *Holarrhena* .
3. Histochemical tests of (a) Curcumin (*Curcuma longa*), (b) Starch in non-lignified vessel (*Zingiber*), (c) Alkaloid  
(stem of *Catharanthus* and bark of *Holarrhena* ).

### **STRESS BIOLOGY (BOT-A-DSE-A-6-4-TH)**

#### **THEORETICAL**

**(Credits 4, Lectures 60)**

1. Plant stress- definition. Acclimation and adaptation.  
.....2 lectures
2. Environmental factors- water stress, salinity stress and temperature stress- plant response. Pathogenesis- related (PR) proteins, systemic acquired resistance; mediation of insect and disease resistance by jasmonates.  
.....20 lectures
3. Stress sensing mechanism in plants: calcium modulation, phospholipid signaling.  
.....20 lectures
4. Developmental and physiological mechanisms that protect plants against environmental stress: adaptation of plants, changes in root-shoot ratios, aerenchyma development; osmotic adjustment, compatible solute production.  
.....12 lectures
5. Reactive oxygen species- production and scavenging mechanism.  
.....6 lectures

### **PRACTICAL- STRESS BIOLOGY (BOT-A-DSE-A-6-4-P)**

**(Credits 2)**

1. Workout
2. Classroom performance (Laboratory Records)
3. Viva

## **STRESS BIOLOGY**

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
2. Superoxide dismutase activity in the absence and presence of stress.
3. Catalase activity in the presence and absence of stress.
4. Comparative study of plants/seedlings subjected to different degree of stress/ pollutants.
5. To study the effect of stress (salt/ water/ heavy metal) on seed germination and seedling growth (any commonly available specimen)

### **DSE-B**

#### **PLANT BIOTECHNOLOGY (BOT-A-DSE-B-5-5-TH)**

#### **THEORETICAL**

**(Credits 4, Lectures 60)**

#### **1. Plant tissue culture –Introduction:**

- 1.1. Basic concept and milestones, 1.2. Cellular totipotency, 1.3. Tissue culture media, 1.4. Aseptic manipulation, 1.5. Cyto-differentiation and dedifferentiation.

.....10 lectures

#### **2. Callus culture:**

- 2.1. Callus induction, maintenance and application, 2.2. Suspension culture- introductory idea.

.....6 lectures

#### **3. Plant regeneration:**

- 3.1. Organogenesis (direct and indirect), 3.2. Somatic embryogenesis, 3.3. Significance of organogenesis and somatic embryogenesis, 3.4. Artificial seed.

.....8 lectures

#### **4. Haploid Culture:**

- 4.1. Anther and Pollen culture methods, 4.2. Applications.

.....6 lectures

#### **5. Protoplast Culture:**

- 5.1. Protoplast isolation and culture, 5.2. Protoplast fusion (somatic hybridization), 5.3. Significance.

.....6 lectures

#### **6. Plant Genetic Engineering:**

- 6.1. Brief concept of different gene transfer methods, special emphasis on *Agrobacterium* mediated gene transfer, Role of Reporter gene, 6.2. Achievements in crop biotechnology,



environment and industry (suitable example)- pest resistant plants (BT cotton), herbicide resistance, disease and stress tolerance, transgenic crop with improved quality (flavr tomato, golden rice), role of transgenic in population degradation (super-bug), leaching of minerals, production of industrial enzymes, oil, edible vaccine.

.....24 lectures

**PRACTICAL- PLANT BIOTECHNOLOGY (BOT-A-DSE-B-5-5-P)**  
**(Credits 2)**

1. Field report on a visit to a tissue culture lab.
2. Classroom performance (Laboratory Records, charts/ models)
3. Viva

**PLANT BIOTECHNOLOGY**

1. Familiarization of basic equipments in plant tissue culture
2. Study through photographs/ charts/ models of anther culture, somatic embryogenesis, endosperm and embryo culture, micropropagation.
3. Preparation of basal media. Sterilization techniques.
4. Demonstration of any tissue culture technique during visit in a plant tissue culture lab.

**DSE B**

**HORTICULTURAL PRACTICES AND POST- HARVEST TECHNOLOGY (BOT-A-DSE-B-5-6-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

1. **Horticulture** –scope, importance and branches. Role in rural economy and employment generation; importance in food and nutritional security; urban horticulture and ecotourism.

.....4 lectures

2. **Ornamental plants:** types, classifications (annuals, perennials, climbers and trees), identification and salient features of some ornamental plants (rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulants). Ornamental flowering trees (Indian laburnum, gulmohor, jacaranda, Lagerostoemia, fishtail and Erica palms, simul, coral tree).

.....4 lectures

3. **Fruit and vegetable crops:** production, origin and distribution; description of plants and their

economic products; management and marketing of vegetables and fruit crops; identification of some fruits and some vegetables varieties (citrus, banana, mango, chillis and cucurbits).

.....4 lectures

4. **Horticultural techniques:** application manures, fertilizers, nutrients and PGRs; weed controls, biofertilizers, biopesticides, irrigation methods. Hydroponics, propagation methods; vegetative (grafting, cutting, layering, budding), sexual (seed production), scope and limitations.

.....8 lectures

5. Landscaping and garden designing: planning and lay out (parks and gardens).

.....6 lectures

6. **Floriculture:** cut flowers, bonsai, commerce (market demand and supply), importance of flower shows and exhibitions.

.....6 lectures

7. **Post harvest technology:** Importance of post harvest technology in horticultural crops, evaluation of quality, traits; harvesting and handling of fruits, vegetables, cut flower; principles, methods of preservation and processing, methods of minimizing losses during storage and transportation; food irradiation- advantages and disadvantages; food safety.

.....10 lectures

8. **Disease control and management:** field and post harvest diseases, identification of deficiency symptoms, remedial measures and nutritional management practices; crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); quarantine practices; identification of common diseases and pest of ornamental fruits and vegetable crops.

.....8 lectures

9. **Horticultural crops-** conservation and management: documentation and conservation of germplasm. Role of micropropagation and tissue culture techniques; varieties and cultivars of various horticultural crops; IPR issues, national international and professional societies and sources of information on horticulture.

.....10 lectures

**PRACTICAL- HORTICULTURAL PRACTICES AND POST- HARVEST TECHNOLOGY (BOT-A-DSE-B-5-6-P)**  
**(Credits 2)**

Field trip- field visits to gardens, standing crop sites, nurseries, vegetable gardens, horticultural fields at IARI/AHSI or other suitable locations and if possible to cold storage.

## **RESEARCH METHODOLOGY (BOT-A-DSE-B-6-7-TH)**

### **THEORETICAL**

**(Credits 4, Lectures 60)**

1. Basic concepts of research: research- definition and types of research (Descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical), research methods vs. methodology; literature- review and its consolidation; library research; field research; laboratory research.

.....10 lectures

2. General laboratory techniques: common calculations in botany laboratories; understanding the details on the label of reagent bottles; molarity and normality of common amino acids and bases; preparation of solutions. Dilution, percentage, molar, molal and normal solutions. Techniques of handling micropipettes; knowledge about common toxic chemicals and safety measures in their handling.

.....12 lectures

3. Data collection and documentation of observations. Maintaining of laboratory records, tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

.....6 lectures

4. Overview of biological problems: plant science research key areas, model organisms in research.

.....6 lectures

5. Methods to study plant cells/ tissue structure: whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning, tissue preparation- fixation, dehydration etc., paraffin and plastic infiltration, preparation of thin and ultra-thin sections.

.....6 lectures

6. Plant micro-techniques: staining procedures, classification and chemistry of stains, staining equipments. Cytogenetic techniques with squashed plant materials.

.....12 lectures

7. The art of scientific writing and its presentation: numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power point presentation. Poster presentation. Scientific writing ethics. Introduction to copy write- academic misconduct/ plagiarism.

.....8 lectures

## **PRACTICAL- RESEARCH METHODOLOGY (BOT-A-DSE-B-6-7-P)**

**(Credits 2)**

1. Experiments based on calculations
2. Plant microtechnique experiments

3. The art of imaging of samples through photomicrography and field photography
4. Poster/ power point presentation on defined topics
5. Technical writing on topics assigned.

## **Natural resource management (BOT-A-DSE-B-6-8-TH)**

### **THEORETICAL**

**(Credits 4, Lectures 60)**

#### **Unit 1: Natural resources**

Definition and types.

..... 2 lectures

#### **Unit 2: Sustainable utilization**

Concept, approaches (economic, ecological and socio-cultural).

..... 8 lectures

#### **Unit 3: Land**

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

..... 8 lectures

#### **Unit 4: Water**

Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

..... 8 lectures

#### **Unit 5: Biological Resources**

Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

..... 12 lectures

#### **Unit 6: Forests**

Definition, Cover and its significance (with special reference to India); Major and minor Forest products; Depletion; Management.

..... 6 lectures

#### **Unit 7: Energy**

Renewable and non-renewable sources of energy.

..... 6 lectures

#### **Unit 8: Contemporary practices in resource management**

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

..... 8 lectures

#### **Unit 9: National and international efforts in resource management and conservation**

..... 4 lectures

**PRACTICAL- Natural resource management (BOT-A-DSE-B-6-8-P)**  
**(Credits 2)**

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Estimation of foliar dust deposition.
3. Determination of total solid in water (TDS)
4. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)
5. Estimation of organic carbon percentage present in soil sample.
6. Collection of data on forest cover of specific area.

## REFERENCES

### Suggested Readings

#### 1. General studies

1. Ganguli, H.C., Das, K.S.K. & Dutta, C.T. College Botany, Vol. I, latest Ed., New Central Book Agency
2. Ganguli, H.C. and Kar, A.K. College Botany, Vol. II, latest Ed., New Central Book Agency
3. Mukherjee, S. College Botany, Vol. III, latest Ed., New Central Book Agency
4. Uno, Storey & Moore, Principles of Botany, 2001, McGraw Hill.
5. Kenrick, P. & Crane, P. The Origin & early diversification of land plants (1997), Smithsonian Institution Press.
6. Bell, P.R. & Hensley, A.R. Green plants; their Origin & Diversity (2nd ed.), 2000, Cambridge University Press
7. Frenchel, T. The origin & early Evolution of life, 2002, Oxford University Press.
8. Hait, G., Ghosh, A. and Bhattacharya, K. A Text Book of Botany (Vols. I, II & III), 2007, New Central Book Agency
9. Lock, A.J., & Evans, D.E., Plant Biology, 2001, Viva Books
10. Chatterjee, T., Santra, S.C. and Das, A. Practical College Botany, New Central Book Agency

#### 2. Algae

1. Kumar, H.D. Introductory Phycology (2nd ed.), 1999, Affiliated East-West Press Pvt. Ltd.
2. Lee, R.E. Phycology (3rd ed.), 1999, Cambridge University Press
3. Vashishta, B.R., Sinha, A.K. & Singh, V.P. Algae (9th ed.), 2002, S. Chand & Company
4. Sambamurty, A.S.S. A text book of Algae, 2005, I.K. International Pvt. Ltd. 22
5. Graham, L.E. & Wilcox, L.W. Algae, 2000, Prentice Hall
6. Smith, G.M. Cryptogamic Botany, Vol. 1 (2nd ed.), 1955. McGraw Hill
7. Prescott, G.W. Algae: A Review: 1969 Bishen Singh Mahendra Pal Singh
8. Fritsch, F.E. The Structure & Reproduction of Algae, 1936, Vols. I & II, Cambridge University Press
9. Hoek, Van den. Algae, 1995, Cambridge University press
10. Laura De Basanti : Algae, 2004
11. Ray, S. (3rd ed.), Algal Biotechnology Biodiversity, 2010, New Central Book Agency
12. Sharma, O.P. Text Book of Algae, Tata McGraw Hill
13. Ray, S. Algae: Cyanobacteria (2006), New Age International (P) Ltd. Publishers

#### 3. Microbiology

1. Stainer, T.Y., Ingrahm, J.L., Wheelis, M.L. & Painter, P.R. General Microbiology (5th ed.), 1986, Macmillan Education Ltd.
2. Dubey, R.C. & Maheswari, D.K. A Text Book of Microbiology, 2005, S.Chand & Company
3. Case. Funke & Tortora, G.J. Microbiology, an Introduction (Latest Ed.)

4. Atlas, R.M. Principles of Microbiology, Latest Ed., McGraw Hill
5. Schlegel, H.G. General Microbiology, Latest Ed., Cambridge University Press
6. Prescott, L.M., Harley, P. & Klein, A. General Microbiology (5th ed.), 2002, WBC McGraw Hill
7. Sinleton, P. Bacteria; in Biology, Biotechnology and Medicine (5th ed.), 1999, John Wiley & Sons Ltd.
8. Jay, J.M. Modern Food Microbiology (5th ed.), 1996, Chapman & Hall
9. Madigan, M.T., Martinko, J.M. & Parker, J. Brock, Biology of Microorganuisms (10th ed.), 2003, Prentice Hall
10. Hull, R. Matthew Plant Virology (4th ed.), 2002, Academic Press
11. Biswas, S.B. & Biswas, A. An Introduction to Viruses (4th ed.), 1996, Vikas Publishing House
12. Agarwal, A.K. & Parihar, P. Industrial Microbiology, 2005, Agrobios (India)
13. Power, C.B. & Dagimawata, H.F. General Microbiology, Vol. I&II, Himalaya Publishing House
14. Mitchel, R. Environmental Microbiology, Latest Ed. Wiley, N.Y.
15. Sale, A.J. Fundamental Principles of Microbiology, Latest Ed., Tata McGraw Hill
16. Banerjee, A.K. & Banerjee, N. Microbiology & Immunology, 2006, new Central Book Agency
17. Prescott & Dunn. Industrial Microbiology
18. Verma, H.N. Basics of Plant Virology (2003), Oxford and IBH

#### **4. Fungi, Lichen & Plant Pathology**

1. Dubey, H.C. An Introduction to Fungi (2nd ed.), 1990, Vikas Publishing House 23
2. Webster, J. Introduction to Fungi (3rd ed.), Cambridge University Press
3. Alexopoulos, C.J., Mims, C.W. & Blackwell, M. Introductory Mycology (4th ed.), 1996, John Wiley & Sons
4. Hawksworth, D.L. Ainsworth & Bisby Dictionary of Fungi (8th ed.), 1995, Oxford University Press
5. Kavanagh, K. (ed.) Fungi, 2005, Wiley
6. Carlile, M.J., Witkinson, S.C. & Goodlay, G.W. The Fungi (2nd ed.), 2005, Academic Press
7. Arora, D. (ed.). Hand book of Fungal Biotechnology (2nd ed.), 2003, Dekker, N.Y.
8. Sharma, P.D. Fungi & Allied Organisms, 2005, Narosa Publishing House
9. Deacon, J.W. Fungal Biology, 2006, Black Well Science Ltd.
10. Ingold, C.T. & Hudson, H.J. The Biology of Fungi 96th ed.), 1993, Chapman & Hall
11. Sharma, O.P. Text book of Fungi, Tata McGraw Hill
12. Vashista, B.R. Fungi, Latesgt Ed., S. Chand & Company
13. Chopra, G.L. and Verma, V.A. Text Book of Fungi, Pradeep Publications
14. Liver, R. and Schweizer, M. Molecular Fungal Biology, 1999, Cambridge University Press
15. Dix, N.J. and Webster, J. Fungal Ecology, Chapman & Hall
16. Mehrotra, R.S. and Aneja, K.R. An Introduction to Mycology, Wiley Eastern Ltd.
17. Sharma, P.D. the Fungi, Rastogi Publication

18. Moore Landrecker, E. Fundamentals of the Fungi, Prentice Hall
19. Agrios, G.N. Plant Pathology (5th ed.), 2005, Elsevier, Academic Press
20. Mehrotra, R.S. & Agarwal, A. plant Pathology (2nd ed.), 2003, Tata McGraw Hill
21. Singh, R.S. Principles of Plant Pathology (4th ed.), 2002, oxford & IBH Publishing Com.
22. Manners, J.G. Principles of Plant Pathology (2nd ed.), 1993, Cambridge University Press
23. Trigiano et al. (ed.) Plant Pathology, Concepts and Laboratory exercises, 2004, CRC Press
24. Lucas John, A. Plant Pathology & Plant Pathogen, Oxford
25. Singh, R.S. Plant diseases, Oxford & IBH Publishing Com
26. Rangaswami, G.K. & Mahadevan, A. Diseases of Crop Plants in India, Prentice Hall
27. Dickinson, M. Molecular Plant Pathology, 2003, Bio-Scientific Publishers
28. Isaac, S. Fungal plant Interaction, 1992, Chapman & Hill
29. Bilgrami, K.S. and Dubey, H.C. A TextBook of Modern Plant Pathology, Vikas Publishing House
30. Sharma, P.D. Plant Pathology (2nd ed.), Rastogi Publications
31. Strange, R.N. (ed.) Introduction of plant Pathology, 2003, Wiley
32. Dube, H.C. An Introduction to Fungi (2005), Vikas Publishing House

## **5. Bryophytes**

1. Parihar, N.S. Introduction to Embryophyta (Vol. 1 Bryophyta), Central Book Distributors
2. Shaw, A. Jonathan and Goffinet Bernard, Bryophyte Biology, 2009, Cambridge university Press
3. Rashid, A. An Introduction to Bryophyta, 1998, Vikas Publishing House
4. Chopra, R.N. & Kumar, P.K. Biology of Bryophyta, Latest Ed., Wiley Eastern
5. Puri, P. Bryophyte, Latest Ed., Atmaram & Sons
6. Vashista, B.R. Bryophyta, Latest Ed., S. Chand & Company
7. Schofield, W.B. Introduction to Bryology, 201, Blackburn Press
8. Smith, A.J.E. (ed.), Bryophyte Ecology, 1982, Chapman & Hall
9. Vanderpoorten & Goffinet, B., Introduction to Bryophytes, 2009, Cambridge university Press

## **6. Palaeobotany and Palynology**

1. Stewart, W.N. & Rothwell, G.W. Palaeobotany & Evolution of Plants, Latest Ed., Cambridge university Press
2. Agashe, S.N. Palaeobotany, Latest Ed., Oxford & IBH
3. Thomas, B.A. & Spicer, R.A. The Evolution & Palaeobotany of Land Plants, Latest Ed., Croomhelm
4. Andrews, H.N. Studies in Palaeobotany, Latest., John Wiley & Sons
5. Meyen, S.V. Fundamentals of Palaeobotany, latest Ed., Chapman & Hill
6. Erdtman, G. pollen Morphology & Plant Taxonomy, Latest Ed., Lelden, E.G. Brill
7. Faegri, K. & Iversen, Text Book of Pollen Analysis, Latest Ed., Munksgor, Copenhagen



8. Nair, P.K. Pollen Morphology of Angiosperms, Latest Ed., Scholar Publications
9. Heslop- Harisson, Pollen: Development & Physiology, Latest Ed., Butterworth
10. Shivanne, K.H. Pollen Biology & Biotechnology, 2003, Oxford & IBH
11. Taylor, T.N. & Taylor, E. N. The Biology & Evolution of Fossil Plants, 1993, Prentice Hall.
12. Willis, K.J. & Mc Elwain, J.C. The Evolution of Plants, 2002, Oxford University Press.
13. Bhattacharya, K., Majumdar, M.R. & Gupta Bhattacharya, S. A Text Book of Palynology, 2006, New Central Book Agency.

## **7. Embryology**

1. Raghavan, V. Molecular Embryology of Flowering Plants, 1997, Camb. University Press.
2. Maheswari, P. An Introduction to Embryology of Angiosperm, Latest Ed., Tata McGraw Hill.
3. Raghavan, V. Embryogenesis in Angiosperms: A Development & Experimental Study, 1986, Cambridge University Press.
4. Bhojwan, S.S. & Bhatnagar, S.D. The Embryology of Angiosperms(4th ed.), 1989, Vikas Publishing House.
5. John, B.M.(ed.). Experimental Embryology of Vascular Plants, 1982, Springer, Heidelberg.
6. Westhaff, P. et al. Molecular Plant Development; From Gene to plant, 1998, Oxford University Press.

## **8. Pteridophytes**

1. Spore, K.R. The Morphology of Pteridophyte, Latest Ed. , Huchinson & Co. Ltd.
2. Rashid, A. An Introduction to Pteridophyta, Latest Ed., Vani Educational Books.
3. Vashista, P.C. Pteridophyta, Latest Ed., S. Chand & Company Pvt. Ltd.
4. Gifford, E. M. & Foster, A. S. Morphology & Evolution of Vascular Plants (3rd ed.), 1998, Freeman and Co.
5. Mukherjee, R.N. & Chakraborty, K.A. Introduction to Vascular Cryptogams (Pteridophyta) 1995, Kalyani Publications.
6. Parihar, N.S. The Biology & Morphology of Pteridophytes (2nd ed.), 1989, Central Book Distributors.

## **9. Gymnosperms**

1. Sporne, K.R. The Morphology of Gymnosperms, Latest Ed., Hutchinson &Co. Ltd.
2. Vashishta, P.C. Gymnosperm, Latest Ed., S. Chand & Company Pvt.
3. Karkar, R.K. & Karkar, R. The Gymnosperms, Latest Ed.
4. Bhatnagar, S.P. & p.Moitra, A.Gymnosperm, 1997, New Age International
5. Biswas, C. & Johri, P.M. The Gymnosperm, 1997, Narosa Publishing House
6. Dutta, S.C. An Introduction to Gymnosperms (3rd ed.), 1984, Kalyani Publishers
7. Gifford, E.M. and Foster, A.S. Morphology & Evolution of Vascular Plants (3rd ed.), 1989, Freeman & Co.
8. Norstag, J. & Nicholls. T.J. The Biology of the Cycads, 1997, Cornell University Press
9. Friedman, W.E. Biology & Evolution of the Gnetales, 1996, University of Chicago Press

## **10. Ecology & Plant Geography**

1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press
2. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.
3. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House
4. Begon, M., Herper, J.L. and Townsend, C.R. Ecology- Individuals, Populations and Communities (3rd ed.), Oxford Blackwell Science
5. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company
6. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders
7. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications
8. Ambasht, R.S. & Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors
9. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.
10. Mackenzie et al. Ecology, Latest Ed., Viva Books.
11. Gurevitch, J. (et al.), The Ecology of plants, 2002, Sinauer Associates.
12. Kimar, U. & Asija, M.J. Bio-diversity: Principles & Conservation, 2005, Student Edition, Agrobios (India)
13. Krishnamurthy, K.V. An Advanced Text Book on Biodiversity, 2003, Oxford & IBH Publishing Co. Ltd.
14. Mitra, D., Guha, J.K., Chowdhury, S.K. Studies in Botany, Vol. II (7th ed.) Moulik Library.
15. Primack, R.B. Essentials of Conservation Biology, 1993, Sinauer Associates.
16. Lo, C.P. & Yeung, A.K.W. Concepts and Techniques of Geographic Information Systems, 2002, Printice-Hall of India.
17. Cain, Bowman, Hacker. Ecology. 2014. 3rd Ed. Sinauer Associates

## **11. Evolution**

1. Futuyma., D. Evolution. 2015. (3rd Ed.) Sinauer Associates
2. Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece. Campbell Biology. 2017. 11th Ed. Pearson

## **12. Anatomy**

1. Fahn, A. Plant Anatomy (4th ed.), 1990, Wiley Eastern.
2. Mauseth, J. D. Plant Anatomy, Latest Ed., Benjamin Cummings Pub.
3. Metcalfe, C.P. & Chalk, L. Anatomy of Dicotyledons, Vol. I & II, London Press, Oxford
4. Dickison, W.C. Integrative Plant Anatomy, 2002, Academic Press
5. Eames, A.J. & Mac. Daniels, L.H. An Introduction to Plant Anatomy, Latest Ed., McGraw Hill
6. Esau, K. Anatomy of Seed Plants (2nd ed.), 1977, John Wiley & Sons
7. Cutter, E.G. Plant Anatomy: Experiment and Interpretations, Part I & II, Edward Arnold
8. Beck, C.B. An Introduction to plant Structure and Development (2nd ed.), Cambridge University Press

9. Howels, S.H. Molecular Genetics of Plant Development, 1998, Cambridge University Press
10. Pandey, B.P. Plant Anatomy, Latest Ed., S. Chand & Company
11. Tayal, M.S. Plant Anatomy, Latest Ed., Rastogi Publications
12. Roy, P. Plant Anatomy, Latest Ed., New Central Book Agency

### **13. Morphology and Taxonomy of Angiosperms**

1. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. Plant Systematics, A Phylogenetic Approach (4th ed.), 2016, Sinauer Associates, Inc.
2. Jones, S.B. and Luchsinger, A.E. Plant Systematics (2nd ed.), 1987, McGraw Hill Book Company
3. Singh, G. Plant Systematics: An Integrated Approach (3rd ed.), 2016, CRC Press
4. Sambamurthy, A.V.S.S. Taxonomy of Angiosperms, 2005, I.K. International Pvt. Ltd.
5. Sivarajan, V.V. Principles of Plant Taxonomy (2nd ed.), 1991, Oxford & IBH
6. Subrahmanyam, N.S. Modern Plant Taxonomy, Latest Ed., Vikas Publishing House
7. Naik, V.N. Taxonomy of Angiosperms, Latest Ed., Tata McGraw Hill
8. Stace, C. A Plant Taxonomy & Biosystematics, Latest Ed., Arnold Publishers
9. Mitra, J.N. An Introduction to Systematic Botany & Ecology, Latest Ed., World Press
10. Dutta, S.C. systematic Botany, Latest Ed., Wiley Eastern.
11. Lawrence, G.H.M. Taxonomy of Vascular Plants Ed., Oxford & IBH.
12. Prain, D. Bengal Plants (Vol I & II), Bishen Singh Mahendra Pal Singh.
13. Jeffrey, C. An Introduction to Plant Systematics, Latest Ed., Allied Publishers Pvt. Ltd.
14. Radford, A.B. Fundamentals of Plant Systematics, Latest Ed., Harper & Row.
15. Paria, N.D. and Chattopadhyay, S.P. Flora of Hazaribagh District, Bihar, 2000 & 2001, Vol I & II, BSI, Kolkata
16. Simpson, G. Plant Systematics, 2006, Springer.
17. Bhattacharya, B. Systematic Botany, 2006, Narosa Publishing House.
18. Heywood, V.H. Plant Taxonomy 1967, Edward Arnold, London.
19. Cronquist, A. The Evolution & Classification of Flowering Plant, 1988 (2nd ed.), New York Bot. Garden Bronx. New York.
20. Cronquist, A. An Integrated System of Classification of Flowering Plants. 1981. Bishen Singh Mahendra Pal Singh.
21. Subramanyam, N.S. Laboratory Manual of Plant Taxonomy (2nd ed.) 1999, Vikas Publishing House.
22. Mondal, A. Taxonomy: Advances Plant Taxonomy 2005, New Central Book Agency.
23. Heywood, V.H. Flowering Plants of the World 1978, Oxford University Press.

### **14. Biochemistry & Plant Physiology**

1. Taiz, L., & Zeiger, E. Plant Physiology (4th ed.), 2006, Sinauer Associates, Inc. Publishers.

2. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy. Plant Physiology and Development. (6th ed.) Sinauer Associates.
3. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
4. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.
5. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
6. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
7. Wilkins, M.B. Advances Plant Physiology. 1984, ELBS Longman.
8. Srivastava, L.M. Plant Growth and Development, 2001, Academy Press.
9. Davies P.J. (ed.) Plant Physiology: Physiology, Bio-Chemistry & Molecular Biology, Academic Press.
10. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
11. Hames, B.D. Bio-Chemistry (2nd ed.) Viva Books.
12. Sackheim, G. Chemistry for Biology Students (5th ed.) 1996, Benjamin/Cummings
13. Raman, H. Transport Phenomenon in Plants, 1997. Narosa Publishing House.
14. Heldt, Hans-Walter. Plant Bio-Chemistry (3rd ed.), 2005. Elsevier Academic Press.
15. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pthways 2008, New Central Book Agencies.
16. Mehta, S.L., Lodha, M.L. & Bane, P.V. Recent Advances in Plant Biochemistry, 1989. I.C.A.R.
17. Conn, E.E. and Stumpf, R.R. Outlines of Bio-Chemistry, Latest Ed., Wiley Eastern.
18. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
19. Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
20. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
21. Goodwin, T.W., & Mercer, E.I. Introduction to Plant Biochenistry, Latest Ed., Oxford Pergamon.
22. Berg, J.M., Tymoczko, J.L., & Stryer, L., Bio-Chemistry, Latest Ed., Freeman Publ.
23. Mekee, T. & Mekee, J.R. Bio-Chemistry: The Molecular Basis of Life, 2003, McGraw Hill.
24. Sinha, R.K. Modern Plant Physiology, 2004, Narosa Publishing House.
25. Srivastava, H.S. Plant Physiology (2nd ed.), 1998, Rastogi Publications.
26. Singhal, G.S. Concepts of Photobiology: Photosynthesis & Photomorphogenesis, 1999. Narosa Publishing House.
27. Hall. D.O. & Rao, K.K. photosynthesis (5th ed.), 1995, Cambridge University Press.
28. Buchanon, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.

## **15. Pharmacognosy**

1. Trease & Evans. Pharmacognosy, Saunders.
2. Taylor, V.E., Brady, L.R. and Robbers, J.E. Pharmacognosy, Ind. Ed. K.M. Vergese Co.
3. Wallis, T.E. Text Book of Pharmacognosy, Latest Ed., CBS Publishers & Distributors.
16. Cell Biology, Genetics & Molecular Biology
  1. Pierce, Benjamin A. Genetics (2nd ed.), 2005, W.H. Freeman & Company.
  2. Atherly, A.G., Girton, J.R. & McDonald, J.F. Science of Genetics, 1999, Saunders College Publications.
  3. Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. & Veres, R.C. Genetics (2nd ed.), 2004, McGraw Hill.
  4. Tamarin, Robert H. Principles of Genetic (7th ed., 2002, Tata McGraw Hill.
  5. Elrod, S.K. & Stanfield, W. Schuam's Outlines Genetics (4th ed.), 2002, Tata McGraw Hill.
  6. Hartl, D.L. & Jones, E.W. Genetics , 2005, Jones & Barlett Publishers.
  7. Lewin, B. Genes VIII, 2004, Pearson Educational International.
  8. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. Molecular Biology of the Gene (5th ed.) 2004. Pearson Education Inc.
  9. Griffiths, A.I.F., Miller, J.H., Suzuki, D.T., Lewentin, C.R. & Gilbert, M.W. An Intrduction to Genetic Analysis, 2005 (8th ed.), W.H. Freeman & Company.
  10. Brown, T.A. Genomes, 1999, John Wiley & Sons.
  11. Brown, T.A. Genomes 3, 2007, Garland Science Publishing.
  12. Snustad, D.P. & Simmons, M.J. Principles of Genetics (2nd ed.), 2000, (4th ed.), 2006, John Wiley & Sons.
  13. Klug, W.S. & Cummings, M.R. Concepts of Genetics, 2003, Pearson Education.
  14. Gerald Karp. Cell Biology. 2013. 7th Ed. International Student Version. Wiley.
  15. Hawkins, J.D. Gene Structure & Expression (3rd ed.), 1996, Cambridge University Press.
  16. Becker, M.W., Klemsmith, L.J. & Hardin, J. The World of the Cell (5th ed.), 2003, Pearson Education.
  17. Cooper, G.M. The Cell, A molecular approach (2nd ed.), 2000, ASM Press.
  18. Weaver, R.F. Molecular Biology (2nd ed./3rd ed.), 2002/2005, McGraw Hill.
  19. Malacinski, G.M. Freifelder, Essentials of Molecular Biology (4th ed.), 2003, Narosa Publishing House.
  20. Sambamurty, A.V.S.S. Genetics (2nd ed.), 2005, Narosa publishing House.
  21. Sharma, A. & Sen, S. Chromosome Botany, 2002, Oxford & IBH Publishing.
  22. Sen, S. & Kar, D.K. Cytology& Genetics, 2005, Narosa Publishing House.
  23. Miglani. G.S. Advanced Genetics, 2002, Naroas Publishing House.
  24. Gupta, P.K. Genetics, 2007, Rastogi Publications.
  25. De Robertis, E.D.P. & De Robertis, E.M.M, Cell & Molecular Biology (8th ed.), 1987, Informed Limited.
  26. Sharma, A.K. and Sharma, A. Chromosome Technique, 1980, Butterworth Publications.

27. Strickberg, M.W. Genetics, McMillan.
28. Jain, H.K. Genetics, 1999, Oxford & IBH Publishing Company.
29. Swanson, C.P., Merz, T. & Young, W.J. Cytogenetics, 1981, Prentice Hall.
30. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. Molecular Biology of the Cell, 2002 (4th ed.), Garland Sciences.
31. Gardner, E.J., Simmons, M.J. & Snustad, D.P. Principles of Genetics (8th ed.) 1991, John Wiley & Sons.
32. Twyman, R.M. Gene Transfer to Plant Bios.
33. Gregory, T.R. The Evolution of the Genome, 2005, Elsevier.
34. Russell, P.J. Fundamentals of Genetics (2nd ed.), 2000, Pearson Education.
35. Sinnott, E.W., Dunn, L.C. & Dobzhansky, T. Principles of Genetics (5th ed.) 1958, Tata McGraw Hill.
36. Old, R.W. & Primrose, S.B. Principles of Gene Manipulation, 1989, Blackwell Scientific Publications.
37. Kar, D.K. and Halder, S. Cell Biology, Genetics and Molecular Biology 2008, New Central Book Agency.
38. Roy, S.C. and De, K.K. Cell Biology, 1997, New Central Book Agency.
39. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell. 2015. 6th Ed: Garland Science.
40. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. Molecular Cell Biology. 2013. 8th Ed. Freeman.

### **17. Plant Breeding & Biometry**

1. Chaudhuri, H.K. Elementary Principles of Plant Breeding, Latest Ed., Oxford & IBH.
2. Allaed, R.W. Principles of Plant Breeding, 1960, John Wiley & Sons.
3. Poehlman, J.M. & Barthakur, D. Plant Breeding, Latest Ed., Oxford & IBH.
4. Singh, B.D. Plant Breeding, Principles & Methods (7th ed.), 2005, Kalyani Publishers.
5. Barley, N.T.J. Statistical Methods in Biology, Latest Ed., Cambridge University Press
6. Roy, D. Plant Breeding: Analysis & Exploitation of Variation, 2000, Narosa Publishing House.
7. Zar, J.H. Biostatistical Analysis (3rd ed.), 1996, Prentice Hall.
8. Kar, D.K. and Halder, S. Plant Breeding & Biometry, 2006, New Central Book Agency.
9. Dutta, Animesh K. Basic Biostatistics & its Application 2006, New Central Book Agency.

### **18. Plant Biotechnology**

1. Chawla, H.S. An Introduction to Plant Biotechnology (2nd ed.), 2002, Oxford & IBH
2. Borer, A., Sentos, F.R. & Bowen, D.B. Understanding Biotechnology, 2003, Pearson Education
3. Ingacimuthu, S. Plant Biotechnology, 1997, Oxford & IBH
4. Walker, J.M. & Rapley, R. Molecular Biology & Biotechnology, 2000, Royal Society of Chemistry
5. Collin, H.A. and Edwards, S. Plant Cell Culture, 1998, Bios Scientific Publishers

6. Dixon, R.A. & Gonzales, R. A. Plant Cell Culture: A Practical Approach, 1994, Oxford University Press
7. Gamorgs, O.L. & Phillips, G.C. Plant Cell, Tissue and Organ Culture: Fundamental method, Narosa Publishing House
8. Dubey, R.C. Biotechnology, Latest Ed., S.Chand & Company Pvt. Ltd.
9. Bhojwani, S.S. & Razdan, M.I. Plant Tissue Culture: Theory and Practise, Elsevier
10. Rajdan, M.K. An Introduction to Plant Tissue Culture, Latest Ed., Oxford & IBH
11. Jha, T.B. & Ghosh, B. Plant Tissue Culture, 2003, Universities Press
12. Singh, B.D. Biotechnology Latest ed., Kalyani Publishers.
13. Mascarenhas, A.F. Handbook of Plant Tissue Culture, ICAR
14. Kar, D.K. & Halder, S. Plant Breeding, Biometry & Biotechnology, 2010, New Central Book Agency
15. Gupta, P.K. Biotechnology & Genomes, latest Ed., Rastogi Publications
16. Slatter, A., Scott, N. & Fowler, N. Plant Biotechnology, 2003, Oxford University Press
17. Dey, K.K. Plant Tissue Culture, 1992, New Central Book Agency

#### **19. Natural resource management**

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

**UNIVERSITY OF CALCUTTA**  
**SYLLABUS**  
**FOR**  
**THREE-YEAR B.Sc. PROGRAMME IN**  
**BOTANY (GENERAL COURSE)**  
**UNDER CHOICE BASED CREDIT SYSTEM**



**BOTANY**

**Syllabus for three-year B.Sc. Botany Programme**  
**(With effect from 2018-2019)**



## **CORE COURSES (4)**

**Each theoretical course of 4 credits and practical of 2 credits.**

- 1. Plant diversity I (Phycology, Mycology, Phytopathology, Bryophytes and Anatomy) – a) Theoretical- BOT-G-CC-1-1-TH b) Practical- BOT-G-CC-1-1-P (... .. GE-1-1-TH & P)**
- 2. Plant diversity II (Pteridophytes, Gymnosperms, Palaeobotany, Morphology and Taxonomy) – a) Theoretical- BOT-G-CC-2-2-TH b) Practical- BOT-G-CC-2-2-P (... .. GE-2-2-TH & P)**
- 3. Cell biology, Genetics and Microbiology – a) Theoretical- BOT-G-CC-3-3-TH b) Practical- BOT-G-CC-3-3-P (... .. GE-3-3-TH & P)**
- 4. Plant physiology and metabolism – a) Theoretical- BOT-G-CC-4-4-TH b) Practical- BOT-G-CC-4-4-P (... .. GE-4-4-TH & P)**

**N.B.:** The above said four core courses (CC) may be considered as GE 1, 2, 3 & 4 respectively for the honours students of other allied disciplines opting Botany as one of the general courses.

**Skill enhancement courses (SEC, four courses to be selected strictly on 2 subjects out of 3 subjects opted taking 2 courses from each subject. Each general subject shall have 2 groups (A & B) of SEC papers. One paper from Group A from each of the 2 subjects to be chosen in the 3<sup>rd</sup> and 5<sup>th</sup> Semester, one paper from Group B of each of the 2 subjects to be chosen in the 4<sup>th</sup> and 6<sup>th</sup> Semesters. Each paper of 2 credits and theoretical only)**

### **SEC A**

- 1. Plant breeding and biometry (BOT-G-SEC-A-3/5-1)**
- 2. Biofertilizers (BOT-G-SEC-A-3/5-2)**

### **SEC B**

- 1. Plant biotechnology (BOT-G-SEC-B-4/6-3)**
- 2. Mushroom culture technology (BOT-G-SEC-B-4/6-4)**

**Discipline specific elective courses (DSE, two courses to be selected from the list taking one each from Group A in 5<sup>th</sup> semester and one from Group B in 6<sup>th</sup> Semester. Each course comprises of theoretical component of 4 credits and practical ones of 2 credits)**

### **DSE A**

- 1. Phytochemistry and medicinal botany- a) Theoretical- BOT-G-DSE-A-5-1-TH, b) Practical- BOT-G-DSE-A-5-1-P**
- 2. Natural resource management- a) Theoretical- BOT-G-DSE-A-5-2-TH, b) Practical- BOT-G-DSE-A-5-2-P**

### **DSE B**

- 3. Economic botany- a) Theoretical- BOT-G-DSE-B-6-3-TH, b) Practical- BOT-G-DSE-B-6-3-P**
- 4. Horticultural practices and post harvest technology - a) Theoretical- BOT-G-DSE-B-6-4-TH, b) Practical- BOT-G-DSE-B-6-4-P**

SEME STER	CORE COURSES (CC-1-4)	ABILITY ENHANCEMENT COMPULSORY COURSE (AEC-1&2)	SKILL ENHANCEMEN T COURSE (SEC-1-4)	DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE-1&2)
I	PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) <b>BOT-G-CC-1-1-TH</b>	AECC-1 ENGLISH COMUUNICATIO N		
	PRACTICALS <b>BOT-G-CC-1-1-P</b>			
	OTHER DESCIPLINES (2)			
II	PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) <b>BOT-G-CC-2-2-TH</b>	AECC-2 ENVIRONMENTA L SCIENCE		
	PRACTICALS <b>BOT-G-CC-2-2-P</b>			
	OTHER DESCIPLINES (2)			
III	CELL BIOLOGY, GENETICS AND MICROBIOLOGY <b>BOT-G-CC-3-3-TH</b>		SEC-A	
	PRACTICALS <b>BOT-G-CC-3-3-P</b>			
	OTHER DESCIPLINES (2)			
IV	PLANT PHYSIOLOGY AND METABOLISM <b>BOT-G-CC-4-4-TH</b>		SEC-B	
	PRACTICALS <b>BOT-G-CC-4-4-P</b>			
	OTHER DESCIPLINES (2)			
V			SEC-A	DSE-A (any one from GROUP A) THEORY & PRACTICAL OTHER DESCIPLINES (2)
VI			SEC-B	DSE-B (any one from GROUP B) THEORY & PRACTICAL OTHER DESCIPLINES (2)

## SEMESTER I

### CORE COURSE 1

#### PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) (BOT-G-CC-1-1-TH)

##### THEORETICAL

(Credits 4, Lectures 60)

#### 1. Introduction to different plant groups

.....2 lectures

#### 2. Phycology

2.1. Diagnostic characters and examples of Cyanophyceae, Rhodophyceae, Chlorophyceae, Charophyceae and Phaeophyceae, 2.2 Classification: Criteria and system of Fritsch, 2.3. Life histories of *Chlamydomonas*, *Chara* and *Ectocarpus*, 2.4. Role of algae in the environment, agriculture, biotechnology and industry.

.....14 lectures

#### 3. Mycology

3.1 Diagnostic characters and examples of Oomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina (Ainsworth, 1973). 3.2 Life histories of *Rhizopus* and *Ascobolus*, 3.3. Economic importance of fungi, 3.4 Fungal symbioses: *Mycorrhiza*, Lichen and their importance.

.....12 lectures

#### 4. Phytopathology

4.1 Symptoms - necrotic, hypoplastic and hyperplastic, 4.2 Koch's postulates, 4.3 Biotrophs and Necrotrophs, 4.4 Disease triangle, 4.5 Pathotoxins and phytoalexins (brief concept), 4.6 Symptoms, causal organism, disease cycle and control measures of plant diseases (Late blight of potato, Brown spot of Rice, Stem rot of jute).

.....10 lectures

#### 5. Bryophytes

5.1 Unifying features of archaegoniates and transition to land habit, 5.2 Amphibian nature of bryophytes, 5.3 Diagnostic characters and examples of Hepaticopsida, Anthocerotopsida and Bryopsida (Proskauer 1957), 5.4 Life histories of *Marchantia* and *Funaria*, 5.5 Ecological and economic importance.

.....10 lectures

#### 6. Anatomy

6.1 Stomata - Types (Metcalf & Chalk), 6.2 Anatomy of root, stem and leaf of monocots and dicots, 6.3 Stelar types and evolution, 6.4 Secondary growth – normal in dicot stem and anomaly in stem of *Tecoma* & *Dracaena*.

.....12 lectures

**PRACTICAL- PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES  
AND ANATOMY) (BOT-G-CC-1-1-P)  
(Credits 2)**

- 1. Work out:** Microscopic preparation, drawing and labeling of *Chlamydomonas*, *Chara*, *Ectocarpus*, *Rhizopus* and *Ascobolus*
- 2. Anatomical studies (following double staining method) of:** 2a. Stem- *Cucurbita*, sunflower and maize. 2b. Root- *Colocassia*, gram and orchid. 2c. Leaf- *Nerium*
- 3. Identification with reasons:** 3a. Cryptogamic specimens (macroscopic/microscopic as prescribed in the theoretical syllabus. 3b. Pathological specimens (herbarium sheets) of Late blight of potato, Brown spot of rice and stem rot of jute.
- 4. Laboratory records:** Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited.
- 5. Atleast one local excursion to be conducted to give an idea of plant diversity, habitat of algae and fungi**

**SEMESTER II**

**CORE COURSE 2**

**PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND  
TAXONOMY) (BOT-G-CC-2-2-TH)  
THEORETICAL  
(Credits 4, Lectures 60)**

**1. Pteridophytes**

1.1 Diagnostic characters and examples of Psilophyta, Lycophyta, Sphenophyta & Filicophyta (Gifford & Foster 1989). 1.2 Life histories of *Selaginella* and *Pteris*, 1.3 Economic importance.

.....12 lectures

**2. Gymnosperms**

2.1 Progymnosperms (brief idea), 2.2 Diagnostic characters and examples of Cycadophyta, Coniferophyta and Gnetophyta (Gifford & Foster 1989), 2.3 Life histories of *Cycas* and *Pinus*, 2.4 *Williamsonia* (reconstructed), 2.5 Economic importance of Gymnosperms.

.....12 lectures

**3. Paleobotany & Palynology**

3.1 Fossil, fossilization process and factors of fossilization, 3.2 Importance of fossil study. 3.3 Geological time scale, 3.4 Palynology - Definition, spore & pollen (brief idea), Applications.

.....10 lectures

**4. Angiosperm Morphology**

4.1 Inflorescence types with examples, 4.2 Flower, 4.3 Fruits and seeds- type and examples.

.....12 lectures

**5. Taxonomy of Angiosperms**

5.1 Artificial, Natural and Phylogenetic systems of classification with one example each, 5.2 Diagnostic features of following families- Malvaceae, Leguminosae (Fabaceae), Cucurbitaceae,

Rubiaceae, Compositae (Asteraceae), Solanaceae, Acanthaceae, Labiateae (Lamiaceae), Orchidaceae, Gramineae (Poaceae).

.....14 lectures

**PRACTICAL- PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY,  
MORPHOLOGY AND TAXONOMY) (BOT-G-CC-2-2-P)  
(Credits 2)**

**1.** Dissection, drawing and labelling, description of angiospermic plants and floral parts, floral formula and floral diagram, identification (family) from the following families: Leguminosae (Fabaceae), Malvaceae, Solanaceae, Labiateae (Lamiaceae), Acanthaceae.

**2. Identification with reasons:**

Macroscopic specimens of *Selaginella* and *Pteris*, male and female strobilus of *Cycas* and *Pinus*, Anatomical slides (stellar types, transfusion tissue, sieve tube, sunken stomata, lenticels), inflorescence types.

**3. Spot identification** of the following Angiospermic plants (scientific names and families): *Sida rhombifolia* (Malvaceae), *Abutilon indicum* (Malvaceae), *Cassia sophora* (Fabaceae), *Tephrosia halimtonii* (Fabaceae), *Crotolaria palida* (Fabaceae), *Coccinia grandis* (Cucurbitaceae), *Solanum indicum* (Solanaceae), *Nicotiana plumbagenifolia* (Solanaceae), *Leucas aspera* (Lamiaceae), *Leonurus sibiricus* (Lamiaceae), *Parthenium hysterophorus* (Asteraceae), *Tridax procumbense* (Asteraceae), *Eclipta prostrate* (Asteraceae), *Eragrostis tenella* (Poaceae), *Chrysopogon aciculatus* (Poaceae), *Eleusine indica* (Poaceae), *Vanda taesellata* (Orchidaceae).

**4. Laboratory records:** Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited.

**5. Field excursion:** Local Excursions (at least two including one to Acharya Jagadish Chandra Bose Botanic Garden, Shibpur, Howrah)

**6. Field Records:** Field note book and 15 herbarium sheets of common Angiospermic weeds are to be prepared and submitted at the time of Practical Examination. Regular attendance in the class must be credited.

**SEMESTER III**

**CORE COURSE 3**

**CELL BIOLOGY, GENETICS AND MICROBIOLOGY (BOT-G-CC-3-3-TH)**

**THEORETICAL**

**(Credits 4, Lectures 60)**

**1. Cell Biology and Genetics**

1.1 Ultrastructure of nuclear envelope, nucleolus and their functions, 1.2 Molecular organisation of metaphase chromosome (Nucleosome concept).

.....6 lectures

2. Chromosomal aberrations- 2.1 deletion, duplication, inversion & translocation, 2.2 Aneuploidy & Polyploidy-types, importance and role in evolution.

.....6 lectures

3. Central Dogma, 3.1 Transcription and Translation.

.....10 lectures

4. Genetic Code- properties.

.....4 lectures

5. Linkage group and Genetic map (three-point test cross).

.....6 lectures

6. Mutation – 6.1 Point mutation (tautomerisation; transition, transversion and frame shift), 6.2 Mutagen-physical and chemical.

.....8 lectures

7. Brief concept of Split gene, Transposons.

.....4 lectures

## **2. Microbes**

2.1 Viruses- Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; 2.2 Bacteria- discovery, general characteristics and cell structure; reproduction- vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

..... 16 lectures

## **RACTICAL- CELL BIOLOGY, GENETICS AND MICROBIOLOGY (BOT-G-CC-3-3-P) (Credits 2)**

### **1. Cell Biology:**

Staining (Aceto-orcein) and squash preparation of onion root tip: study of mitotic stages. Determination of mitotic index (from onion root tip).

### **2. Microbiology:**

Workout gram staining (curd/any natural source)

### **3. Identification with reasons:**

Cytological slides of different mitotic and meiotic stages.

Different forms of bacteria (*Coccus*, *Bacillus*, *Spiral*)

**4. Laboratory Records:** Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited

## SEMESTER IV

### CORE COURSE 4

#### PLANT PHYSIOLOGY AND METABOLISM (BOT-G-CC-4-4-TH) THEORETICAL (Credits 4, Lectures 60)

##### 1. Proteins

1.1 Primary, secondary and tertiary structure, 1.2 Nucleic acid- DNA structure, RNA types, 1.3 Enzyme- Classifications with examples (IUBMB), Mechanism of action.

.....8 lectures

##### 2. Transport in plants

2.1 Ascent of sap and Xylem cavitation , 2.2 Phloem transport and source-sink relation.

.....4 lectures

##### 3. Transpiration

3.1 Mechanism of stomatal movement, significance.

.....4 lectures

##### 4. Photosynthesis

4.1 Pigments, Action spectra and Enhancement effect, 4.2 Electron transport system and Photophosphorylation, 4.3 C3 and C4 photosynthesis, CAM- Reaction and Significance.

.....12 lectures

##### 5. Respiration

5.1 Glycolysis & Krebs cycle— Reactions and Significance, 5.2 ETS and oxidative phosphorylation.

.....8 lectures

##### 6. Nitrogen metabolism

6.1 Biological dinitrogen fixation, 6.2 Amino acid synthesis (reductive amination and transamination).

.....6 lectures

##### 7. Plant Growth regulators

7.1 Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA.

.....10 lectures

##### 8. Photoperiodism (Plant types, Role of phytochrome and GA in flowering) and Vernalization.

.....6 lectures

##### 9. Senescence (brief idea).

.....2 lectures

#### PRACTICAL- PLANT PHYSIOLOGY AND METABOLISM (BOT-G-CC-4-4-P) (Credits 2)

##### Plant Physiology:

i) Experiment on Plasmolysis.

ii) Measurement of leaf area (graphical method) and determination of transpiration rate per unit

area by weighing method.

iii) Imbibition of water by dry seeds - proteinaceous and fatty seeds.

iv) Evolution of O<sub>2</sub> during photosynthesis (using graduated tube).

v) Evolution of CO<sub>2</sub> during aerobic respiration and measurement of volume.

## SEC A

### PLANT BREEDING AND BIOMETRY (BOT-G-SEC-A-3/5-1)

(Credits 2, Lectures 30)

#### 1. Plant breeding:

1.1 Introduction and objective, 1.2 Techniques of hybridisation.

.....2 lectures

#### 2. Mass and Pure line selection:

2.1 Procedure, 2.2 Advantages and limitations.

.....8 lectures

3. Heterosis and hybrid seed production.

.....4 lectures

4. Role of mutation, polyploidy, distant hybridization and role of biotechnology in crop improvement.

.....8 lectures

#### 5. Biometry:

5.1 Measures of central tendency (Mean, Median and Mode), 5.2 Standard error and standard deviation, 5.3 Test of significance: Chi-square test for goodness of fit.

.....8 lectures

### BIOFERTILIZERS (BOT-G-SEC-A-3/5-2)

(Credits 2, Lectures 30)

1. **Biofertilizers:** General account about microbes used as biofertilisers; *Rhizobium*-identification, mass multiplication. Actinorrhizal symbiosis.

.....4 lectures

2. ***Azospirillum***- identification, mass multiplication, associative effect of different microorganisms. *Azotobacter* and crop response to *Azotobacter* inoculums.

.....6 lectures

3. Cyanobacteria, *Azolla*, *Anabaena* and *Azolla* association, blue green algae and *Azolla* in rice cultivation.

.....6 lectures

4. **Mycorrhizal association:** 4.1 Types of Mycorrhizal association- Brief idea, 4.2 Its influence on growth and yield of crop plants.



- .....6 lectures
5. **Organic farming:** 5.1 Green manuring and organic fertilizers, 5.2 Biocompost and vermicompost- making methods and field applications. 5.3 Recycling of biodegradable municipal, industrial and agricultural wastes.

.....8 lectures

**SEC B**  
**PLANT BIOTECHNOLOGY (BOT-G-SEC-B-4/6-3)**  
**(Credits 2, Lectures 30)**

1. **Plant tissue culture-** 1.1 Introduction and basic concepts, 1.2 Cellular potency, 1.3 Callus culture and plant regeneration.

.....4 lectures

2. **Micropropagation-** 2.1 Somatic embryogenesis and artificial seed.

.....4 lectures

3. Protoplast culture and its application.

.....6 lectures

4. **Recombinant DNA technology-** 4.1 Recombinant DNA, 4.2 Restriction enzymes, 4.3 Plasmids as vectors.

.....8 lectures

5. Gene cloning (basic steps).

.....4 lectures

6. **Achievements in crop biotechnology-** 6.1 Pest resistant plant (Bt cotton), 6.2 Transgenic crops with improved quality (flavr tomato and golden rice).

.....4 lectures

**MUSHROOM CULTURE TECHNOLOGY (BOT-G-SEC-D-4/6-4)**  
**(Credits 2, Lectures 30)**

1. **Mushroom-** nutritional and medicinal value of mushrooms. Poisonous mushrooms.

.....4 lectures

2. Cultivation techniques/ technology of edible mushrooms in India: *Volvarealla volvacea*, *Pleuretus citrinopyrineatus*, *Agaricus bisporus*.

.....12 lectures

3. **Storage-** short term and long term, storage, drying.

.....6 lectures

4. **Food preparation-** types of foods prepared from mushroom. Cost and benefit ratio.

.....6 lectures

5. **Research centres-** national and regional.

.....2 lectures

**DSE A (Group A)**  
**PHYTOCHEMISTRY AND MEDICINAL BOTANY (BOT-G-DSE-A-5-1-TH)**  
**THEORETICAL**  
**(Credit 4, Lectures 60)**

- 1. Medicinal botany-** History, scope and importance of medicinal plants, a brief idea about indigenous medicinal sciences- Ayurveda, Siddha and Unani. Polyherbal formulations.

.....14 lectures

- 2. Pharmacognosy-** 2.1 Scope and its importance, 2.2 Primary metabolites, 2.3 Secondary metabolites- alkaloids, terpenoids, phenolics and their functions.

.....10 lectures

- 3. Organoleptic** evaluation of crude drugs.

.....10 lectures

- 4. Pharmacologically active constituents:** Source plants (one example), parts used and uses of: 4.1 Steroids (Diosgenin, Digitoxin), 4.2 Tannin (Catechin), 4.3 Resins (Gingerol, Curcuminoids), 4.4 Alkaloids (Strychnine, Reserpine, Vinblastine), 4.5 Phenols (Capsaicin).

.....6 lectures

- 5. Ethnobotany and folk medicine:** 5.1 Brief idea, 5.2 Applications of ethnobotany, 5.3 Application of natural product to certain diseases- Jaundice, Cardiac and Diabetics.

.....20 lectures

**PRACTICAL- PHYTOCHEMISTRY AND MEDICINAL BOTANY (BOT-G-DSE-A-5-1-P)**  
**(Credit 2)**

1. Preparations of solution and buffers
2. Acquaintance with laboratory instruments- Autoclave, Incubator, Clinical centrifuge, Analytical balance, pH meter, Colorimeter, Water bath, Distillation plant, Laminar air flow.
3. Qualitative test for proteins and carbohydrates, reducing and non reducing sugar (glucose, fructose and sucrose)
4. Tests (chemical) for tannin and alkaloid
5. Identification of medicinal plants (list to be provided)
6. Field study (local) and listing of medicinal plants. Records to be substantiated with photographs and description.

## **NATURAL RESOURCE MANagements (BOT-G-DSE-A-5-2-TH)**

### **THEORETICAL**

**(Credits 4, Lectures 60)**

1. Natural resources- definition and types.  
.....2 lectures
2. Sustainable utilization- concept, approaches (economic, ecological and socio-cultural).  
.....10 lectures
3. Land utilization. Soil degradation and management.  
.....8 lectures
4. Water, fresh water marine, estuarine. Wetlands- threats and management.  
.....10 lectures
5. Biological resources, biodiversity- definition and types. Significance, threats and management strategies.  
.....10 lectures
6. Forests- definition, cover and its significance (with special reference to India). Major and minor forest products.  
.....8 lectures
7. Energy- renewable and non-renewable source of energy.  
.....8 lectures
8. EIA and waste management.  
.....4 lectures

## **PRACTICAL- NATURAL RESOURCE MANagements (BOT-G-DSE-A-5-2-P)**

**(Credits 2)**

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Measurement of dominant woody species by DBH (diameter at breast height)
3. Study of community structure by Quadrat method and determination of minimal size of quadrat, frequency density and abundance of components to be done during field visit.
4. Measurement of dissolved O<sub>2</sub> by azide modification of Winkler's method.
5. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)

**DSE B**  
**ECONOMIC BOTANY (BOT-G-DSE-B-6-3-TH)**  
**THEORETICAL (Credits 4, Lectures 60)**

1. Origin of cultivated plants: 1.1 Concepts of centres of origin and their importance with reference to Vavilov's work.  
.....12 lectures
2. Rice- origin, morphology and uses.  
.....12 lectures
3. Legumes: General account with special reference to *Vigna*.  
.....8 lectures
4. Beverages: Tea- morphology, processing and uses.  
.....12 lectures
5. Study of the following economically important plants (Scientific names, families, parts used and importance): 5.1 Cereals- Rice, wheat, 5.2 Pulses- Mong, gram, 5.3 Spices- Ginger, cumin, 5.4 Beverages- Tea, coffee, 5.5 Medicinal plants- Cinchona, neem, Ipecac, Vasaka, 5.6 Oil yielding plants- Mustard, groundnut, coconut, 5.7 Vegetables- Potato, raddish, bottle gourd, cabbage, 5.8 Fibre yielding plants- Cotton, jute, 5.9 Timber yielding plants- Teak, Sal 5.10 Fruits- Mango, apple, 5.11 Sugar yielding plant- Sugarcane.  
.....16 lectures

**PRACTICAL- ECONOMIC BOTANY (BOT-G-DSE-B-6-3-P)**  
**(Credits 2)**

1. Study of economically important plants (rice/jute/ tea) through herbarium specimens and field study.
2. Study of cultivation practices in field and submission of report.
3. Study of local economically important plants and submission of report with photographs.

**HORTICULTURAL PRACTICES AND POST HARVEST**  
**TECHNOLOGY (BOT-G-DSE-B-6-4-TH)**  
**THEORETICAL**  
**(Credits 4, Lectures 60)**

1. Horticulture- role in rural economy and employment generation. Urban horticulture- its scope and importance.  
.....6 lectures
2. Ornamental plants- identification and salient features of some ornamental plants (rose, marigold, gladiolus, gerberas, tube rose, carnations, cacti and succulents). Ornamental flowering trees (Gulmohor, Lagerstromia, Shimul, Coral tree and jacaranda).

.....12 lectures

3. Identification of some fruits and vegetable plants- Citrus, Banana, Papaya, Mango, Jackfruit, Chillies and cucurbits. Fruit processing- scope and benefits.

.....10 lectures

4. Horticultural techniques- propagation methods, application of manure, fertilizers, nutrients and PGR. Weed control. Biofertilizers and biopesticides.

.....12 lectures

5. Post harvest technology- importance of post harvest technology in horticultural practices. Harvesting and handling of fruits, vegetables and cut flower. Methods of preservation and processing.

.....10 lectures

6. Disease control and management- field and post harvest diseases of common crops. Crop sanitation, quarantine practices. Identification of common diseases and pest of fruits and vegetable crops.

.....10 lectures

**PRACTICAL- HORTICULTURAL PRACTICES AND POST HARVEST TECHNOLOGY (BOT-G-DSE-B-6-4-P)**  
**(Credits 2)**

1. Field trips to gardens, standing crop sites, nurseries, vegetable gardens, horticultural fields and cold storages.

## REFERENCES

### Suggested Readings

#### 1. General studies

1. Ganguli, H.C., Das, K.S.K. & Dutta, C.T. College Botany, Vol. I, latest Ed., New Central Book Agency
2. Ganguli, H.C. and Kar, A.K. College Botany, Vol. II, latest Ed., New Central Book Agency
3. Mukherjee, S. College Botany, Vol. III, latest Ed., New Central Book Agency
4. Uno, Storey & Moore, Principles of Botany, 2001, McGraw Hill.
5. Kenrick, P. & Crane, P. The Origin & early diversification of land plants (1997), Smithsonian Institution Press.
6. Bell, P.R. & Hensley, A.R. Green plants; their Origin & Diversity (2nd ed.), 2000, Cambridge University Press
7. Frenchel, T. The origin & early Evolution of life, 2002, Oxford University Press.
8. Hait, G., Ghosh, A. and Bhattacharya, K. A Text Book of Botany (Vols. I, II & III), 2007, New Central Book Agency
9. Lock, A.J., & Evans, D.E., Plant Biology, 2001, Viva Books
10. Chatterjee, T., Santra, S.C. and Das, A. Practical College Botany, New Central Book Agency

#### 2. Algae

1. Kumar, H.D. Introductory Phycology (2nd ed.), 1999, Affiliated East-West Press Pvt. Ltd.
2. Lee, R.E. Phycology (3rd ed.), 1999, Cambridge University Press
3. Vashishta, B.R., Sinha, A.K. & Singh, V.P. Algae (9th ed.), 2002, S. Chand & Company
4. Sambamurthy, A.S.S. A text book of Algae, 2005, I.K. International Pvt. Ltd. 22
5. Graham, L.E. & Wilcox, L.W. Algae, 2000, Prentice Hall
6. Smith, G.M. Cryptogamic Botany, Vol. 1 (2nd ed.), 1955. McGraw Hill
7. Prescott, G.W. Algae: A Review: 1969 Bishen Singh Mahendra Pal Singh
8. Fritsch, F.E. The Structure & Reproduction of Algae, 1936, Vols. I & II, Cambridge University Press

#### 3. Microbiology

1. Stainer, T.Y., Ingraham, J.L., Wheelis, M.L. & Painter, P.R. General Microbiology (5th ed.), 1986, Macmillan Education Ltd.
2. Dubey, R.C. & Maheswari, D.K. A Text Book of Microbiology, 2005, S. Chand & Company
3. Case, Funke & Tortora, G.J. Microbiology, an Introduction (Latest Ed.)
4. Jay, J.M. Modern Food Microbiology (5th ed.), 1996, Chapman & Hall
5. Madigan, M.T., Martinko, J.M. & Parker, J. Brock, Biology of Microorganisms (10th ed.), 2003, Prentice Hall
10. Hull, R. Matthew Plant Virology (4th ed.), 2002, Academic Press
6. Biswas, S.B. & Biswas, A. An Introduction to Viruses (4th ed.), 1996, Vikas Publishing House
7. Agarwal, A.K. & Parihar, P. Industrial Microbiology, 2005, Agrobios (India)

8. Power, C.B. & Dagimawata, H.F. General Microbiology, Vol. I&II, Himalaya Publishing House
9. Mitchel, R. Environmental Microbiology, Latest Ed. Wiley, N.Y.
10. Sale, A.J. Fundamental Principles of Microbiology, Latest Ed., Tata McGraw Hill
11. Banerjee, A.K. & Banerjee, N. Microbiology & Immunology, 2006, new Central Book Agency
12. Prescott & Dunn. Industrial Microbiology 18. Verma, H.N. Basics of Plant Virology (2003), Oxford and IBH

#### **4. Fungi, Lichen & Plant Pathology**

1. Dubey, H.C. An Introduction to Fungi (2nd ed.), 1990, Vikas Publishing House 23
2. Arora, D. (ed.). Hand book of Fungal Biotechnology (2nd ed.), 2003, Dekker, N.Y.
3. Sharma, P.D. Fungi & Allied Organisms, 2005, Narosa Publishing House
4. Deacon, J.W. Fungal Biology, 2006, Black Well Science Ltd.
5. Ingold, C.T. & Hudson, H.J. The Biology of Fungi 96th ed.), 1993, Chapman & Hall
6. Sharma, O.P. Text book of Fungi, Tata McGraw Hill
7. Vashista, B.R. Fungi, Latest Ed., S. Chand & Company
8. Chopra, G.L. and Verma, V.A. Text Book of Fungi, Pradeep Publications
9. Mehrotra, R.S. and Aneja, K.R. An Introduction to Mycology, Wiley Eastern Ltd.
10. Sharma, P.D. the Fungi, Rastogi Publication
11. Mehrotra, R.S. & Agarwal, A. plant Pathology (2nd ed.), 2003, Tata McGraw Hill
12. Singh, R.S. Principles of Plant Pathology (4th ed.), 2002, oxford & IBH Publishing Com.
13. Manners, J.G. Principles of Plant Pathology (2nd ed.), 1993, Cambridge University Press
14. Singh, R.S. Plant diseases, Oxford & IBH Publishing Com
15. Rangaswami, G.K. & Mahadevan, A. Diseases of Crop Plants in India, Prentice Hall
16. Sharma, P.D. Plant Pathology (2nd ed.), Rastogi Publications
17. Strange, R.N. (ed.) Introduction of plant Pathology, 2003, Wiley
18. Dube, H.C. An Introduction to Fungi (2005), Vikas Publishing House

#### **5. Bryophytes**

1. Parihar, N.S. Introduction to Embryophyta (Vol. 1 Bryophyta), Central Book Distributors
2. Shaw, A. Jonathan and Goffinet Bernard, Bryophyte Biology, 2009, Cambridge university Press
3. Rashid, A. An Introduction to Bryophyta, 1998, Vikas Publishing House
4. Chopra, R.N. & Kumar, P.K. Biology of Bryophyta, Latest Ed., Wiley Eastern
5. Puri, P. Bryophyte, Latest Ed., Atmaram & Sons
6. Vashista, B.R. Bryophyta, Latest Ed., S. Chand & Company

#### **6. Palaeobotany and Palynology**

1. Stewart, W.N. & Rothwell, G.W. Palaeobotany & Evolution of Plants, Latest Ed., Cambridge university Press

2. Agashe, S.N. Palaeobotany, Latest Ed., Oxford & IBH
3. Thomas, B.A. & Spicer, R.A. The Evolution & Palaeobotany of Land Plants, Latest Ed., Croomhelm
4. Nair, P.K. Pollen Morphology of Angiosperms, Latest Ed., Scholar Publications
5. Shivanne, K.H. Pollen Biology & Biotechnology, 2003, Oxford & IBH
6. Bhattacharya, K., Majumdar, M.R. & Gupta Bhattacharya, S. A Text Book of Palynology, 2006, New Central Book Agency.

## **7. Embryology**

1. Raghavan, V. Molecular Embryology of Flowering Plants, 1997, Camb. University Press.
2. Maheswari, P. An Introduction to Embryology of Angiosperm, Latest Ed., Tata McGraw Hill.
3. Raghavan, V. Embryogenesis in Angiosperms: A Development & Experimental Study, 1986, Cambridge University Press.
4. Bhojwani, S.S. & Bhatnagar, S.D. The Embryology of Angiosperms (4th ed.), 1989, Publishing House.

## **8. Pteridophytes**

1. Spore, K.R. The Morphology of Pteridophyte, Latest Ed. , Huchinson & Co. Ltd.
2. Rashid, A. An Introduction to Pteridophyte, Latest Ed., Vani Educational Books.
3. Vashista, P.C. Pteridophyta, Latest Ed., S. Chand & Company Pvt. Ltd.
4. Gifford, E. M. & Foster, A. S. Morphology & Evolution of Vascular Plants (3rd ed.), 1998, Freeman and Co.

## **9. Gymnosperms**

1. Sporne, K.R. The Morphology of Gymnosperms, Latest Ed., Hutchinson & Co. Ltd.
2. Vashishta, P.C. Gymnosperm, Latest Ed., S. Chand & Company Pvt.
3. Karkar, R.K. & Karkar, R. The Gymnosperms, Latest Ed.
4. Bhatnagar, S.P. & p.Moitra, A. Gymnosperm, 1997, New Age International
5. Biswas, C. & Johri, P.M. The Gymnosperm, 1997, Narosa Publishing House
6. Dutta, S.C. An Introduction to Gymnosperms (3rd ed.), 1984, Kalyani Publishers
7. Gifford, E.M. and Foster, A.S. Morphology & Evolution of Vascular Plants (3rd ed.), 1989, Freeman & Co.

## **10. Ecology & Plant Geography**

1. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.
2. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House
3. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company
4. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders
5. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications
6. Ambasht, R.S. & Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors
7. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.



8. Krishnamurthy, K.V. An Advanced Text Book on Biodiversity, 2003, Oxford & IBH Publishing Co. Ltd.
9. Mitra, D., Guha, J.K., Chowdhury, S.K. Studies in Botany, Vol. II (7th ed.) Moulik Library.
10. Cain, Bowman, Hacker. Ecology. 2014. 3rd Ed. Sinauer Associates

## **11. Evolution**

1. Futuyma., D. Evolution. 2015. (3rd Ed.) Sinauer Associates

## **12. Anatomy**

1. Fahn, A. Plant Anatomy (4th ed.), 1990, Wiley Eastern.
2. Eames, A.J. & Mac. Daniels, L.H. An Introduction to Plant Anatomy, Latest Ed., McGraw Hill
3. Esau, K. Anatomy of Seed Plants (2nd ed.), 1977, John Wiley & Sons
4. Pandey, B.P. Plant Anatomy, Latest Ed., S. Chand & Company
5. Tayal, M.S. Plant Anatomy, Latest Ed., Rastogi Publications
6. Roy, P. Plant Anatomy, Latest Ed., New Central Book Agency
7. Morphology and Taxonomy of Angiosperms
8. Singh, G. Plant Systematics: An Integrated Approach (3rd ed.), 2016, CRC Press
9. Sambamurty, A.V.S.S. Taxonomy of Angiosperms, 2005, I.K. International Pvt. Ltd.
10. Sivarajan, V.V. Principles of Plant Taxonomy (2nd ed.), 1991, Oxford & IBH
11. Subrahmanyam, N.S. Modern Plant Taxonomy, Latest Ed., Vikas Publishing House
12. Naik, V.N. Taxonomy of Angiosperms, Latest Ed., Tata McGraw Hill
13. Stace, C. A Plant Taxonomy & Biosystematics, Latest Ed., Arnold Publishers
14. Mitra, J.N. An Introduction to Systematic Botany & Ecology, Latest Ed., World Press
15. Dutta, S.C. systematic Botany, Latest Ed., Wiley Eastern.
16. Lawrence, G.H.M. Taxonomy of Vascular Plants Ed., Oxford & IBH.
17. Prain, D. Bengal Plants (Vol I & II), Bishen Singh Mahendra Pal Singh.
18. Jeffrey, C. An Introduction to Plant Systematics, Latest Ed., Allied Publishers Pvt. Ltd.
19. Radford. A.B. Fundamentals of Plant Systematics, Latest Ed., Harper & Row.
20. Paria, N.D. and Chattopadhyay, S.P. Flora of Hazaribagh District, Bihar, 2000 & 2001, Vol I & II, BSI, Kolkata
16. Simpson, G. Plant Systematics, 2006, Springer.
21. Bhattacharya, B. Systematic Botany, 2006, Narosa Publishing House.
22. Subramanyam, N.S. Laboratory Manual of Plant Taxonomy (2nd ed.) 1999, Vikas Publishing House.
23. Heywood, V.H. Flowering Plants of the World 1978, Oxford University Press.

## **14. Biochemistry & Plant Physiology**

1. Taiz, L., & Zeiger, E. Plant Physiology (4th ed.), 2006, Sinauer Associates, Inc. Publishers.
2. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy. Plant Physiology and Development. (6th ed.) Sinauer Associates.
3. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.

4. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.
5. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
6. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
7. Wilkins, M.B. Advances Plant Physiology. 1984, ELBS Longman.
8. Srivastava, L.M. Plant Growth and Development, 2001, Academy Press.
9. Davies P.J. (ed.) Plant Physiology: Physiology, Bio-Chemistry & Molecular Biology, Academic Press.
10. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
11. Hames, B.D. Bio-Chemistry (2nd ed.) Viva Books.
12. Sackheim, G. Chemistry for Biology Students (5th ed.) 1996, Benjamin/Cummings
13. Raman, H. Transport Phenomenon in Plants, 1997. Narosa Publishing House.
14. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pthways 2008, New Central Book Agencies.
15. Mehta, S.L., Lodha, M.L. & Bane, P.V. Recent Advances in Plant Biochemistry, 1989. I.C.A.R.
16. Conn, E.E. and Stumpf, R.R. Outlines of Bio-Chemistry, Latest Ed., Wiley Eastern.
17. Singhal, G.S. Concepts of Photobiology: Photosynthesis & Photomorphogenesis, 1999. Narosa Publishing House.
18. Hall. D.O. & Rao, K.K. photosynthesis (5th ed.), 1995, Cambridge University Press.
19. Buchanon, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.

#### **15. Pharmacognosy/ Medocinal Botany**

1. Trease & Evans. Pharmacognosy, Saunders.
2. Trivedi P.C. 2006. Medicinal Plants: Ethnobotanical approach, Agrobios India
3. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur 1995.

#### **16. Cell Biology, Genetics & Molecular Biology**

1. Pierce, Benjamin A. Genetics (2nd ed.), 2005, W.H. Freeman & Company.
2. Atherly, A.G., Girton, J.R. & McDonald, J.F. Science of Genetics, 1999, Saunders College Publications.
3. Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. & Veres, R.C. Genetics (2nd ed.), 2004, McGraw Hill.
4. Tamarin, Robert H. Principles of Genetic (7th ed., 2002, Tata McGraw Hill.
5. Elrod, S.K. & Stanfield, W. Schuam's Outlines Genetics (4th ed.), 2002, Tata McGraw Hill.
6. Hartl, D.L. & Jones, E.W. Genetics , 2005, Jones & Barlett Publishers.
7. Lewin, B. Genes VIII, 2004, Pearson Educational International.
8. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. Molecular Biology of the Gene (5th ed.) 2004. Pearson Education Inc.

9. Griffiths, A.I.F., Miller, J.H., Suzuki, D.T., Lewentin, C.R. & Gilbert, M.W. An Introduction to Genetic Analysis, 2005 (8th ed.), W.H. Freeman & Company.
10. Brown, T.A. Genomes, 1999, John Wiley & Sons.
11. Brown, T.A. Genomes 3, 2007, Garland Science Publishing.
12. Snustad, D.P. & Simmons, M.J. Principles of Genetics (2nd ed.), 2000, (4th ed.), 2006, John Wiley & Sons.
13. Klug, W.S. & Cummings, M.R. Concepts of Genetics, 2003, Pearson Education.
14. Gerald Karp. Cell Biology. 2013. 7th Ed. International Student Version. Wiley.
15. Hawkins, J.D. Gene Structure & Expression (3rd ed.), 1996, Cambridge University Press.
16. Becker, M.W., Klemsmith, L.J. & Hardin, J. The World of the Cell (5th ed.), 2003, Pearson Education.
17. Cooper, G.M. The Cell, A molecular approach (2nd ed.), 2000, ASM Press.
18. Weaver, R.F. Molecular Biology (2nd ed./3rd ed.), 2002/2005, McGraw Hill.
19. Malacinski, G.M. Freifelder, Essentials of Molecular Biology (4th ed.), 2003, Narosa Publishing House.
20. Sambamurty, A.V.S.S. Genetics (2nd ed.), 2005, Narosa publishing House.
21. Sharma, A. & Sen, S. Chromosome Botany, 2002, Oxford & IBH Publishing.
22. Sen, S. & Kar, D.K. Cytology & Genetics, 2005, Narosa Publishing House.
23. Miglani, G.S. Advanced Genetics, 2002, Narosa Publishing House.
24. Gupta, P.K. Genetics, 2007, Rastogi Publications.
25. Jain, H.K. Genetics, 1999, Oxford & IBH Publishing Company.
26. Swanson, C.P., Merz, T. & Young, W.J. Cytogenetics, 1981, Prentice Hall.
27. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. Molecular Biology of the Cell, 2002 (4th ed.), Garland Sciences.
28. Gardner, E.J., Simmons, M.J. & Snustad, D.P. Principles of Genetics (8th ed.) 1991, John Wiley & Sons.
29. Kar, D.K. and Halder, S. Cell Biology, Genetics and Molecular Biology 2008, New Central Book Agency.
30. Roy, S.C. and De, K.K. Cell Biology, 1997, New Central Book Agency.
31. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell. 2015. 6th Ed: Garland Science.

### **17. Plant Breeding & Biometry**

1. Chaudhuri, H.K. Elementary Principles of Plant Breeding, Latest Ed., Oxford & IBH.
2. Allaed, R.W. Principles of Plant Breeding, 1960, John Wiley & Sons.
3. Singh, B.D. Plant Breeding, Principles & Methods (7th ed.), 2005, Kalyani Publishers.
4. Roy, D. Plant Breeding: Analysis & Exploitation of Variation, 2000, Narosa Publishing House.
5. Kar, D.K. and Halder, S. Plant Breeding & Biometry, 2006, New Central Book Agency.
6. Dutta, Animesh K. Basic Biostatistics & its Application 2006, New Central Book Agency.

### **18. Plant Biotechnology**

1. Chawla, H.S. An Introduction to Plant Biotechnology (2nd ed.), 2002, Oxford & IBH
2. Walker, J.M. & Rapley, R. Molecular Biology & Biotechnology, 2000, Royal Society of Chemistry Publishing House
3. Dubey, R.C. Biotechnology, Latest Ed., S.Chand & Company Pvt. Ltd.
4. Bhojwani, S.S. & Razdan, M.I. Plant Tissue Culture: Theory and Practise, Elsevier
5. Rajdan, M.K. An Introduction to Plant Tissue Culture, Latest Ed., Oxford & IBH
6. Jha, T.B. & Ghosh, B. Plant Tissue Culture, 2003, Universities Press
7. Singh, B.D. Biotechnology Latest ed., Kalyani Publishers.
8. Kar, D.K. & Halder, S. Plant Breeding, Biometry & Biotechnology, 2010, New Central Book Agency
9. Gupta, P.K. Biotechnology & Genomes, latest Ed., Rastogi Publications
10. Slatter, A., Scott, N. & Fowler, N. Plant Biotechnology, 2003, Oxford University Press
11. Dey, K.K. Plant Tissue Culture, 1992, New Central Book Agency

#### **19. Resource methodology**

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

#### **20. Biofertilizers**

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas, S.C., Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming, Akta Prakashan, Nadiad.

#### **21. Mushroom culture technology**

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.



# UNIVERSITY OF CALCUTTA

## Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

### List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
✓ 14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies ( General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE  
KOLKATA-700073  
The 4<sup>th</sup> June, 2018

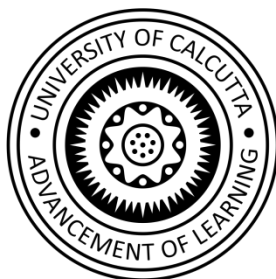
*Paul*  
4/6/18  
(Dr. Santanu Paul)  
Deputy Registrar

**MODEL COURSE CURRICULUM FOR UNDERGRADUATE  
COURSES UNDER CHOICE BASED CREDIT SYSTEM**

**FINAL SYLLABUS**

**FOR**

**BACHELOR IN ENVIRONMENTAL  
SCIENCE (HONOURS)**



**UNIVERSITY OF CALCUTTA**

### Details of course under B.Sc. in Environmental Science (Hons.)

Course	Credits*
	Theory + Practical
<b>I Core Courses (14 Papers)</b>	
Core Courses - Theory (14 Papers) (4 Credits each)	14x4=56
Core Course – Practical (2 Credits Each)	14x2=28
<b>II. Discipline Specific Electives (4 Papers)</b>	
Discipline Specific Electives - Theory (4 Papers) (4 Credits)	4x4=16
Discipline Specific Electives - Practical (4 Papers) (2 Credits Each)	4x2=8
<b>III Generic Electives (4 Papers)</b>	
Generic Electives- Theory (4 Papers) (4 Credits)	4x4=16
Generic Electives – Practical (4 Papers) (2 Credits Each)	4x2=8
<b>III. Ability Enhancement Courses (2 Papers)</b>	
1. Ability Enhancement Compulsory Courses (AECC 1) English Communications. (2 credits)	2x2=4
2. Ability Enhancement Compulsory Courses (AECC 2) Environmental Studies (2 C credits)	
<b>IV. Skill Enhancement Courses (SEC)</b>	
Skill Enhancement Courses (SEC) (Theory) (2 Papers of 2 Credits each)	2x2=4
<b>Total Credits</b>	<b>140</b>

**Bachelor in Environment Science (Hons.)**  
**Courses/Papers Sequence**

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
CC 1: Earth and Earth Surface Processes	CC3: Water and Water Resources Management	CC5: Ecology and Ecosystems	CC8: Systematics & Biogeography	CC 11: Biodiversity & Conservation Biology	CC 13: Environmental Pollution and Human Health
CC2: Physics & Chemistry of Environment	CC4: Land management and soil conservation	CC6: Environmental Biotechnology	CC9: Urban Ecosystems	CC 12: Organismal & Evolutionary Biology	CC 14: Natural Resources Management & Sustainability
AECC1: English Communication IMIL	AECC2: Environmental Studies	CC7: Atmosphere & Global Climate Change	CC 10: Environmental Legislation & Policy	DSE A1: Energy & Environment	DSE B1: Natural Hazards & Disaster Management
		SEC A1: Remote Sensing, Geographic Information System & Modelling	SEC B1: Environment Impact & Risk Assessment	DSE B2: Solid Waste Management  OR	DSE A2: Environmental Economics and Statistics  OR
		SEC A2: Wildlife Management	SEC B2: Analytical methods, instrumentation and Measurement	DSE B3: Environmental Health and Toxicology	DSE A3: Green Technologies



## **CC1 (1<sup>ST</sup> SEMESTER) ENV-A-CC-1-1-TH: EARTH AND EARTH SURFACE PROCESSES**

**Theory (50 Lectures)**

### **Unit 1: History of Earth**

**(5 lectures)**

Formation of the Earth: formation and composition of core, mantle, crust, atmosphere and hydrosphere; chemical composition of Earth; geological time scale and major changes on the Earth's surface.

### **Unit 2: Earth system processes**

**(15 lectures)**

Movement of lithosphere plates; mantle convection and plate tectonics, major plates and hotspots, plate boundaries; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, Pangaea and present-day continents, paleontological evidences of plate tectonics.

Land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes.

### **Unit 3: Rocks, weathering and minerals**

**(15 lectures)**

Minerals and important rock forming minerals; rock cycle: lithification and metamorphism; Three rock laws; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion; agents of erosion: rivers and streams, glacial and aeolian transportation and deposition of sediments by running water, wind and glaciers.

### **Unit 4: Earth atmosphere**

**(6 lectures)**

Atmosphere: evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere-ocean interface, atmosphere-land interface, ocean-land interface.

### **Unit 5: Mountain and river systems of India**

**(9 lectures)**

Continental collision and mountain formation; Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc.; Formation of the Himalaya; perennial river systems and evolution of monsoon in Indian subcontinent; formation of Indo-Gangetic Plains, progression of agriculture in the Indian subcontinent in Holocene; withdrawing monsoon and lessons to draw.

## **CC1 (1<sup>ST</sup> SEMESTER) ENV-A-CC-1-1-P: EARTH AND EARTH SURFACE PROCESSES**

1. Identification of rocks & minerals (Hand Specimen)
  - a) Rocks- Granite, Basalt, Dolerite, Shale, Sandstone, Limestone, Slate, Marble, Quartzite, Gneiss
  - b) Minerals- Talc, Bauxite, Mica, Quartz, Hematite, Galena (15)
2. Topological sheet interpretation for geomorphology. (10)
3. Viva Voce (5)

## CC2 (1<sup>ST</sup> SEMESTER) ENV-A-CC-1-2-TH: PHYSICS AND CHEMISTRY OF ENVIRONMENT

**Theory (50 Lectures)**

### **Unit 1: Fundamentals of environmental physics**

**(10 lectures)**

**Part A:** Basic concepts of light and matter; spectroscopic concepts: Introduction to the concept of absorption and transmission of light, Beer–Lambert law; scattering of light, Rayleigh and Mie scattering.

**Part B:** Basic concepts of pressure, force, work and energy; types of forces and their relation (pressure gradient, viscous, Coriolis, gravitational, centripetal, and centrifugal force); concept of heat transfer, conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); laws of thermodynamics; concept of heat and work, Carnot engine.

### **Unit 2: Fundamentals of environmental chemistry**

**(15 lectures)**

**Part A:** Atomic structure, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds); mole concept, molarity and normality, quantitative volumetric analysis.

**Part B:** Types of chemical reactions; acids, bases and salts, concept of chemical equilibrium, solubility products; solutes and solvents; redox reactions, concepts of pH and pE, electrochemistry, Nernst equation, electrochemical cells.

**Part C:** Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, organic functional groups, polarity of the functional groups, colloid chemistry. Xenobiotic compounds, chemistry of pesticides and dyes, synthetic polymers.

### **Unit 3: Atmospheric chemistry**

**(9 lectures)**

Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain, reactions of NO<sub>x</sub> and SO<sub>x</sub>; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

### **Unit 4: Water chemistry**

**(9 lectures)**

Chemical and physical properties of water; Gases in water, Henry's Law, alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; heavy metals in water.

## **Unit 5: Soil chemistry**

**(7 lectures)**

Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil.

### **CC2 (1<sup>ST</sup> SEMESTER) ENV-A-CC-1-2-P: PHYSICS AND CHEMISTRY OF ENVIRONMENT**

1. Acidity, Alkalinity (PA & TA), Total Hardness of water, Calcium Hardness of Water (10)
2. Soil moisture, Soil pH, Soil electrical conductivity. (10)
3. Viva Voce (5) Laboratory notebook (5)

## **CC3 (2<sup>ND</sup> SEMESTER) ENV-A-CC-2-3-TH: WATER AND WATER RESOURCES MANAGEMENT**

**Theory (50 Lectures)**

### **Unit 1: Water resource (5 lectures)**

Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapo-transpiration; classification of water resources (oceans, rivers, lakes and wetlands).

### **Unit 2: Properties of water (10 lectures)**

Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: major inorganic and organic constituents, dissolved gases, DO, COD, BOD, electrical conductivity, sodium adsorption ratio; Biological: phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes.

### **Unit 3: Surface and Groundwater (14 lectures)**

Introduction to surface and ground water; water table; vertical distribution of water; formation and properties of aquifers; hydraulic potential, Darcy's equation, types of flow, turbulence, techniques for ground water recharge; watershed and drainage basins; importance of watershed and watershed management.

### **Unit 4: Wetlands and their management (6 lectures)**

Definition of a wetland; types of wetlands (fresh water and marine); ecological and hydrological functions of wetlands; threats to wetlands; wetland conservation and management; Ramsar Convention, 1971; major wetlands of India.

### **Unit 5: Water resource in India and Water sharing conflicts (15 lectures)**

Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; role of state in water resources management. Water resources and sharing problems, case studies on Kaveri and Krishna river water disputes; Multi- purpose river valley projects in India and their environmental and social impacts; case studies of dams - Narmada and Tehri dam – social and ecological losses versus economic benefits.

## **CC 3 (2<sup>ND</sup> SEMESTER) ENV-A-CC-2-3-P: WATER AND WATER RESOURCES MANAGEMENT**

1. pH, Electrical conductivity, Salinity (through Chloride Estimation), Dissolved oxygen, TSS, TDS, Iron. (20)
2. Viva Voce (5), Laboratory Notebook (5)

## **CC 4 (2<sup>ND</sup> SEMESTER) ENV-A-CC-2-4-TH: LAND MANAGEMENT AND SOIL CONSERVATION**

**Theory (50 Lectures)**

### **Unit 1: Introduction to Land Resource**

**(5 lectures)**

Land as a resource, types and evaluation, soil health; ecological and economic importance of soil; types and causes of soil degradation; impact of soil loss and soil degradation on agriculture and food security; need for soil conservation and restoration of soil fertility.

### **Unit 2: Fundamentals of soil science**

**(10 lectures)**

Soil formation; classification of soil; soil architecture; physical properties of soil; soil texture; soil profile; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphorus economy of soil; soil biodiversity; soil taxonomy maps.

### **Unit 3: Soil degradation and conservation**

**(10 lectures)**

Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation; nutrient depletion; soil pollution due to mining and mineral extraction, industrial and urban development, toxic organic chemicals, and organic contaminants in soils; fertilizers and fertilizer management; recycling of soil nutrients.

Different techniques of soil conservation (mechanical and biological)

### **Unit 4: Land use changes**

**(5 lectures)**

Land use pattern, drivers of land use and land cover change in major geographic zones and biodiverse regions with particular reference to the Himalaya and the Western Ghats.

### **Unit 5: Land degradation and management**

**(20 lectures)**

Land degradation: biological and physical phenomena; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors, Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on farming communities; effects on food security; effects on nutrient cycles; future effects of soil degradation; emerging threats of land degradation to developing countries.

Sustainable land use planning; role of databases and data analysis in land use planning control and management; land tenure and land policy; legal, institutional and sociological factors; participatory land degradation assessment; integrating land degradation assessment into conservation.

**CC 4 (2<sup>ND</sup> SEMESTER) ENV-A-CC-2-4-P: LAND MANAGEMENT AND SOIL  
CONSERVATION**

1. Soil Organic Carbon, Water Holding Capacity, Determination of Soil carbonate and Bicarbonate , Available NPK of Soil (Demonstration only). (20)
2. Viva voce (5), Laboratory Notebook (5)

## **CC 5 (3<sup>RD</sup> SEMESTER) ENV-A-CC-3-5-TH: ECOLOGY AND ECOSYSTEMS**

**Theory (50 Lectures)**

### **Unit1: Introduction to Ecology**

**(12 lectures)**

Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes. Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types of niche: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation.

### **Unit 2: Population Ecology**

**(8 lectures)**

Concept of population; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; limits to population growth.

### **Unit 3: Community Ecology**

**(8 lectures)**

Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism, protooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession: primary and secondary successions, models and types of successions, and meta-population; r- and K-selection, climax community concepts, examples of succession, rudreal, competitive and stress-tolerance strategies

### **Unit 4: Ecosystem ecology**

**(15 lectures)**

Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem boundary; ecosystem function; ecosystem metabolism; primary production and models of energy flow; secondary production and trophic efficiency; ecosystem connections: food chain, food web; detritus pathway of energy flow and decomposition processes; ecological efficiencies; ecological pyramids: pyramids of number, biomass, and energy. Concept of exotics and invasives; natural spread versus man-induced invasions; characteristics of invaders; stages of invasion; mechanisms of invasions; invasive pathways; impacts of invasion on ecosystem and communities; invasive ecogenomics – role of polyploidy and genome size in determining invasiveness; economic costs of biological invasions.

### **Unit 5: Biogeochemical cycles and nutrient cycling**

**(7 lectures)**



Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake; role of mycorrhizae; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies.

**CC 5 (3<sup>RD</sup> SEMESTER) ENV-A-CC-3-5-TH: ECOLOGY AND ECOSYSTEMS**

1. Field study in ecology using both qualitative and quantitative studies (Checklist/Quadrat /Transect) from any one of the following bio-geographical area (coastal/ forest/ Hills) with report submission. (20)
2. Viva-voce (10)

## **CC 6 (3<sup>RD</sup> SEMESTER) ENV-A-CC-3-6-TH: ENVIRONMENTAL BIOTECHNOLOGY**

### **Theory (50 Lectures)**

#### **Unit 1: Basic Concepts of Microbiology**

**(6 lectures)**

Classification of microorganisms, different factors for microbial growth, staining techniques

#### **Unit 2: The Structure and Function of DNA, RNA and Protein**

**(10 lectures)**

DNA: structural forms and their characteristics (B, A, C, D, T, Z); physical properties: UV absorption spectra, denaturation and renaturation kinetics; biological significance of different forms; Synthesis.

RNA: structural forms and their characteristics (rRNA, mRNA, tRNA; SnRNA, Si RNA, miRNA, hnRNA); biological significance of different types of RNA; synthesis.

Protein: hierarchical structure (primary, secondary, tertiary, quaternary), types of amino acids; post-translational modifications and their significance; synthesis; types and their role: structural, functional (enzymes).

Central dogma of biology; genetic material prokaryotes, viruses, eukaryotes and organelles; mobile DNA; chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin).

#### **Unit 3: Recombinant DNA Technology**

**(10 lectures)**

Recombinant DNA: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA: restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); genomic and cDNA libraries: construction, screening and uses; cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes)

#### **Unit 4: Biotechnology of Solid waste and solid waste treatment**

**(15 lectures)**

Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques; solid waste treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment); specific bioremediation technologies: land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, use of bioreactors for bioremediation; phytoremediation; remediation of degraded ecosystems; degradation of xenobiotics in environment

**Unit 4: Ecologically safe products and processes****(7 lectures)**

PGPR bacteria: biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation, accumulation and concentration of metals, metal leaching.

**Unit 5: GMs and GMOs****(2 lectures)**

Concept of GM and GMOs, case studies, biosafety protocol

**CC 6 (3<sup>RD</sup> SEMESTER) ENV-A-CC-3-6-P: ENVIRONMENTAL BIOTECHNOLOGY**

1. Gram Staining, Total coliform count (MPN), ABO Blood grouping. (10)
2. Review paper preparation/ presentation on topics related to Environmental Biotechnology. (15)
3. Viva-voce. (5)

## CC 7 (3<sup>RD</sup> SEMESTER) ENV-A-CC-3-7-TH:ATMOSPHERE AND GLOBAL CLIMATE CHANGE

**Theory (50 Lectures)**

### **Unit 1: Global energy balance**

**(4 lectures)**

Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; green house gases (GHGs); greenhouse effect; global conveyor belt.

### **Unit 2: Atmospheric circulation**

**(12 lectures)**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; *El Nina* and *La Nina*; tropical cyclone; Indian monsoon and its development, effect of urbanization on micro climate; Asian brown clouds.

### **Unit 3: Meteorology and atmospheric stability**

**(14 lectures)**

Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion; plume behavior; Gaussian plume model.

### **Unit 4: Global warming and climate change**

**(12 lectures)**

Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green house gases (GHGs) causing the climate change; atmospheric windows; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO<sub>2</sub> fertilization and agriculture; impact on economy and spread of human diseases.

Environmental policy debate; International agreements; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

### **Unit 5: Ozone layer depletion**

**(8 lectures)**

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols - Montreal protocol 1987.

**CC 7 (3<sup>RD</sup> SEMESTER) ENV-A-CC-3-7-P:ATMOSPHERE AND GLOBAL CLIMATE  
CHANGE**

1. Estimation of atmospheric pressure, relative humidity, rainfall, insolation, wind speed, light intensity (Lux meter) (20)
2. Viva-voce. (5), Laboratory notebook (5)

## **SKILL ENHANCEMENT COURSE (SEC)**

**SEC-A (Anyone from SEC A1 OR SEC A2 IN 3<sup>RD</sup> SEMESTER)**

**ENV-A-SEC-A-3-X-TH**

### **SEC A 1: REMOTE SENSING, GEOGRAPHIC INFORMATION SYSTEM & MODELLING**

**Theory (Lectures: 30)**

**Unit 1:** Remote Sensing: definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation.

**Unit 2:** Geographical Information Systems: definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use! land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping.

**Unit 3:** Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies.

### **SEC A 2: WILDLIFE MANAGEMENT**

**Theory (Lectures: 30)**

**Unit 1:** Need of wildlife management; role of stakeholders in managing wildlife. Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetka wall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; understanding wildlife management, conservation and policies regarding protected areas in 21<sup>st</sup> century; positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

**Unit 2:** Principles and practices of wildlife management, Course and fine filter approaches for wildlife Management. Analysis of wild life management problems. Species conservation projects in India (Tiger, Rhino, Lion)

**Unit 3:** Capture and handling techniques, Identification and marking techniques, Measuring animal abundance, radio telemetry,

## CC 8 (4<sup>TH</sup> SEMESTER) ENV-A-CC-4-8-TH: SYSTEMATICS AND BIOGEOGRAPHY

**Theory (Lectures: 50)**

### **Unit 1: Concept and systematics approaches (12 lectures)**

Definition of systematics; taxonomic identification; keys; field inventory; herbarium; museum; botanical gardens; taxonomic literature; nomenclature; evidence from anatomy, ultrastructure, cytology, phytochemistry, numerical and molecular methods. Concept of taxa (species, genus, family, order, class, phylum, kingdom); concept of species (taxonomic, typological, biological, evolutionary, phylogenetic); categories and taxonomic hierarchy.

### **Unit 2: Nomenclature and systems of classification (6 lectures)**

Principles and rules (International Code of Botanical and Zoological Nomenclature); ranks and names; types and typification; author citation; valid publication; rejection of names; principle of priority and its limitations; names of hybrids.

### **Unit 4: Biogeography (6 lectures)**

Biogeographical rules – Gloger's rule, Bergmann's rule, Allen's rule, Geist rule; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species.

### **Part-A: Historical Biogeography (6 lectures)**

Earth's history; paleo-records of diversity and diversification; continental drift and plate tectonics and their role in biogeographic patterns – past and present; biogeographical dynamics of climate change and Ice Age.

### **Part-B: Ecological Biogeography (10 lectures)**

Species, habitats; environment and niche concepts; biotic and abiotic determinants of communities; species-area relationships; concept of rarity and commonness; Island Biogeography theory; Equilibrium Theory of Insular Biogeography; geography of diversification and invasion; phylogeography.

### **Part-C: Conservation Biogeography (2 lectures)**

Application of biogeographical rules in design of protected area and biosphere reserves; use of remote sensing in conservational planning.

## Unit 5: Speciation and extinction

(8 lectures)

Types and processes of speciation – allopatric, parapatric, sympatric; ecological diversification; adaptive radiation, convergent and parallel evolution; dispersal and immigration; means of dispersal and barriers to dispersal; extinction.

### CC 8 (4<sup>TH</sup> SEMESTER) ENV-A-CC-4-8-P: SYSTEMATICS AND BIOGEOGRAPHY

1. Identification of suitable flora and fauna (Definite list of specimens of ecological and economic significance). (20)

#### Specimens for Identification

*Agaricus* sp.  
Crustose Lichen  
*Azolla* sp.  
*Pteris* sp.  
*Ceratophyllum* sp.  
*Andrographis paniculata*  
*Eichhornia crassipes*  
*Lemna minor*  
*Parthenium hysterophorus*  
*Lantana camara*  
*Jatropha* sp.  
*Rauwolfia serpentina/canescens*  
*Acanthus ilicifolius*  
*Pisum sativum*  
*Opuntia dillenii*  
*Solanum lycopersicum*  
*Ficus benghalensis*  
*Datura metel*  
*Vanda roxburghii*  
*Aloe vera*

#### Specimens for Identification

*Hirudinea* sp.  
*Physalia* sp.  
*Taenia solium*  
*Ascaris lumbricoides*  
*Entamoeba histolytica*  
*Coccinella septempunctata*  
*Tryporyza incertulas*  
Spider  
*Lamellidens marginalis*  
*Octopus* sp.  
*Pila* sp.  
*Asterias* sp.  
*Carcharodon carcharias*  
*Tilapia* sp.  
*Exocetus* sp.  
*Rhacophorus* sp.  
*Naja* sp.  
*Chamaeleo* sp.  
*Columba livia*  
*Culex* sp.

2. Identification Key Preparation. (5)
3. Laboratory notebook and Viva voce (5)



## **CC 9 (4<sup>TH</sup> SEMESTER) ENV-A-CC-4-9-TH: URBAN ECOSYSTEMS**

**Theory (50 Lectures)**

### **Unit 1: Environment in an urban setting**

**(8 lectures)**

Man as the driver of urban ecosystem; commodification of nature; metros, cities and towns as sources and sinks of resources; resource consumption and its social, cultural, economic and ecological perspectives; urban transformation; increasing challenges posed by modernity for the environment.

### **Unit 2: Urban dwelling**

**(12 lectures)**

Urban Sprawl; Housing scenario across a range of large-medium-small cities; poverty and slums in an urban context; Town planning Acts and their environmental aspects; energy consumption and waste disposal as well as accumulation; environmental costs of urban infrastructure.

### **Unit 3: Urban interface with the environment**

**(10 lectures)**

Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources; individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; Green technologies in historical and contemporary perspectives; successful green technologies: wind turbines, solar panels; 3R's of green technology: recycle, renew and reduce.

### **Unit 4: Natural spaces in a city**

**(8 lectures)**

Concept of 'controlled nature'; scope, importance and threats to nature in the city; organization and planning of green spaces such as parks, gardens and public spaces; concept of green belts; urban natural forest ecosystem as green lungs.

### **Unit 5: Planning and environmental management**

**(12 lectures)**

Green buildings; history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building; Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities, role of informal sector in waste management, public transportation for sustainable development, green belts.; rainwater harvesting (Corporation and Municipal areas)

**CC 9 (4<sup>TH</sup> SEMESTER) ENV-A-CC-4-9-P: URBAN ECOSYSTEMS**

1. Urban survey in group of maximum five students (Corporations and Municipal areas) with field report submission and field viva (20)
2. Viva-voce (10)

## **CC 10 (4<sup>TH</sup> SEMESTER) ENV-A-CC-4-10-TH: ENVIRONMENTAL LEGISLATION AND POLICY**

**Theory (50 lectures)**

### **Unit 1: Introduction**

**(4 lectures)**

Constitution of India; fundamental rights; fundamental duties; Union of India; union list, state list, concurrent list; legislature; state assemblies; judiciary; panchayats and municipal bodies.

### **Unit 2: History of environmental legislation and policy**

**(8 lectures)**

Provision of Environmental Conservation - British India: Indian Penal Code 1860, Forest Act 1865, Fisheries Act 1897; Independent India: Van Mahotsava 1950, National Forest Policy 1952, National Forest Policy 1988.

### **Unit 3: Environmental legislation**

**(25 lectures)**

Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).

The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Water (Prevention and Control of Pollution) Cess Act 1977; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002; The Schedule Tribes and other Traditional Dwellers (Recognition of Forests Rights) Act 2006; The National Green Tribunal Act 2010; scheme and labeling of environment friendly products, Ecomarks.

### **Unit 4: Role of Government institutions and National Policies**

**(5 lectures)**

Role of Ministry of Environment, Forests & Climate Change in environmental law and policy making; role of central and state pollution control boards in environmental law and policy making; National Green Tribunal; National Environment Policy, 2006.

### **Unit 5: International laws and policy**

**(8 lectures)**

Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar convention.

## **CC 10 (4<sup>TH</sup> SEMESTER) ENV-A-CC-4-10-P : ENVIRONMENTAL LEGISLATION AND POLICY**

1. Review of different Case studies on Environmental Issues and power point presentation. (30)

## **SKILL ENHANCEMENT COURSE (SEC)**

### **SEC-B (Anyone from SEC B1 OR SEC B2 IN 4<sup>TH</sup> SEMESTER)**

#### **ENV-A-SEC-A-4-X-TH**

### **SEC B1 : ENVIRONMENTAL IMPACT AND RISK ASSESSMENT**

#### **Theory (30 Lectures)**

**Unit 1:** Environmental impact assessment (EIA): definitions, introduction and concepts; rationale and historical development of EIA; scope and methodologies of EIA; role of project proponents, project developers and consultants; Terms of Reference; impact identification and prediction; baseline data collection; Environmental Impact Statement (EIS), Environmental Management Plan (EMP)

**Unit 2:** Rapid EIA; Strategic Environmental Assessment; Social Impact Assessment; Cost-Benefit analysis; Life cycle assessment; environmental appraisal; environmental management - principles, problems and strategies; environmental planning; environmental audit; introduction to ISO and ISO 14000; sustainable development.

**Unit 3:** EIA regulations in India; status of EIA in India; current issues in EIA; case study of hydropower projects! thermal projects.

**Unit 4:** Risk assessment: introduction and scope; project planning; exposure assessment; toxicity assessment; hazard identification and assessment; risk characterization; risk communication; environmental monitoring; community involvement; legal and regulatory framework; human and ecological risk assessment.

### **SEC B 2: ANALYTICAL METHODS, INSTRUMENTATION AND MEASUREMENT**

#### **Theory (30 Lectures)**

**Unit 1:** Sampling, preservation, storage techniques; Principles and applications of titrimetry (Acidimetry, Alkalimetry, Complexometry, Argentometry, Iodometry) gravimetry, potentiometry, conductimetry.

**Unit 2:** Principles and application of UV-VIS Spectrophotometry, Atomic absorption spectrophotometry flame photometry, electrophoresis Chromatography, X-Ray fluorescence and Microscopy- Properties, Types

and applications.

**Unit 3:** Data Information Knowledge Wisdom Loop, data analysis, errors in data representation.

## **CC 11 (5<sup>TH</sup> SEMESTER) ENV-A-CC-5-11-TH: BIODIVERSITY AND CONSERVATION BIOLOGY**

**Theory (50 Lectures)**

### **Unit 1: Biodiversity patterns and estimation**

**(12 lectures)**

Definition; Types; Spatial patterns: latitudinal and elevational trends in biodiversity; temporal patterns: seasonal fluctuations in biodiversity patterns.

Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation; community diversity estimation: alpha, beta and gamma diversity.

### **Unit 2: Importance of biodiversity**

**(8 lectures)**

Economic values – medicinal plants, drugs, fisheries and livelihoods; ecological services – primary productivity, role in hydrological cycle, biogeochemical cycling; ecosystem services – purification of water and air, nutrient cycling, climate control, pest control, pollination, and formation and protection of soil; social, aesthetic, consumptive, and ethical values of biodiversity.

### **Unit 3: Threats to biodiversity**

**(10 lectures)**

Natural and anthropogenic disturbances; habitat loss, habitat degradation, and habitat fragmentation; climate change; pollution; hunting; over-exploitation; deforestation; hydropower development; invasive species; land use changes; overgrazing; man wildlife conflicts; consequences of biodiversity loss; Intermediate Disturbance Hypothesis.

### **Unit 4: Conservation of biodiversity**

**(10 lectures)**

Importance of biodiversity patterns in conservation; In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation (botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissue culture and DNA banks), role of local communities and traditional knowledge in conservation; biodiversity hotspots; IUCN Red List categorization – guidelines, practice and application; Red Data book; ecological restoration; afforestation; social forestry; agro forestry; joint forest management; role of remote sensing in management of natural resources.

### **Unit 5: Biodiversity in India**

**(10 lectures)**

India as a mega diversity nation; phytogeographic and zoogeographic zones of the country; forest types and forest cover in India; fish and fisheries of India; impact of hydropower development on biological diversity; status of protected areas and biosphere reserves in the country; National Biodiversity Action Plan.

**CC 11 (5<sup>TH</sup> SEMESTER) ENV-A-CC-5-11-P**

1. Biodiversity assessment in local field work (Calculation of parameters (Frequency, density, abundance, relative density) and indices (Shannon wiener diversity index, Simpson's index, Simpson's index of diversity, evenness index) and report submission. (20)
2. Viva voce (10)

## **CC 12 (5<sup>TH</sup> SEMESTER) ENV-A-CC-5-12-TH: ORGANISMAL AND EVOLUTIONARY BIOLOGY**

### **Theory (50 Lectures)**

#### **Unit 1: History of life on Earth**

**(17 lectures)**

Part-A : Paleontology and evolutionary History; evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; stages in primate evolution including Homo.

Part B: Lamarck's concept of evolution; Darwin's Evolutionary Theory: variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; The Evolutionary Synthesis.

#### **Unit 2: Evolution of unicellular life**

**(8 lectures)**

Origin of cells and unicellular evolution and basic biological molecules; abiotic synthesis of organic monomers and polymers; Oparin-Haldane hypothesis; study of Miller; the first cell;

#### **Unit 3: Geography of evolution**

**(5 lectures)**

Biogeographic evidence of evolution; patterns of distribution.

#### **Unit 4: Molecular evolution**

**(7 lectures)**

Introduction to biomolecules: Protein, Lipids, Carbohydrates (General characteristics and classification) Neutral evolution; molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis.

#### **Unit 5: Fundamentals of population genetics**

**(13 lectures)**

Concepts of populations, gene pool, gene frequency; concepts and rate of change in gene frequency through natural selection, migration and genetic drift; adaptive radiation; isolating mechanisms; speciation (allopatric, sympatric, peripatric and parapatric); convergent evolution; sexual selection; co-evolution; Hardy-Weinberg Law.

## **CC 12 (5<sup>TH</sup> SEMESTER) ENV-A-CC-5-12-P: ORGANISMAL AND EVOLUTIONARY BIOLOGY**

1. Numerical problems on pedigree and population genetics. (10)
2. Estimation of protein using BSA (Lowry method), Glucose (Anthrone Method) (10)
3. Viva-voce (5), Laboratory Notebooks (5)



## **DISCIPLINE SPECIFIC ELECTIVE**

### **5<sup>TH</sup> SEMESTER**

**ENV-A-DSE-A-5-1-TH+P AND ANY ONE FROM ENV-A-DSE-B-5-2-TH+P OR  
ENV-A-DSE-B-5-3-TH+P**

#### **ENV-A-DSE-A-5-1-TH : ENERGY AND ENVIRONMENT**

**Theory (50 Lectures)**

##### **Unit 1: Energy resources**

**(12 lectures)**

Defining energy; forms and importance; Global energy resources; renewable and non-renewable resources: distribution and availability; sources and sinks of energy; past, present, and future technologies for capturing and integrating these resources into our energy infrastructure.

##### **Unit 2: Energy demand**

**(7 lectures)**

Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector; generation and utilization in rural and urban environments; changes in demand in major world economies; energy subsidies; environmental costs.

##### **Unit 3: Energy, environment and society**

**(15 lectures)**

Energy production as driver of environmental change; nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution, nuclear energy and related issues such as radioactive waste, spent fuel; energy production, transformation and utilization associated environmental impacts (Chernobyl and Fukushima nuclear accidents, construction of dams, environmental pollution); energy over-consumption and its impact on the environment, economy, and global change; social inequalities related to energy production, distribution, and use; energy conservation.

##### **Unit 4: Our energy future**

**(16 lectures)**

Current and future energy use patterns in the world and in India; evolution of energy use over time; alternative sources as green energy (biofuels, wind energy, solar energy, geothermal energy; tidal energy, ocean energy; nuclear energy); need for energy efficiency; energy conservation and sustainability; action strategies for sustainable energy management from a future perspective

## **DSE A1: ENV-A-DSE-A-5-1-P**

1. Calculation of energy efficiency from given data. (10)
2. Preparation of energy audit of a domestic unit and report submission. (10)
3. Viva-voce (10)

## **DSE B2 ENV-A-DSE-B-5-2-TH : SOLID WASTE MANAGEMENT**

**Theory (50 Lectures)**

### **Unit 1: Introduction**

**(3 lectures)**

Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.

### **Unit 2: Effect of solid waste disposal on environment**

**(5 lectures)**

Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.

### **Unit 3: Solid waste Management**

**(12 lectures)**

Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques.

### **Unit 4: Industrial waste management**

**(6 lectures)**

Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant.

### **Unit 5: Resource Recovery**

**(6 lectures)**

4R - reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.

### **Unit 6: Waste-to-energy (WTE)**

**(4 lectures)**

Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification.

**Unit 7: Integrated waste management****(4 lectures)**

Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management.

**Unit 8: Policies for solid waste management****(10 lectures)**

Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Plastic Waste (Management and Handling) Rules, 2011; E-Waste (Management) Rules, 2016

**DSE B2: ENV-A-DSE-B-5-2-P**

1. Visit to a Solid Waste Management site and Report submission. (20)
2. Viva-voce (10)

**DSE B3: ENV-A-DSE-B-5-3-TH: ENVIRONMENTAL HEALTH AND TOXICOLOGY****Theory (50 Lectures)****Unit 1: Epidemiology and Health****(6 lectures)**

Concept of Health and Disease, principles of epidemiology and epidemiological methods, aims of epidemiology, measurement of mortality, measurement of morbidity.

**Unit 2: Concept of Disease****(10 lectures)**

Concept of screening the diseases, some communicable diseases like small pox, cholera, acute diarrheal disease, viral hepatitis, water borne pathogens, vector borne diseases, diseases caused by contaminated food and water, soil borne infections, insect borne diseases.

**Unit 3: Concept of Immunology****(12 lectures)**

Elementary idea about antigens and antibody, hyper sensitivity, allergic reactions, pollens and their allergens. Immunological techniques.

**Unit4: Community and Health****(2 lectures)**

Communication for health education, health care of the country.

**Unit 5: Basic Concept of Toxicology****(20 lectures)**

Different types of toxicant, toxicity test, toxicity by different factors, exposure effect relationship, different route of exposure, synergistic and antagonistic effect, Bioaccumulation and Biomagnification. Detoxification, toxico-dynamics.

**DSE B3: ENV-A-DSE-B-5-3-P**

1. LC<sub>50</sub> calculation by probit analysis with data provided. (10)
2. Study of Nuclear abnormalities in the erythrocytes of fish/ from root tip of *Allium cepa* (10)
3. Viva-voce (5), Laboratory notebooks (5)

## **CC 13 (6<sup>TH</sup> SEMESTER) ENV-A-CC-6-13-TH: ENVIRONMENTAL POLLUTION AND HUMAN HEALTH**

**Theory (50 Lectures)**

### **Unit 1: Introduction**

**(9 lecture)**

Definition of pollution; pollutants; classification of pollutants. Solubility of pollutants (hydrophilic and lipophilic pollutants), transfer of pollutants within different mediums, role of chelating agents in transferring pollutants, concept of biotransformation and bioaccumulation, concept of radioactivity, radioactive decay and half-life of pollutants, organometallic compounds, acid mine drainage.

### **Unit 2: Air pollution**

**(8 lectures)**

Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NO<sub>x</sub>, SO<sub>x</sub>, PM, CO, CO<sub>2</sub>, hydrocarbons and VOCs) and control measures; indoor air pollution: sources and effects on human health.

### **Unit 3: Water pollution**

**(8 lectures)**

Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; COD, BOD, DO; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).

### **Unit 4: Soil pollution**

**(4 lectures)**

Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies.

### **Unit 5: Noise pollution**

**(3 lectures)**

Noise pollution-sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures.

### **Unit 6: Radioactive and thermal pollution**

**(4 lectures)**

Radioactive material and sources of radioactive pollution; effect of radiation on human health (somatic and genetic effects); thermal pollution and its effects.

**Unit 7: Marine pollution****(4 lectures)**

Marine resources and their importance; sources of marine pollution; oil spill and its effects; coral reefs and their demise; coastal area management; existing challenges and management techniques (planning, construction, environmental monitoring of coastal zones).

**Unit 8: Pollution control****(10 lectures)**

Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG in NCT of Delhi.

**CC 13 (6<sup>TH</sup> SEMESTER) ENV-A-CC-6-13-P: ENVIRONMENTAL POLLUTION AND HUMAN HEALTH**

1. BOD, COD, Noise (dB(A), SPM, RSPM, Dust fall rate, Soil respiration. (20)
2. Viva Voce (5), Laboratory notebook (5)

## **CC 14 (6<sup>TH</sup> SEMESTER) ENV-A-CC-6-14-TH: NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY**

### **Theory (50 Lectures)**

#### **Unit 1: Introduction**

**(7 lectures)**

Resource and reserves; classification of natural resources; renewable and non-renewable resources; resource degradation; resource conservation; resource availability and factors influencing its availability; land resources; water resources; fisheries and other marine resources; energy resources; mineral resources; human impact on natural resources; ecological, social and economic dimension of resource management.

#### **Unit 2: Natural resources and conservation**

**(7 lectures)**

Forest resources: economic and ecological importance of forests, forest management strategies, sustainable forestry; water resources: supply, renewal, and use of water resources, freshwater shortages, strategies of water conservation; soil resources: importance of soil, soil conservation strategies; food resources: world food problem, techniques to increase world food production, green revolution.

#### **Unit 3: Mineral resources**

**(8 lectures)**

Mineral resources and the rock cycle; identified resources; undiscovered resources; reserves; types of mining: surface, subsurface, open-pit, dredging, strip; reserve-to-production ratio; global consumption patterns of mineral resources techniques to increase mineral resource supplies; ocean mining for mineral resources; environmental effects of extracting and using mineral resources.

#### **Unit 4: Energy resources**

**(20 lectures)**

**Part A:** Oil: formation, exploration, extraction and processing, oil shale, tar sands; natural gas: exploration, liquefied petroleum gas, liquefied natural gas; coal: reserves, classification, formation, extraction, processing, coal gasification; environmental impacts of non-renewable energy consumption; impact of energy consumption on global economy; application of green technology; future energy options and challenges.

**Part B:** Energy efficiency; life cycle cost; cogeneration; solar energy: technology, advantages, passive and active solar heating system, solar thermal systems, solar cells, 1NN solar mission; hydropower: technology, potential, operational costs, benefits of hydropower development; nuclear power: nuclear fission, fusion, reactors, pros and cons of nuclear power, storage of radioactive waste, radioactive contamination; tidal energy; wave energy; ocean thermal energy conversion (OTEC); geothermal energy; energy from biomass; bio-diesel.

## **Unit 5: Resource management**

**(8 lectures)**

Approaches in resource management: ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies; concept of sustainability science: different approach towards sustainable development and its different constituents; sustainability of society, resources and framework; sustainable energy strategy; principles of energy conservation; Indian renewable energy programme.

### **CC 14 (6<sup>TH</sup> SEMESTER) ENV-A-CC-6-14-P: : NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY**

1. **Project Work: Submission of report & presentation (30)**



## **DISCIPLINE SPECIFIC ELECTIVE**

### **6<sup>TH</sup> SEMESTER**

**ENV-A-DSE-B-6-1-TH+P AND ANY ONE FROM ENV-A-DSE-A-6-2-TH+P OR ENV-A-DSE-A-6--3-TH+P**

**DSE B1: ENV-A-DSE-B-6-1-TH: NATURAL HAZARDS AND DISASTER MANAGEMENT**

**Theory (50 Lectures)**

#### **Unit 1: Introduction (3 lectures)**

Definition of hazard; natural, technological, and context hazards; concept of risk and vulnerability; reasons of vulnerability - rapid population growth, urban expansion, environmental pollution, epidemics, industrial accidents, inadequate government policies.

#### **Unit 2: Natural hazards (16 lectures)**

Natural hazards: hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution; floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought-meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF); tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.

#### **Unit 3: Anthropogenic hazards (15 lectures)**

Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation, mangroves destruction; role of construction along river banks in elevating flood hazard; disturbing flood plains. deforestation and landslide hazards associated with it; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster.

#### **Unit 4: Risk and vulnerability assessment (4 lectures)**

Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses, and intangible losses); application of geoinformatics in hazard, risk & vulnerability assessment.

#### **Unit 5: Mitigation and preparedness (6 lectures)**

Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigations such as barrier, deflection and retention systems; concept of preparedness; importance of planning, exercise, and training in preparedness; role of public, education and media in hazard preparedness.

#### **Unit 6: Disaster management in India**

**(6 lectures)**

Lessons from the past considering the examples of Bhuj earthquake, tsunami disaster, and Bhopal tragedy; National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study of efficient disaster management during cyclone 'Phailin' in 2013.

#### **DSE B1 ENV-A-DSE-B-6-1-P**

1. Preparation of disaster management plan for any of the following disaster flood, earthquake, cyclone, fire outbreak and report submission. (20)
2. Viva-voce (10)

**DSE A2:**

#### **ENV-A-DSE-A-6-2-TH: ENVIRONMENTAL ECONOMICS AND STATISTICS**

**Theory (50 Lectures)**

#### **Unit 1: Economic solutions to environmental problems**

**(15 lectures)**

Social costs and benefits of environmental programmes: marginal social benefit of abatement, marginal social cost of abatement; pollution control: policies for controlling air and water pollution, disposal of toxic and hazardous waste- standards vs. emissions charges, environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system.

#### **Unit 2: Natural resource economics**

**(5 lectures)**

Economics of non-renewable resources; economics of fuels and minerals; Hotelling's rule and extensions; taxation; economics of renewable resources; economics of water use, management of fisheries and forests; introduction to natural resource accounting.

#### **Unit 3: Tools for environmental economic policy**

**(10 lectures)**

Growth and environment; environmental audit and accounting, Kuznets curve, environmental risk analysis, assessing benefits and cost for environmental decision making; cost benefit analysis and

valuation: discounting, principles of Cost-Benefit Analysis, estimation of costs and benefits, techniques of valuation, adjusting and comparing environmental benefits and costs.

#### **Unit 4: Statistical techniques applied to Environmental systems (20 lectures)**

Variables, population and Sampling, sampling methods, sampling error, frequency distribution, bar diagram, pie diagram, arithmetic and geometric mean, mode, median, measures of deviation, null and alternative hypothesis, probability distribution, t-test,  $\chi^2$  Test, correlation and regression.

#### **DSE A2**

##### **ENV-A-DSE-A-6-2-P**

1. Numerical problems on biostatistics Chi-Square test (Goodness of fit, Contingency) Student's t test (Paired and Unpaired) (20)
2. Viva-voce (5), Laboratory Notebooks (5)

#### **DSE A3:**

##### **ENV-A-DSE-A-6-3-TH: GREEN TECHNOLOGIES**

#### **Unit 1: Green infrastructure, planning and economy (14 lectures)**

Green buildings; history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building; Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities, role of informal sector in waste management, public transportation for sustainable development, green belts.

#### **Unit 2: Applications of green technologies (14 lectures)**

Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats). Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets, promotion and/ or subsidy of alternative forms of transportation for employees, such as carpools, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse).

Pollution reduction and removal (Flue Gas Desulfurization (FGD) methods, catalytic or thermal destruction of NO<sub>x</sub>, Fluidized Bed Combustion, Dioxins reduction and removal methods, Thermal Oxidizers or Wet Scrubbers to neutralize chemicals or heavy metals, solvent recovery systems, Low Volatile Organic Compound (VOC) paints and sealers).

**Unit 3: Green chemistry****(12 lectures)**

Introduction to green chemistry; principles and recognition of green criteria in chemistry; bio- degradable and bio-accumulative products in environment; green nanotechnology; reagents, reactions and technologies that should be and realistically could be replaced by green alternatives; photodegradable plastic bags.

**Unit 5: Green future****(10 lectures)**

Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usage and consumption, etc.); emphasis on waste reduction instead of recycling, emphasis on innovation for green future; role of advancement in science in developing environmental friendly technologies.

**DSE A3: ENV-A-DSE-A-6-3-P**

1. Analysis of stability of vermicompost by compost respiration method. (10)
2. Analysis of rainwater harvesting potential in uraban/rural catchments (10)
3. Viva-voce (5), Laboratory Notebooks (5)

## Suggested Readings:

1. Abbasi T. and Abbasi S.A., 2010. *Renewable Energy Resources: Their Impact on Global warming and Pollution*. PHI.
2. Abraham, C.M. 1999. *Environmental Jurisprudence in India*. Kluwer Law International.
3. APHA, 2012. *Standard Methods for the Examination of Water and Waste water (21<sup>st</sup> ed)*. APHA.
4. Anastas, P.T. & Warner, J.C. 1998. *Green Chemistry: Theory & Practice*. Oxford University Press
5. Asnani, P.U. 2006. Solid waste management. *India Infrastructure Report 570*.
6. Bagchi, A. 2004. *Design of Landfills and Integrated Solid Waste Management*. John Wiley & Sons.
7. Baird C., and Cann M., 2005. *Environmental Chemistry (3<sup>rd</sup> Ed.)*. W H Freeman and Co.
8. Banerjee P.K., 2006. *Textbook of Geology*, World Press.
9. Banerjee P.K., 2011. *Introduction to Biostatistics*. S, Chand.
10. Bansil, P.C. 2004. *Water Management in India*. Concept Publishing Company, India.
11. Barrow, C.J. 2000. *Social Impact Assessment: An Introduction*. Oxford University Press.
12. Barry, R. G. 2003. *Atmosphere, Weather and Climate*. Routledge Press, UK.
13. Bawa K.S., Primack R.B, Oommen M.A. 2004. *Conservation Biology: A Primer for South Asia*. University Press.
14. Blackman, W.C. 2001. *Basic Hazardous Waste Management*. CRC Press.
15. Bluman, 2007. *Elementary Statistics: A step by Step Approach*. Mc Grawhill.
16. Blyth F.G.H., and Freitas M.H. 2006. *A Geology for Engineers (7<sup>th</sup> Ed. & 1<sup>st</sup> Indian ed.)*. Elsevier.
17. Boeker, E. & Grondelle, R. 2011. *Environmental Physics: Sustainable Energy and Climate Change*. Wiley
18. Boyle G., 2004. *Renewable Energy: Power for Sustainable Future*. Oxford University Press.
19. Brady, N.C. & Weil, R.R. 2007. *The Nature and Properties of Soils (13<sup>th</sup> edition)*, Pearson Education Inc.
20. Brebbia, C.A. 2013. *Water Resources Management VII*. WIT Press.
21. Bridge, J., & Demicco, R. 2008. *Earth Surface Processes, Landforms and Sediment Deposits*. Cambridge University Press.
22. Coppola D.P. 2007. *Introduction to International Disaster Management*. Butterworth Heinemann.
23. Craig, J.R., Vaughan, D.J. & Skinner, B.I. 1996. *Resources of the Earth: Origin, Use, and Environmental Impacts (2<sup>nd</sup> edition)*. Prentice Hall, New Jersey.
24. Craig, J.R., Vaughan, D.J., Skinner, B.J. 1996. *Resources of the Earth: Origin, use, and environmental impact (2<sup>nd</sup> edition)*. Prentice Hall, New Jersey.
25. Critchfield, H.J. 2012. *General Climatology (4<sup>th</sup> & Indian edition)*, PHI.
26. Cutter, S.L. 2012. *Hazards Vulnerability and Environmental Justice*. Earth Scan, Routledge Press.
27. Das Asim K. 2010. *Environmental Chemistry with Green Chemistry*. Books and Allied.
28. Das, N.G. *Statistical Methods*. McGrawHill Publication.

29. Demers, M.N. 2005. *Fundamentals of Geographic Information System*. Wiley & Sons.
30. Divan, S. & Rosencranz, A. 2001. *Environmental Law and Policy in India*. Oxford University Press.
31. D'Monte, Darryl. 1985. *Industry versus Environment Templesar Tambs*. Three Controversies, Delhi, CSE.
32. Elliott, D. 1997. *Sustainable Technology. Energy, Society and Environment* (Chapter 3). New York, Routledge Press.
33. Emiliani C. 1992. *Planet Earth*, Cambridge University Press.
34. Evans, G.G. & Furlong, J. 2010. *Environmental Biotechnology: Theory and Application* (2<sup>nd</sup> edition). Wiley-Blackwell Publications.
35. Farndon, J. and Parker, S. 2009. *The Illustrated Encyclopedia of Minerals Rocks & Fossils of the World*, Hermes House.
36. Forinash, K. 2010. *Foundation of Environmental Physics*. Island Press.
37. Freeman, A.M. 2003. *Millennium Ecosystem Assessment: Conceptual Framework*. Island Press.
38. Freeman, A.M. 2001. *Measures of Value and Resources: Resources for the Future*. Washington DC.
39. Futuyma, D.J. 2009. *Evolution* (2<sup>nd</sup> edition). Sinauer Associates.
40. Gaston, K.J. 2010. *Urban Ecology*. Cambridge University Press, New York.
41. Gaston, K.J. & Spicer, J.I. 1998. *Biodiversity: An Introduction*. Blackwell Science, London, UK.
42. Gillespie, J. H. 1991. *The Causes of Molecular Evolution*. Oxford University Press.
43. Ginley, D.S. & Cahen, D. 2011. *Fundamentals of Materials for Energy and Environmental Sustainability*. Cambridge University Press.
44. Glasson, J., Therivel, R., Chadwick, A. 1994. *Introduction to Environmental Impact Assessment*. London, Research Press, UK.
45. Graur, D. & Li, W.H. 1999. *Fundamentals of Molecular Evolution* (2<sup>nd</sup> edition). Sinauer Associates.
46. Groom, B. & Jenkins, M. 2000. *Global Biodiversity: Earth's Living Resources in the 21<sup>st</sup> Century*
47. Guha, P.K. 2013. *Remote Sensing for the Beginner* (3<sup>rd</sup> ed.), Affiliated East West Press.
48. Gupta, K.R. 2006. *Environmental Legislation in India*. Atlantic Publishers and Distributors.
49. Gurevitch, J., Scheiner, S.M., & Fox, G.A. 2002. *The Ecology of Plants*. Sinauer associates incorporated.
50. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. *Air Pollution: Health and Environmental Impacts*. CRC Press, Taylor & Francis.
51. Hardy, J.T. 2003. *Climate Change: Causes, Effects and Solutions*. John Wiley & Sons.
52. Havlin J.L., Beaton J.D., Tisdale, S.L., Nelson W.L, 2013. *Soil Fertility and Fertilizer: An Introduction to Nutrient Management* (8<sup>th</sup> Ed.). PHI / Pearson.
53. Henry J.G. and Heinke G.W. 2004. *Environmental Science and Engineering* (2<sup>nd</sup> Ed.). PHI.
54. Hester, R.E. & Harrison, R.M. 1998. *Air Pollution and Health*. The Royal Society of Chemistry, UK.

55. Hewwood, I., Cornelius, S., Carver, S. 2009. *An Introduction to Geographical Information Systems (3<sup>rd</sup> ed.)*. Pearson.
56. Hites, R.A. 2012. *Elements of Environmental Chemistry*(2<sup>nd</sup>edition). Wiley & Sons.
57. Jenson J.R. 2003. *Remote Sensing of the Environment: An Earth Resource Perspective*. Pearson.
58. John M. Fryxell, Anthony R. E. Sinclair, Graeme Caughley 2014 *Wildlife Ecology, Conservation, and Management*, (3rd Edition), Wiley Blackwell
59. Johnson, D.L. 2006. *Land Degradation*(2<sup>nd</sup>edition). Rowman & Little field Publishers.
60. Jordening, H.J. & Winter J.2005. *Environmental Biotechnology: Concepts and Applications*. John Wiley & Sons.
61. Judith, P. 1999. *Handbook of Environmental Impact Assessment*. Blackwell Science.
62. Keller, E.A. 2011. *Introduction to Environmental Geology* (5<sup>th</sup>edition). Pearson Prentice Hall.
63. Keller, E.A. 1996. *Introduction to Environmental Geology*. Prentice Hall, Upper Saddle River, New Jersey.
64. Klee, G.A. 1991. *Conservation of Natural Resources*. Prentice Hall Publication.
65. Krebs C. 2009. *Ecology: Experimental Analysis of Distribution and Abundance (6<sup>th</sup> Ed.)*. Pearson.
66. Krishnamurthy, K.V. 2004. *An Advanced Text Book of Biodiversity-Principles and Practices*.
67. Lal D.S. 2011. *Climatology*. Sharda Pustak Bhawan.
68. Leeder, M., Arlucea, M.P. 2005. *Physical Processes in Earth and Environmental Sciences*. Blackwell Publishing.
69. Leelakrishnan, P. 2008. *Environmental Law in India*(3<sup>rd</sup>edition). LexisNexis India.
70. Lillesand T.M. and Kiefer R.W., 2011. *Remote Sensing and Image Interpretation (6<sup>th</sup> ed.)*. Wiley.
71. Lodish, H.F., Baltimore, D., Berk, A., Zipursky, S.L., Matsudaira, P. & Darnell, J. 1995. *Molecular Cell Biology*. W.H. Freeman.
72. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. & Brown, J.H. 2010. *Biogeography*(4<sup>th</sup> edition) Sinauer Associates, Sunderland.
73. Loreau, M. & Inchausti, P. 2002. *Biodiversity and Ecosystem functioning: Synthesis and Perspectives*. Oxford University Press, Oxford, UK.
74. Loucks, D.P., Stedinger, J.R. & Haith, D.A. 1981. *Water Resource Systems Planning and Analysis*. Englewood Cliffs, NJ, Prentice Hall.
75. Manhan, S. E. 2000. *Fundamentals of Environmental Chemistry*. CRC Press.
76. Manhan, S. E. 2015. *Water Chemistry*. CRC Press.
77. Mani, M.S. 1974. *Ecology and Biogeography in India*. Dr. W Junk Publishers., The Hague.
78. Marriott, B. 1997. *Environmental Impact Assessment: A Practical Guide*. McGraw-Hill, New York, USA.
79. Marsh, W.M. & Dozier, J. 1983. *Landscape Planning: Environmental Applications*. John Wiley and Sons.
80. Masters, G.M., and Ela W.P., 2008. *Introduction to Environmental Engineering and Science (3<sup>rd</sup> Ed.)*. Pearson.
81. Mathez, E.A. 2009. *Climate Change: The Science of Global Warming and our Energy Future*. Columbia University Press.

82. Mays, L.W. 2006. *Water Resources Sustainability*. The McGraw-Hill Publications.
83. McDougall, F.R., White, P. R., Franke, M., & Hindle, P. 2008. *Integrated Solid Waste Management: A Life Cycle Inventory*. John Wiley & Sons.
84. McMurry J.H., and Fay, R.C, 2008. *Chemistry (5<sup>th</sup> Ed.)*, Pearson.
85. Miller G.T., 1996. *Living in the Environment (9<sup>th</sup> Ed.)* Wadsworth publication.
86. Miller, G.T 2012. *Environmental Science*. Wadsworth Publishing Co.
87. Minkoff, E.C. 1983. *Evolutionary Biology*. Addison Wesley. Publishing Company.
88. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. & Sen, K. 2004. *Climate Change and India*. Universities Press, India.
89. Agawal, A., Narain, S. and Khurana, I. 2001. *Making Water Everybody's Business*. CSE Publication.
90. Agarwal, A. and Narain, S. 1997. *Dying Wisdom*. CSE Publication.
91. Narain S., 2017. *Environment Reader for Universities*. CES Delhi Publication.
92. Nei, M. 1987. *Molecular Evolutionary Genetics*. Columbia University press.
93. Nelson, D.L. & Cox, M.M. 2013. *Lehninger's Principles of Biochemistry*. W.H. Freeman.
94. Narayanan, P. 2000. *Essentials of Biophysics*. New Age Publications.
95. Odum, E.P. 1971. *Fundamentals of Ecology*. W.B. Saunders Natraj publication (Indian edition).
96. Owen, O.S, Chiras, D.D, & Reganold, I.P. 1998. *Natural Resource Conservation - Management for Sustainable Future (7<sup>th</sup> edition)*. Prentice Hall.
97. Pandey G.N. 2013. *Environmental Management*. Vikash.
98. Pandit, M.K. & Grumbine R.E. 2012. Ongoing and proposed hydropower development in the Himalaya and its impact on terrestrial biodiversity. *Conservation Biology* 26: 1061-1071.
99. Park, K. 2015. *Park's Textbook of Preventive and Social Medicine (23<sup>rd</sup> edition)*. Banarsi das Bhanot Publishers.
100. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. *Environmental and Pollutant Science*. Elsevier.
101. Perman, R. 2003. *Natural Resource and Environmental Economics*. Pearson Education.
102. Philander, S.G. 2012. *Encyclopedia of Global Warming and Climate Change (2<sup>nd</sup> edition)*. Sage Publications.
103. Pimentel, D. (Ed.). 2011. *Biological Invasions: Economic and environmental costs of alien plant, animal, and microbe species*. CRC Press.
104. Pine, J.C. 2009. *Natural Hazards Analysis: Reducing the Impact of Disasters*. CRC Press, Taylor and Francis Group.
105. Prasad CVRK, 2005, *Elementary Exercises in Geology*, University Press.
106. Prescott, Harley and Klein, 2008. *Microbiology (7<sup>th</sup> ed.)*. McGrawhill.
107. Primack, R.B. 2002. *Essentials of Conservation Biology (3<sup>rd</sup> edition)*. Sinauer Associates, Sunderland, USA.
108. Purohit, S.S. & Ranjan, R. 2007. *Ecology, Environment & Pollution*. Agrobios Publications.
109. Radojevic, M. and Baskin V.N. 1999. *Practical Environmental Analysis*. Royal Society of Chemistry, Cambridge.



110. Ramachandra T.V., 2009. *Municipal Solid Waste Management*. TERI press.
111. Ramade, F. 1984. *Ecology of Natural Resources*. John Wiley & Sons Ltd.
112. Rastogi, B.B. *Biostatistics*. MEDTEC.
113. Richards, J.A. &Jia, X. 1999.*Remote Sensing and Digital Image Processing*. Springer.
114. Richter, M. & Weiland, U. (ed.). 2012.*Applied Urban Ecology*. Wiley-Blackwell, UK.
115. Ricklef, R.E., and Miller G.L., 1999. *Ecology (4<sup>th</sup> Ed.)*. Freeman.
116. Rittman, B.E. & McCarty, P.L. 2001. *Environmental Biotechnology. Principles and Applications*. McGraw-Hill, New York.
117. Sabins, F.F. 1996. *Remote Sensing: Principles and Interpretation*. W.H. Freeman.
118. Santra S.C. 2005. *Environmental Science (2<sup>nd</sup> Ed.)*. New Central Book Agency.
119. Sawyer C.N, McCarty P.L. and Parkin G.F., 2003. *Chemistry for Environmental Engineering and Science (5<sup>th</sup> Ed., Indian Ed. 2017)*. McGraw Hill Education.
120. Scherr, S.J. 1999. *Soil degradation: A threat to developing country food security by 2020?* (Vol. 27). International Food Policy Research Institute.
121. Schneid, T.D. & Collins, L. 2001. *Disaster Management and Preparedness*. Lewis Publishers, New York, NY.
122. Schwab G.O., Fangmeier, D.D. Elliot, W.J., Frevert R.K., 2005. *Soil and Water Conservation Engineering (4<sup>th</sup> Ed.)*. Wiley.
123. Schwarze & Zhang, 2003. *Fundamentals of Groundwater*. John Wiley and Sons.
124. Scragg A. 2005. *Environmental Biotechnology (2<sup>nd</sup> Ed.)*. Oxford University press.
125. Sengar D.S. 2012. *Environmental Law*. PHI.
126. Sharma P.D 2014 *Environmental Biology and Toxicology*. Rastogi Publications
127. Shaw R., and Krishnamurthy R.R., 2009. *Disaster: Global Challenges and Local Solutions*.
128. Silberberg M.S., 2016. *Chemistry: The molecular Nature of Matter and Change (7<sup>th</sup> Ed.)*. McGraw Hill Higher Education.
129. Sincero A.P. and Sincero G.A., 2012. *Environmental Engineering (Indian Ed.)*. PHI.
130. Singh, K. & Shishodia, A. 2007. *Environmental Economics: Theory and Applications*. Sage publications.
131. Singh, G. 2012. *Plant Systematics: Theory and Practice (3<sup>rd</sup> edition)*. Oxford & IBH Pvt. Ltd., New Delhi.
132. Singh, J.S., Singh, S.P. & Gupta, S. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publications, New Delhi.
133. Smith, K. 2001. *Environmental Hazards: Assessing Risk and Reducing Disaster*. Routledge Press.
134. Snustad, D.P. & Simmons, M.J. 2011. *Principles of Genetics (6<sup>th</sup> edition)*. John Wiley & Sons.
135. Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. *Conservation Biology for All*. Oxford University Press.
136. Subrahmanyam N.S. and Sambamurty A.V.S.S. 2006. *Ecology (2<sup>nd</sup> ed.)*. Narosa.
137. Taylor D.J., Green NPO, Stout G.W., 2005. *Biological Science (3<sup>rd</sup> ed)*. Cambridge University Press.
138. Thompson and Fredrick. 1997. *Ecological Design and Planning*. John Wiley and Sons.

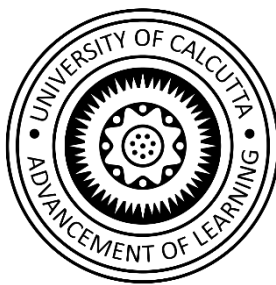
139. Thornbury William D. 2002. *Principles of Geomorphology*, CBS Publishers and Distributors.
140. Tietenberg, T. 2004. *Environmental and Natural Resource Economics* (6<sup>th</sup> Edition). Pearson Education Pvt.Ltd.
141. Tieten berg, T. H.& Lewis,L. 2010. *Environmental Economics and Policy*. Addison-Wesley.
142. Tiwari, G.N. &Ghosal. M.K. 2005. *Renewable Energy Resources: Basic Principles and*
143. Todd, D.K. and Mays L.W., 2011. *Ground Water Hydrology* (3<sup>RD</sup> Ed). Wiley.
144. Tortora, Funke and Case, 2001. *An Introduction to Microbiology* (7<sup>th</sup> ed.). Benjamin & Cummins.
145. Turner, R.K., Pearce, D., &Bateman, I. 1994. *Environmental Economics: An Elementary Introduction*. Harvester Wheatsheaf.
146. US EPA. 1999. *Guide for Industrial Waste Management*. Washington D.C.
147. Valoon G.W. and Duffy S.J. 2000. *Environmental Chemistry: A global perspective (Indian Edition)*. Oxford University Press.
148. Venkat, A. 2011. *Environmental Law and Policy*. PHI Learning Private Ltd.
149. Vesilind,P.1.,Peirce,1.1.,&WeinerR.F.1990. *Environmental Pollution and Control*. Butterwth- Heinemann, USA.
150. Vickers, A. 2001. *Handbook of Water Use and Conservation*. Water Plow Press.
151. Vogel's *textbook of quantitative inorganic analysis, including elementary instrumental analysis* 1978 (4<sup>th</sup> ed.) Longman
152. Wainwright, M. 1999. *An Introduction to Environmental Biotechnology*. Springer.
153. Wallace,J.M.&Hobbs,P.V.1977.*Atmaspheric Science: An Introductory Survey*. Academic Press, New York.
154. Welford R. 1996. *Corporate Environmental Management*. University Press.
155. Wheeler,Q.D.&MeierR.2000.*SpeciesCanceptsandPhylageneticTheory:ADebate*.Col umbia University Press, New York.
156. Wilkins,J.S. 2009. *Species: A Histary af the Idea*(Vol. 1). University of California Press.
157. Williams, D.M., Ebach, M.C. 2008.*FaundatiansafSystematics and Biogeography*. Springer.
158. Zar, 1.H. 2010. *Biostatistical Analysis*(5<sup>th</sup>edition). Prentice Hall Publications.
159. Zhu,D.,Asnani,P.U.,Zurbrugg,C.,Anapolsky,S.&Mani,S.2008.*ImpravingMunicipalS alid waste Management in India*. The World Bank, Washington D.C.

**MODEL COURSE CURRICULUM FOR UNDERGRADUATE COURSES  
UNDER CHOICE BASED CREDIT SYSTEM**

**FINAL SYLLABUS FOR**

**BACHELOR IN**

**ENVIRONMENTAL SCIENCE  
(GENERAL)**



**UNIVERSITY OF CALCUTTA**

SEMESTER	COURSES	DETAILS OF THE COURSE	CREDIT
I	CORE COURSE ENV-G-CC/GE-1-1-TH	Fundamentals of Environmental Science	4
	CORE COURSE ENV-G-CC/GE-1-1- P	Fundamentals of Environmental Science	2
	ABILITY ENHANCEMENT COURSE AECC 1	English Communications/MIL	2
II	CORE COURSE ENV-G-CC/GE-2-2-TH	Ecology and Biodiversity	4
	CORE COURSE ENV-G-CC/GE-2-2-P	Ecology and Biodiversity	2
	ABILITY ENHANCEMENT COURSE AECC 2	Environmental Studies	2
III	CORE COURSE ENV-G-CC/GE-3-3-TH	Chemistry of Environment	4
	CORE COURSE ENV-G-CC/GE-3-3-P	Chemistry of Environment	2
	SKILL ENHANCEMENT COURSE ENV-G-SEC-3-A1-TH	Environmental Laws and policy, Environmental Audit and EIA	2
IV	CORE COURSE ENV-G-CC/GE-4-4-TH	Environmental Physics and Meteorology	4
	CORE COURSE ENV-G-CC/GE-4-4-P	Environmental Physics and Meteorology	2
	SKILL ENHANCEMENT COURSE ENV-G-SEC-4-B1-TH	Applications of Environmental Biotechnology	2
V	DISCIPLINE SPECIFIC ELECTIVES ENV-G-DSE-A--5-X-TH	A1) Energy and Environment A2) Environmental Economics and Statistics (Any one Paper)	4
	DISCIPLINE SPECIFIC ELECTIVES ENV-G-DSE-A-5-X-P	A1) Energy and Environment A2) Environmental Economics and Statistics (Any one Paper)	2
	SKILL ENHANCEMENT COURSE ENV-G-SEC-5-A2-TH	Environmental Pollution and Green Technologies	2
VI	DISCIPLINE SPECIFIC ELECTIVES ENV-G-DSE-B-6-X-TH	B1) Natural Hazard and Disaster Management B2) Solid Waste Management (Any one Paper)	4
	DISCIPLINE SPECIFIC ELECTIVES ENV-G-DSE-B-6-X-P	Natural Hazard and Disaster Management! Solid Waste Management (Any one Paper)	2
	SKILL ENHANCEMENT COURSE ENV-G-SEC-6-B2-TH	Remote sensing, GIS and its applications	2

THEORY PRACTICAL

CORE COURSE (CC): THEORY (CREDIT 4), PRACTICAL (CREDIT 2) (CC: 12\*)

12X4 =48, 12X2=24

DISCIPLINE SPECIFIC ELECTIVE (DSE):TH (CREDIT 4), PRAC. (CREDIT 2) (DSE: 6\*\*)

6X4 =24, 6X2= 12

SKILL ENHANCEMENT COURSE (SEC): THEORY (CREDIT 2) (SEC: 4\*\*)

4X2 = 8

[Any one Paper either in 3<sup>rd</sup> or 5<sup>th</sup> Semester from SEC A Any one Paper either in 4<sup>th</sup> or 6<sup>th</sup> Semester from SEC B]

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC) THEORY (CREDIT 2)

2X2 = 4

\*Covering three subjects; \*Covering two subjects

**TOTAL COURSE = 42 (24 THEORY+18 PRACTICAL)**

**TOTAL CREDITS = 120 (86 THEORY+ 36 PRACTICAL)**

# Semester Wise Environmental Science General Courses

## Semester-I

### **ENV-G-CC/GE-1-1-TH: Fundamentals of Environmental Science**

**Theory: 50 Lectures**

#### **Unit 1: Concept of Environment and Environmental Science: (15 Lectures)**

Definition, Types and Components of Environment (Atmosphere, Hydrosphere, Lithosphere and Biosphere); Environmental Science: An overview; Scopes and Objective of Environmental and Ecological Science; Man – Environment relationships; Growth of Environmental and Ecological science in India.

#### **Unit 2: Environmental Literacy: (5 Lectures)**

Environmental literacy (formal and non-formal education)

#### **Unit3: Environmental Problems and Global Environmental Issues: (15 Lectures)**

Classifying environmental problems, Green House effect, Climate change, Acid deposition, Desertification, Ozone layer depletion.

#### **Unit 4: Important atmospheric events: (8 Lectures)**

Western disturbance, Tropical cyclones, Monsoon, El-nino phenomenon.

#### **Unit 5: Climatic zone of the world: (7 Lectures)**

Equatorial, Tropical, Sub-Tropical, Tundra.

### **ENV-G-CC/GE-1-1-P: Fundamentals of Environmental Science (Practical)**

1. Study of Laboratory safety rules. (5)
2. To study the principle and applications of following instruments  
(autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter, conductivity meter, spectrophotometer) (10)
3. Assignment on Environmental Education and global environmental issues. (10)
4. Viva Voce. (5)

## **Semester-II**

### **ENV-G-CC/GE-2-2-TH: Ecology and Biodiversity**

**Theory: 50 Lectures**

#### **Unit 1: Ecological Concepts:**

**(6 Lectures)**

Subdivisions and development phases of ecology, Autecology – definition, distribution, phenological studies; Synecology – basic ideas, definition; food chains, food webs and trophic levels.

#### **Unit 2. Population and Community Ecology:**

**(7 Lectures)**

Definition; Population characteristics, growth mortality, survivorship and dynamics; Community structures and characters; Predation; Competition; Symbiosis; Defensive Mechanism; Resilience and stability; Basic concept of ecological succession.

#### **Unit 3: Ecosystem ecology:**

**(10 Lectures)**

Basic concept of ecosystem, structural and functional aspects of ecosystems; Raymond Lindeman – Trophic level dynamics, Ecological pyramids; Productivity concept of ecosystem; Concept of limiting factors – **Liebig's** law of minimum, Shelford's law of tolerance; Cycling of nutrients.

#### **Unit 4: Concept and Importance of Biodiversity:**

**(4 Lectures)**

Definition; Types; India as megadiverse country; Values (Direct and indirect) and Services of Biodiversity.

#### **Unit 5: Threats to Biodiversity:**

**(5Lectures)**

Natural and Anthropogenic disturbances; Habitat loss, Habitat degradation, and Habitat fragmentation; Climate change; pollution; hunting; over-exploitation; deforestation; invasive species; land use changes; overgrazing etc.

#### **Unit 6: Measurement of Biodiversity:**

**(6 Lectures)**

Different types of biodiversity measurement indices viz. Shannon Wiener biodiversity index, Simpson index, Evenness index, frequency, abundance, density, relative density.

#### **Unit 7: Conservation of Biodiversity:**

**(12 Lectures)**

Importance of biodiversity patterns in conservation; In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation (botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissue culture and DNA banks), role of local communities and traditional knowledge in conservation; Biodiversity Hotspots; IUCN Red List categorization - guidelines, practice and application; Red Data book; Joint forest management, Sanctuary and Biosphere reserve – difference and location in India. People's biodiversity register (PBR); Importance of Wetland, its conservation, Ramsar Convention.

### **ENV-G-CC/GE-2-2-P: Ecology and Biodiversity (Practical)**

1. Field study on ecology and biodiversity of flora and fauna of a local area/ex-situ conservation site and field report submission. **(10)**
- 2.. Identification of environmentally important flora and fauna with characteristics features. (Herbarium/specimens) (15)
3. Viva Voce. (5)

## **Semester-III**

### **ENV-G-CC/GE-3-3-TH: Chemistry of the Environment**

**Theory: 50 Lectures**

#### **Unit 1: Basics of General Chemistry: (8 Lectures)**

Molecular weight, Equivalent Weight, Molarity, Normality, Oxidation and Reduction Reactions; Brief idea of Metals and Nonmetals; Aromatic & Aliphatic compounds, Saturated and unsaturated hydrocarbons.

#### **Unit 2: Basics of Chemical Equilibrium and Kinetics: (4 Lectures)**

Stoichiometry; Chemical equilibrium; Acid-base reactions (acidity, alkalinity, buffer and buffer capacity).

#### **Unit 3: Water Chemistry: (10 Lectures)**

Fundamentals of water quality; Concept of DO, BOD, COD, Hardness; Principles of sedimentation, coagulation, filtration.

#### **Unit 4: Air Chemistry: (12 Lectures)**

Classification of elements, particles, ions and radicals in the atmosphere; Chemical process for formation of inorganic and organic particulate matters in air; PM-10, PM-2.5, Sulphur Oxides Chemistry, Nitrogen Oxides Chemistry, Carbon Oxides Chemistry, VOCs (Volatile Organic Compounds), PAHs (Polycyclic Aromatic Hydrocarbons), Peroxyacetyl nitrate (PAN) and Photochemical smog; Ozone chemistry.

#### **Unit 5: Soil Chemistry: (8 Lectures)**

Soil composition; relation between organic carbon and organic matter; inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium pathways in soil.

#### **Unit 6: Chemistry of Heavy metals: (8 Lectures)**

Pb, Hg, Cd and As - Physical and chemical properties; Behavior of heavy metals and their compounds in environment.

### **ENV-G-CC/GE-3-3-P: Chemistry of the Environment (Practical)**

1. Estimation of water quality parameters – pH, conductivity, free CO<sub>2</sub>, hardness, alkalinity, chloride, Dissolved oxygen. (10)
2. Estimation of Soil quality parameters - pH, conductivity, organic carbon. (10)
3. Viva Voce. (10)



## **Semester-IV**

### **ENV-G-CC/GE-4-4-TH: Environmental Physics and Meteorology**

**Theory 50 Lectures**

#### **Unit 1: Thermodynamics: (12 Lectures)**

Concept of System; First and second law of thermodynamics; Entropy; Enthalpy, Free energy; Chemical potential; Heat transfer process; Mass and energy transfer across the various interfaces; Material balance.

#### **Unit 2: Energy Interactions: (8 Lectures)**

Energy budget concept: Radiation fluxes, metabolism of latent heat exchange; Energy equilibrium between biotic and abiotic environmental component.

#### **Unit 3: Concept of Radiation Physics: (8 Lectures)**

Types of Electromagnetic radioactivity and its units, characterizations of various rays, application of radio isotopes; Biological effects of radiation.

#### **Unit 4: Techniques related to environmental physics: (10 Lectures)**

Acoustic radar; Application of LASER radiations; Electrical detection of airborne particles using surface ionization techniques; Biosensor: Concept and application.

#### **Unit 5: Concept of Meteorology: (12 Lectures)**

Basic knowledge of climatological parameters for environmental study; Weather and climate; Classification of Climate; Fundamentals of temperature, pressure, relative humidity, rainfall and wind speed; Concept of atmospheric stability; Mixing height, temperature inversion.

### **ENV-G-CC/GE-4-4-P: Environmental Physics and Meteorology (Practical)**

1. Recording of wind speed, relative humidity, atmospheric pressure, rainfall, insolation and light intensity. (10)
2. Visit to a Weather Station (one day) (10)
3. Viva-Voce (10)

## **SKILL ENHANCEMENT COURSE (SEC)**

**SEC-A** [Any one Paper either in 3<sup>rd</sup> or 5<sup>th</sup> Semester]

### **ENV-G-SEC-3-A1-TH: Environmental Laws and policy, Environmental Audit and EIA**

**Theory: 30 Lectures**

#### **Unit 1: Fundamental rights and duties in Indian Constitution; Policies related to Environment (8 Lectures)**

National Forest Policy 1952, National Forest Policy 1988; National Environment Policy, 2006

#### **Unit 2: Environmental legislation (10 Lectures)**

Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).

The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Water (Prevention and Control of Pollution) Cess Act 1977; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002.

#### **Unit 3: Environmental Audit (6 Lectures)**

Overview of Environmental Audit, Basic steps of Environmental Audit, Benefits of Environmental Audit.

#### **Unit 4: Environmental Impact Assessment (6 Lectures)**

Definitions, introduction concepts and types; scope and methodologies of EIA, EIA regulations in Ind

## **ENV-G-SEC-5-A2-TH: Environmental Pollution and Green Technologies**

**Theory: 30 Lectures**

### **Unit 1: Introduction: (2 Lectures)**

Definition of pollution; pollutants; classification of pollutants (Physical, chemical and biological).

### **Unit 2: Air and Noise Pollution: (8 Lectures)**

Air borne particles and particulate matters, Temperature inversion, SO<sub>x</sub>, NO<sub>x</sub>, Hydrocarbons, Lead & other pollutants; Temperature inversion; photochemical Smog; Health effects of Air pollution; Adverse health effects of tobacco.

Measurement of Noise, Health effects of Noise pollution, Control of noise pollution.

### **Unit 3: Water pollution: (6 Lectures)**

Sources of surface and ground water pollution; Water quality parameters: COD, BOD, DO, hardness, alkalinity; Biological aspects of water pollution: MPN, Eutrophication; Biological indicator; Arsenic pollution of drinking water and its consequence: An overview.

### **Unit 4: Pesticide pollution: (2 Lectures)**

Classification of pesticide, Biological magnification of persistent organic pollutants.

### **Unit 5: Pollution control: (2 Lectures)**

Activated Sludge Process (ASP) - Trickling Filters - oxidation ponds, fluidized bed reactors, concept and working of effluent treatment plants (ETPs).

### **Unit 6: Green technologies and its applications: (10 Lectures)**

Definition and concepts: green technology, Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse; Pollution reduction and removal (Flue Gas Desulfurization (FGD) methods; Rainwater Harvesting; Successful green technologies: wind turbines, solar panels; 3R's of green technology: recycle, renew and reduce.

**SEC-B [Any one Paper either in 4<sup>th</sup> or 6<sup>th</sup> Semester]**

**ENV-G-SEC-4-B1-TH: Applications of Environmental Biotechnology**

**Theory: 30 Lectures**

**Unit 1: Principles of different biotechnological methods: (10 Lectures)**

Plasmid preparation, restriction digestion, DNA ligation, PCR, RAPD and RFLP.

**Unit 2: Biotechnological applications: (3 Lectures)**

Biotechnological applications in medicine and industry.

**Unit 3: Application of Biotechnology in waste treatment: (7 Lectures)**

Wastewater treatment; solid waste treatment: sources and management (composting, vermiculture and methane production); Bioremediation; Phytoremediation.

**Unit 4: Ecologically safe products and processes: (7 Lectures)**

PGPR bacteria: biofertilizers, microbial insecticides and pesticides; Integrated pest management.

**Unit 5: GMs and GMOs: (3 Lectures)**

Concept of GM and GMOs; Biosafety protocol.

**ENV-G-SEC-6-B2-TH: Remote sensing, GIS and its applications**

**Theory: 30 Lectures**

**Unit 1: Remote Sensing: (8 Lectures)**

Definitions and principles; electromagnetic (EME) spectrum; spectral signature; satellites and sensors; aerial photography and image interpretation.

**Unit 2: Geographical Information Systems: (12 Lectures)**

Definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use/ land cover mapping; GPS survey, data import, processing, and mapping.

**Unit 3: Applications of remote sensing and GIS: (8 Lectures)**

Water resource management, land use planning, forest and wildlife resources, agriculture, and atmospheric studies.

## **Semester-V**

### **DISCIPLINE SPECIFIC ELECTIVES**

**DSE-A [Elective Course (Any One from DSE-A1 and DSE-A2)]**

**ENV-G-DSE-A--5-X-TH**

#### **(DSE) A1: Energy and Environment**

**Theory: 50 Lectures**

##### **Unit 1: Energy resources: (10 Lectures)**

Defining energy; forms and importance; Global energy resources; renewable and non-renewable resources: distribution and availability.

##### **Unit 2: Energy demand: (10 Lectures)**

Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector.

##### **Unit 3: Energy Resource Management: (20 Lectures)**

Conventional and non-conventional energy resources; Brief idea of energy production and environmental consequences involved (*viz.* Thermal, Hydel, Solar, Wind, Geothermal, Energy from oceans and Bio-energy); Need for energy efficiency; Energy conservation and sustainability; Action strategies for sustainable energy management from a future perspective.

##### **Unit 4: Energy Audit: (10 Lectures)**

Concept, purpose and methodology.

#### **ENV-G-DSE-A--5-X-P**

##### **(DSE) A 1: Energy and Environment (Practical)**

1. To determine energy efficiencies from the given data. (5)
3. Preparation of Energy audit of a domestic unit/office. (10)
4. Demonstration of water conservation techniques.
5. Demonstration of use of solar devices, photo-cells, wind-mills.
6. Demonstration of Biogas plant (S No. 4,5,6 =5)
7. Preparation of report on Energy Plantation /Visit to a water shed management project and field report preparation. (10)

## **ENV-G-DSE-A--5-X-TH**

### **(DSE) A2: Environmental Economics and Statistics**

**Theory: 50 Lectures**

#### **Unit 1: Concept of environmental economics: (4 Lectures)**

Economy and the environment.

#### **Unit 2: National resource economics: (10 Lectures)**

Economics of non-renewable resources; economics of fuels and minerals; Introduction to natural resource accounting.

#### **Unit 3: Tools for environmental economic policy: (12 Lectures)**

Growth and environment; environmental accounting, Kuznets curve, assessing benefits and cost for environmental decision making; cost benefit analysis; Economic valuation techniques of environmental benefits - various methods; Policies for controlling air and water pollution; polluter pay principles.

#### **Unit 4: Carbon trading: (9 Lectures)**

Carbon tax, carbon trading; clean development mechanism; clean production and technology and ecomark - concept only.

#### **Unit 5: Basic Statistics: (15 Lectures)**

Statistical Sampling, sampling units, estimation of sample size; Mean, mode, median, standard error and deviation, probability, correlation and regression; Testing of hypothesis: Null and alternative, chi-square and student's 't' test.

## **ENV-G-DSE-A--5-X-P**

### **DSEA2: Environmental Economics and Statistics (Practical)**

1. Numerical problems on biostatistics Chi-Square test and Student's t test). (20)
2. Viva -voce. (10)

## **Semester-VI**

### **DISCIPLINE SPECIFIC ELECTIVES**

#### **DSE-B [Elective Course (Any One from DSE-B1 and DSE-B2)]**

#### **ENV-G-DSE-B-6-X-TH**

#### **(DSE) B1: Natural Hazard and Disaster Management**

**Theory: 50 Lectures**

##### **Unit 1: Introduction: (12 Lectures)**

Definition of hazard and disaster; Natural, technological and context hazards; Concept of risk and vulnerability.

##### **Unit 2: Natural hazards: (16 Lectures)**

Natural hazards – earthquake; volcanoes - cause and effects; floods: types and nature, effects; landslides: causes and types of landslides, effects; drought: types of drought - meteorological, agricultural, hydrological and effects; tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis, effects.

##### **Unit 3: Anthropogenic hazards: (16 Lectures)**

Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, deforestation; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; Nature and impact of accidents; Case studies of Bhopal, Minamata and Chernobyl disaster.

##### **Unit 5: Disaster management: (6 Lectures)**

Disaster management cycle; Disaster management plan.

#### **ENV-G-DSE-B-6-X-P**

#### **(DSE) B1: Natural Hazard and Disaster Management (Practical)**

1. Project Report based on any two field-based case studies among following disasters and one disaster preparedness plan of respective college or locality: -Flood and waterlogging, Cyclone, Earthquake, Human Induced Disasters: Fire Hazards, Chemical, Industrial accidents. (15)
2. Poster preparation and presentation on topic related to national and international disaster and disaster management. (5)
3. Viva -voce (10)

## **ENV-G-DSE-B-6-X-TH**

### **(DSE) B2: Solid Waste Management**

**Theory: 50 Lectures**

#### **Unit 1: Solid Waste: (8 Lectures)**

Sources and generation of solid waste; their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.

#### **Unit 2: Effect of solid waste disposal on environment: (8 Lectures)**

Impact of solid waste on environment, human and plant health; water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.

#### **Unit 3: Solid waste Management: (12 Lectures)**

Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques; Concept of Integrated waste management.

#### **Unit 5: Resource Recovery: (10 Lectures)**

4R - reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.

#### **Unit 5: Policies for solid waste management: (12 Lectures)**

Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Plastic Waste (Management and Handling) Rules, 2011; E-Waste (Management) Rules, 2016.

## **ENV-G-DSE-B-6-X-P**

### **(DSE) B 2 : Solid Waste Management (Practical)**

1. Demonstration of composting techniques including vermicomposting (5)
2. Study of soil microbial activity- Soil respiration (for stability and maturity of compost) (5)



3. Visit to sewage treatment plants/ Visit to waste water treatment plants/ Solid waste management site with field report preparation. (15)
4. Viva-Voce. (5)

## Suggested Readings:

1. Agarwal KM., Sikdar PK., Deb SC. A textbook of Environment. Mc millan India Ltd.
2. Anjaneyulu Y. Introduction to Environmental Science. B.S Publication.
3. Enger E, Smith B. Environmental Science. A Study of Interrelationships. McGraw-Hill Higher Education
4. Chapman, Reiss. Ecology: Principles and Applications. Cambridge University Press.
5. Kormondy EJ. Concept of Ecology. Prentice hall of India.
6. Kumar HD. Modern concepts in Ecology
7. Odum EP. Fundamentals of Ecology
8. Sharma PD. Ecology and Environment. Rastogi Publication.
9. Das MC. Fundamental of Ecology. Tata McGraw Hill Publication.
10. Gaston, KJ. & Spicer, J.I. 1998. *Biodiversity: An Introduction*. Blackwell Science,
11. London,
12. UK. Krishnamurthy, K.V. 2004. *An Advanced Text Book of Biodiversity - Principles and Practices*. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
13. Maiti, Maiti. Biodiversity: Perception, Peril and Preservation. PHI Learning Pvt. Ltd.
14. Banerjee SK. Environmental Chemistry.
15. Dara SS. A text book of Environmental Chemistry and Pollution Control.
16. De AK. Environmental Chemistry. New Age (P) Ltd.
17. Gupta PK. 2004. Methods in Environmental analysis - water, soil and air. Agrobios (India), Jodhpur
18. Jadhav HV. Elements of Environmental Chemistry
19. Moore JW, Moore EA. Environmental Chemistry
20. Peavy HS, Rowe DR. Environmental Engineering. McGraw Hill.
21. Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment. London, Research Press, UK.
22. Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.
23. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.
24. Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International.
25. Venkat, A. 2011. Environmental Law and Policy. PHI Learning Private Ltd.
26. Rosencranz A, Divan S, Noble ML. 2001. Environmental law and policy in India. Tripathi.
27. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
28. Boeker, E. & Grondelle, R. 2011. Environmental Physics: Sustainable Energy and Climate Change. Wiley.
29. Forinash, K. 2010. Foundation of Environmental Physics. Island Press.
30. Singh, Savindra Climatology, Prayag Pustak Publication.
31. Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
32. Scagg, A.H. 2005. Environmental Biotechnology. Oxford University Press.
- World Commission on Environment and Development. Our Common Future. Oxford University Press.
33. Elliott, D. 1997. Sustainable Technology. Energy, Society and Environment (Chapter 3). New York, Routledge Press
34. Shastri M.N.1995, Energy Options : Himalaya Publishing House, New Delhi.
35. Das. NG. Statistical Methods.

36. Hanley N, Jason FS, White B. Environmental Economics in Theory and Practice. 1997. New Delhi. Macmillan – India.
37. Sankar U. (ed.) Environmental Economics. New Delhi. Oxford University Press, 2001.
38. Wayne RO Environmental Statistics and Data Analysis. 1995. CRC Press.
39. Arceivala. Waste water treatment for pollution control. Tata Mc Graw Hill
40. Chatwal, Anand. Instrumental Methods of Analysis.  
Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New York, NY.
41. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge Press.
42. Singh Savindra and Jeetendra, Disaster Management, Pravalika publication, Allahabad.
43. Khopkar. Environmental Pollution Analysis
44. Mastters GM. Introduction to Environmental Engineering & Science. Prentice Hall of India.
45. Rossetti, B.B Prospects and perspective of solid waste management., New age International.
46. Singh, J and Ramanathan, AL 2009. Solid Waste Management: Present and Future Challenges
47. Remote sensing and GIS (2<sup>nd</sup> Edition) Basudev Bhatta, Oxford University Press
48. Sabins, F.F. 1996. Remote Sensing: Principles an Interpretation. W.R. Freeman.



# UNIVERSITY OF CALCUTTA

## Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

### List of the subjects

<u>Sl. No.</u>	<u>Subject</u>	<u>Sl. No.</u>	<u>Subject</u>
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies ( General)	44	Zoology (Honours / General)
✓ 17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management – ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE  
KOLKATA-700073  
The 4<sup>th</sup> June, 2018

*Paul*  
4/6/18  
(Dr. Santanu Paul)  
Deputy Registrar

**COURSE CURRICULUM FOR UNDERGRADUATE COURSES UNDER CHOICE BASED CREDIT  
SYSTEM**

**REVISED SYLLABUS**

**FOR**

**B. Sc. (HONOURS)**

**IN**

**FOOD AND NUTRITION**



**UNIVERSITY OF CALCUTTA**

**2018**

**SEMESTER WISE COURSE FOR BSc FOOD AND NUTRITION HONOURS (FNTA)**

	<b>Sem-1</b>	<b>Sem-2</b>	<b>Sem-3</b>	<b>Sem-4</b>	<b>Sem-5</b>	<b>Sem-6</b>
<b>Core Course (CC)</b>	<b>2Th+ 2P</b> <b>CC-1 &amp; 2</b>	<b>2Th+ 2P</b> <b>CC-3 &amp; 4</b>	<b>3Th+ 3P</b> <b>CC-5, 6 &amp; 7</b>	<b>3Th+ 3P</b> <b>CC-8, 9 &amp; 10</b>	<b>2Th+ 2P</b> <b>CC-11 &amp; 12</b>	<b>2Th+ 2P</b> <b>CC-13 &amp; 14</b>
<b>Elective Courses:</b>						
<b>i) Generic Elective (GE)</b>	<b>1Th+ 1P</b> <b>GE-1</b>	<b>1Th+ 1P</b> <b>GE-2</b>	<b>1Th+ 1P</b> <b>GE-3</b>	<b>1Th+ 1P</b> <b>GE-4</b>		
<b>ii) Discipline Specific Elective(DSE)</b>					<b>2Th+ 2P</b> <b>DSE-A(1/2)</b> <b>DSE-B(1/2)</b>	<b>2Th+ 2P</b> <b>DSE-A(3/4)</b> <b>DSE-B(3/4)</b>
<b>Ability Enhancement Compulsory Course(AECC)</b>	<b>1Th+ 0 P</b> <b>AECC-1</b>	<b>1Th+ 0 P</b> <b>AECC-2</b>				
<b>Skill Enhancement Course(SEC)</b>			<b>1Th+ 0 P</b> <b>SEC-A(1/2 )</b>	<b>1Th+ 0 P</b> <b>SEC-B(1/2 )</b>		
<b>Total No. of Courses and Marks</b>	<b>4x100= 400</b>	<b>4x100=400</b>	<b>5x100=500</b>	<b>5x100=500</b>	<b>4x100=400</b>	<b>4x100=400</b>
<b>Total Credits</b>	<b>20</b>	<b>20</b>	<b>26</b>	<b>26</b>	<b>24</b>	<b>24</b>

**Th= Theory, P= practical**

- **CC/GE/DSE:** Each theory and practical course have 4 and 2 credits respectively.
- **GE:** Covering two disciplines with two courses; any discipline in any semester; CC of different subjects in general course is to be treated as GE for Honours course.
- **DSE/SEC:** Choice must be group specific to each semester.
- **AECC/ SEC:** Each course has two credits.
- **AECC1:** Communicative English/ MIL; **AECC2:** Environmental Studies.

**SCHEME AND SYLLABUS FOR CHOICE BASED CREDIT SYSTEM FOR B.Sc. HONOURS  
FOOD AND NUTRITION**

<b>SEMESTER</b>	<b>CORE COURSE (14)</b>	<b>ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)</b>	<b>SKILL ENHANCEMENT COURSE (SEC)</b>	<b>DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE)</b>	<b>ELECTIVE: GENERIC COURSE (GE)</b>
		( 2)	(2)	(4)	(4)
<b>I</b>	<b>FNTA-CC-1Th: BASIC FOOD SCIENCE-I</b> <b>FNTA-CC1P: BASIC FOOD SCIENCE-I (PRACTICAL)</b>				
	<b>FNTA-CC2Th: HUMAN PHYSIOLOGY-I</b> <b>FNTA-CC2P: HUMAN PHYSIOLOGY-I (PRACTICAL)</b>				
<b>II</b>	<b>FNTA-CC3Th: BASIC FOOD SCIENCE-II</b> <b>FNTA-CC3P: BASIC FOOD SCIENCE-II (PRACTICAL)</b>				
	<b>FNTA-CC4Th: HUMAN PHYSIOLOGY-II</b> <b>FNTA-CC4P: HUMAN PHYSIOLOGY-II (PRACTICAL)</b>				
<b>III</b>	<b>FNTA-CC5Th: HUMAN NUTRITION-I</b> <b>FNTA-CC5P: HUMAN NUTRITION-I (PRACTICAL)</b>		<b>SEC-1</b>		
	<b>FNTA-CC6Th: COMMUNITY NUTRITION</b> <b>FNTA-CC6P: COMMUNITY NUTRITION (PRACTICAL)</b>				
	<b>FNTA-CC7Th: FOOD COMMODITIES</b> <b>FNTA-CC7P: FOOD COMMODITIES (PRACTICAL)</b>				

IV	<b>FNTA-CC8Th: HUMAN NUTRITION-II</b> <b>FNTA-CC8P: HUMAN NUTRITION-II (PRACTICAL)</b>		SEC-2		
	<b>FNTA-CC9Th: DIET THERAPY-I</b> <b>FNTA-CC9P: DIET THERAPY-I (PRACTICAL)</b>				
	<b>FNTA-CC10Th: NUTRITIONAL BIOCHEMISTRY-I</b> <b>FNTA-CC10P: NUTRITIONAL BIOCHEMISTRY-I (PRACTICAL)</b>				
V	<b>FNTA-CC11Th: DIET THERAPY-II</b> <b>FNTA-CC11P: DIET THERAPY-II (PRACTICAL)</b>			DSE-1	
	<b>FNTA-CC12Th: NUTRITIONAL BIOCHEMISTRY-II</b> <b>FNTA-CC12P: NUTRITIONAL BIOCHEMISTRY-II (PRACTICAL)</b>			DSE-2	
VI	<b>FNTA-CC13Th: FOOD MICROBIOLOGY</b> <b>FNTA-CC13P: FOOD MICROBIOLOGY (PRACTICAL)</b>			DSE-3	
	<b>FNTA-CC14Th: FOOD PRESERVATION</b> <b>FNTA-CC14P: FOOD PRESERVATION ( PRACTICAL)</b>			DSE-4	



## DISTRIBUTION OF CREDITS IN THE COURSE CURRICULUM

Semester	Name of the Course					Total
	Core Course (CC)	Ability Enhancement Compulsory Course (AECC)	Skill Enhancement Course (SEC)	Discipline Specific Elective (DSE)	Generic Elective (GE)	Credits
I	6x2= 12	2x1=2	---	---	6x1=6	20
II	6x2= 12	2x1=2	---	---	6x1=6	20
III	6x3=18	---	2x1=2	---	6x1=6	26
IV	6x3=18	---	2x1=2	---	6x1=6	26
V	6x2=12	----	---	6x2=12	--	24
VI	6x2=12	----	----	6x2=12	----	24
<b>Total Course</b>	<b>14 (CC) (14×6)=84 credits</b>	<b>2 (AECC) (2x2)=4credits</b>	<b>2 (SEC) (2×2)=4credits</b>	<b>4 (DSE) (4×6)=24 credits</b>	<b>4 (GE) (4x×6)=24 credits</b>	<b>140</b>

**NOTE:**

1. 14 Core Courses (CCs) should be compulsorily studied for BSc. Food and Nutrition (Honours) students.
2. 4 DSE & 2 SEC to be chosen by the Food and Nutrition (Honours) students (Choice based).
3. 4 GE subjects in Food and Nutrition Syllabus are to be studied by other discipline students.
4. Food and Nutrition Honours students have to choose chemistry as GE course.

**SUGGESTED MARKS DISTRIBUTION OF BSc FNTA CBCS SYLLABUS**

COURSE	CREDITS	FULL MARKS	MARKS DISTRIBUTION			
			INTERNAL ASSESSMENT	ATTENDANCE	THEORITICAL EXAMINATION	PRACTICAL EXAMINATION
AECC	2	100	10	10	80	---
CC-Th	4	70	10	10	50	--
CC- P	2	30				30
GE-Th	4	70	10	10	50	--
GE-P	2	30				30
SEC	2	100	10	10	80	
DSE-Th	4	70	10	10	50	---
DSE-P	2	30	---	--	---	30

Th= Theory, P= Practical

## **CORE COURSE (CC)**

### **FIRST SEMESTER**

**[TOTAL CREDITS: 6 (THEORY-4, PRACTICAL-2)]**

#### **FNTA-CC1Th: BASIC FOOD SCIENCE**

**4 CREDITS**

1. Basic concept on Food, Nutrition and Nutrients. Classification of Food, Classification of Nutrients.
2. Carbohydrates - Definition, Classification, Structure and properties.  
Monosaccharides - glucose, fructose, galactose.  
  
Disaccharides - Maltose, lactose, sucrose  
  
Polysaccharides - Dextrin, starch, glycogen, resistant starch.  
  
Carbohydrates - Sources, daily requirements, functions. Effects of too high and too Low carbohydrates on health. Digestion and absorption of carbohydrate.
2. Lipids -Definition, Classification & Properties. Fatty acids-composition, properties, types. Lipids - sources, daily requirements, functions. Digestion & Absorption of nutrients. Role & nutritional significances of PUFA, MUFA, SFA, W-3 fatty acid.
3. Proteins- Definition, Classification, Structure & properties. Amino acids-Classification, types, functions. Proteins - Sources, daily requirements, functions. Effect of too high - too low proteins on health. Digestion & absorption. Assessment of Protein quality (BV, PER, NPU). Factors affecting protein bio-availability including anti-nutritional factors.

#### **FNTA-CC1P: FOOD SCIENCE (PRACTICAL)**

**2 CREDITS**

1. Identification of Mono, Di and polysaccharides
- 2 .Identification of Proteins
- 3 .Identification of glycerol.

**FNTA-CC2Th: HUMAN PHYSIOLOGY-I****4 CREDITS**

1. Unit of Life: Structure and functions of cell with special reference to Plasma membrane (Fluid Mosaic Model), Mitochondria, Ribosome, Endoplasmic reticulum. Nucleus (nuclear membrane, nuclear chromatin and nucleolus). Nucleotide, Homeostasis, Positive and negative feed back
2. Circulatory and Cardiovascular system: Blood and its composition, formed elements, Blood groups, Mechanism of blood coagulation, Introduction to immune system, Erythropoiesis and anaemia, Structure and functions of heart, Cardiac cycle, cardiac output, blood pressure and its regulation.
3. Digestive System: Structure and functions of G.I. tract, Process of digestion and absorption of food, Structure and functions of liver, gallbladder and pancreas.
4. Respiratory System: Structure of Lungs and gaseous exchange (oxygen and carbon dioxide transport).
5. Musculoskeletal System: Formation and functions of muscles, bones and teeth. Muscle energetic, Isometric and isotonic muscle contraction.

**FNTA-CC2P: HUMAN PHYSIOLOGY-I(PRACTICAL)****2 CREDITS**

1. Determination of pulse rate in Resting condition and after exercise (30 beats/10 beats method)
2. Determination of blood pressure by Sphygmomanometer (Auscultatory method).
3. Measurement of Peak Expiratory flow rate. (By spirometer)
4. Determination of Bleeding Time (BT) and Clotting Time (CT).
5. Detection of Blood group (Slide method).
6. Measurement of Haemoglobin level (Sahli's or Drabkin method).

## **SECOND SEMESTER**

**[TOTAL CREDITS: 6 (THEORY-4, PRACTICAL-2)]**

### **FNTA-CC3Th: BASIC FOOD SCIENCE-II**

**4 CREDITS**

1. Dietary Fibre-Classification, sources, composition, properties & nutritional significance.
- 2.
3. Minerals & Trace Elements, Bio-Chemical and Physiological Role, bio-availability & requirements, sources, deficiency & excess (Calcium, Sodium, Potassium Phosphorus, Iron, Fluoride, Zinc, Selenium, Iodine, Chromium)
4. Vitamins - Bio-Chemical and Physiological Role Physiological role, bio-availability and requirements, sources, deficiency & excess.
5. Water - Functions, daily requirements, Water balance.

### **FNTA-CC3P: BASIC FOOD SCIENCE-II**

**2 CREDITS**

1. Determination of Ash content in food
2. Determination of Moisture content in food
3. Determination of calcium, iron, and Vitamin C content in foods.

### **FNTA-CC4Th: HUMAN PHYSIOLOGY-II**

**4 CREDITS**

1. Excretory system: Structure and function of skin, Regulation of temperature of the body, Structure and functions of kidney in special reference to nephron, Physiology of urine formation.
2. Reproductive system: Structure and functions of gonads, concept on menstrual cycle, Brief idea of pregnancy, parturition, lactation and menopause, Brief concept on spermatogenesis and Oogenesis process.
3. Nervous System: Concept on sympathetic and parasympathetic nervous system, Brief anatomy and functions of cerebrum, cerebellum, hypothalamus and neuron, Concept on synapse and synaptic transmission. Reflexes, Special senses.
4. Endocrine system: Structure and functions of pituitary, thyroid, parathyroid and adrenal gland, Structure and functions of pancreas.

**FNTA-CCP4: HUMAN PHYSIOLOGY-II (PRACTICAL)****2 CREDITS**

1. Harvard Step test
2. Identification with reasons of histological slides (Lung, Liver, Kidney, Small intestine, Stomach, Thyroid, Adrenal, Pancreas, Testis, Ovary and Muscle of mammals).
3. Qualitative determination of glucose acetone in urine.
4. Blood film staining and identification of different types of blood cells.

**THIRD SEMESTER****[TOTAL CREDITS: 6 (THEORY-4, PRACTICAL-2)]****FNTA-CC5Th: HUMAN NUTRITION-I****4 CREDITS**

1. Concept and definition of terms-Nutrition, Malnutrition and Health: Scope of Nutrition.
2. Minimum Nutritional Requirement and RDA: formulation of RDA and Dietary Guidelines Reference Man and Reference Woman, Adult consumption unit.
3. Energy in Human Nutrition: Idea of Energy and its unit, Energy Balance, Assessment of Energy Requirements—deficiency and excess, Determination of Energy in food, B.M.R. and its regulation, S.D.A.
4. Growth & Development from infancy to adulthood: Somatic, physical, brain and mental development, puberty, menarch, pre-pubertal and pubertal changes, Factors affecting growth and development. Importance of Nutrition for ensuring adequate development.
5. Growth monitoring and promotion: Use of growth charts and standards, Prevention of growth faltering.

**FNTA-CC5P: HUMAN NUTRITION-I ( PRACTICAL)****2 CREDITS**

1. Process involved in cooking: pressure cooking, microwave ,steaming, grilling ,deep fat frying.

2. General concepts of weights and measures. Eye estimation of raw and cooked foods
3. Preparation of food from different food groups and their significance in relation to health.
4. Preparation of supplementary food for different age group and their nutritional significance.
5. Planning and preparation of low cost diet for Grade I and Grade II malnourished child

## **FNTA-CC6Th: COMMUNITY NUTRITION**

**4 CREDITS**

1. Concept of Community, types of Community, Factors affecting health of the Community.
2. Nutritional Assessment and Surveillance: Meaning, need, objectives and importance
3. Nutritional assessment of human: Clinical findings, nutritional anthropometry, biochemical tests, biophysical methods.
4. Diet survey: Need and importance, methods of dietary survey, Interpretation - concept of consumption unit, individual and total distribution of food in family, adequacy of diet in respect to RDA, concept of family food security.
5. Clinical Signs: Need & Importance's, identifying signs of PEM, vitamin A deficiency and iodine deficiency, Interpretation of descriptive list of clinical signs.
6. Nutritional anthropometry: Need and importance, standard for reference, techniques of measuring height, weight, head, chest and arm circumference, interpretation of these measurements. Use of growth chart.
7. International, national, regional agencies and organisations. Nutritional intervention programmes to combat malnutrition.

## **FNTA-CC6P: COMMUNITY NUTRITION (PRACTICAL)**

**4 CREDITS**

1. Anthropometric Measurement of infant - Length, weight, circumference of chest, mid-upper arm circumference, precautions to be taken.
2. Comparison with norms and interpretation of the nutritional assessment data and its significance. Weight for age, height for age, weight for height, body Mass Index (BMI) Waist - Hip Ratio (WHR). Skin fold thickness.
3. Growth charts - plotting of growth charts, growth monitoring and promotion.
4. Clinical assessment and signs of nutrient deficiencies specially PEM (Kwashiorkor, marasmus) I vitamin A deficiencies, Anaemia, Rickets, B-Complex deficiencies.

5. Estimation of food and nutrient intake: Household food consumption data, adult consumption unit, 24 hours dietary recall 24 hours record, Weighment method, food diaries, food frequency data, use of each of the above, information available through each individual, collection of data, estimation of intakes.

#### **FNTA-CC7Th: FOOD COMMODITIES**

**4 CREDITS**

1. Cereals and Millets: Structure, processing, storage, use in various preparation, variety, selection and cost. Cereal products, breakfast cereals, fast food.
2. Pulses and Legumes: Structures, Selection and variety. Storage, Processing and use in different preparations, Nutritional aspects and cost.
3. Milk and Milk products : Composition, Classification, Selection Quality and Cost, Processing, Storage and uses in different preparations, Nutritional aspects, shelf life and spoilage.
4. Eggs: Production, grade, quality selection, storage and spoilage, cost nutritional aspects and use in different preparations.
5. Meat, Fish and Poultry: Types, Selection, Purchase, Storage, Uses, preparations Cost, Spoilage of fish Poultry and meat.
6. Vegetables and Fruits: Variety, Selection, purchase, storage, availability causes and nutritional aspects of raw and processed products and use in different preparations.
7. Sugar and sugar Products: Types of natural, sweeteners, manufacture, selection, storage and use as preserves, stages in sugar cookery.
8. Fats and Oils: Types and sources (animal and vegetable), Processing, uses in different preparations, storage, cost and nutritional aspects.
9. Raising and Leavening agents: Types, constituents, uses in cookery and bakery, storage.
10. Food Adjuncts: Spices, condiments, herbs, extracts; concentrates essences, food colours, origin, classification, description,uses, specifications, procurements and storage.
11. Convenience Foods: Role, types, advantages, uses, cost and contribution to diet.
12. Salt: Types and uses.
13. Beverages: Tea; Coffee. Chocolate and Cocoa Powder-Processing, cost and nutritional aspects, other beverages-Aerated beverages, juices.

#### **FNTA-CC7P: FOOD COMMODITIES (PRACTICAL)**

**2 CREDITS**

1. Detection of starch, sucrose, formalin, boric acid, and urea in milk.
2. Detection of urea in puffed rice.
3. Detection of Vanaspati in Ghee/Butter.
4. Detection of Khesari flour in besan.



5. Detection of Metanil yellow in turmeric/coloured sweet products.
6. Detection of Argemone oil in edible oil.
7. Detection of artificially colour / foreign matter in tea (dust/leaves).

## **FOURTH SEMESTER**

**[TOTAL CREDITS/ CORE COURSE: 6 (THEORY-4, PRACTICAL-2)]**

### **FNTA-CC8Th: HUMAN NUTRITION-II**

**4 CREDITS**

1. Nutrition During Pregnancy: Factors (non-nutritional) affecting pregnancy outcome, importance of adequate weight gain during pregnancy, antenatal care and its schedule, Nutritional requirements during pregnancy and modification of existing diet and supplementation, Deficiency of nutrients, specially energy, iron folic acid, protein, calcium, iodine. Common problems of pregnancy and their managements, specially - nausea, vomiting, pica, food aversions, pregnancy induced hypertension, obesity, diabetes. Adolescent pregnancy.
2. Nutrition during Lactation: Nutritional requirements during lactation, dietary management, food supplements, galactogogues, preparation for lactation. Care and preparation of nipples during breast feeding.
3. Nutrition during Infancy: Infant physiology relevant to feeding and care, Breast feeding- colostrum, its composition and importance in feeding, Initiations of breast feeding. Advantages of exclusive breast feeding. Basic principles of breast feeding. Introduction of supplementary foods, initiation and management of weaning, Baby-led weaning. Bottle feeding- circumstances under which bottle feeding is to be given. Care & sterilization of bottles. Preparation of formula. Mixed feeding, breast feeding and artificial feeding
4. Management of preterm and low birth weight babies.
5. Nutritional needs of toddlers, preschool, school going children- and adolescents- Dietary management.

### **FNTA-CC8P: HUMAN NUTRITION-II (PRACTICAL)**

**2 CREDITS**

Planning and preparation of adequate meal for different age groups with special reference to different physiological conditions: infants, pre-schooler, school children, adolescents, adults, pregnancy, lactation and old age.

**FNTA-CC9Th: DIET THERAPY-I****4 CREDITS**

1. Basic concepts of diet therapy: Therapeutic adaptations of normal diet, principles and classification of the therapeutic diets.
2. Team approach to health care. Assessment of Patient's needs.
3. Routine Hospital Diets: Regular, light, soft, fluid, parenteral and enteral feeding.
4. Diets for different febrile conditions: influenza, malaria and typhoid.
5. Etiological factors, symptoms, and management of common diseases of stomach- Gastritis and Peptic ulcer.
6. Etiology, symptoms, and management of intestinal diseases: Diarrhoea, steatorrhoea, Diverticular disease, inflammatory bowel disease, Ulcerative Colitis, Flatulence, Constipation, Irritable Bowel Syndrome.
7. Diseases of the liver and Biliary System: Liver function tests. Etiology, symptoms, dietary care and general management of Viral Hepatitis and Cirrhosis of liver. Dietary care and management of Gall Bladder diseases –Cholecystitis and Cholelithiasis.
8. Anaemias: General concept, aetiology, classification, and dietary management of Nutritional anaemia.

**FNTA-CC9P: DIET THERAPY-I (PRACTICAL)****2CREDITS**

1. Planning and preparation of normal diets.
2. Planning and preparation of fluid diets.
3. Planning and preparation of soft/semi solid diets.
4. Planning and preparation of Diets for the following diseases:
  - i) Peptic ulcer
  - ii) Viral hepatitis
  - iii) Anaemia

**FNTA-CC10Th: NUTRITIONAL BIOCHEMISTRY-I****4 CREDITS**

1. Introduction to Biochemistry: Definition, objectives, scope and inter relationship between biochemistry and other biological science.

2. Enzymes: Definition, types and classification of enzymes, definition and types of coenzymes, Functions of coenzymes and cofactors, Specificity of enzymes, Isozymes, enzyme Kinetics including factors affecting enzyme action, velocity of enzyme catalysed reactions, regulations of enzyme activity, zymogen, allosteric enzymes, enzyme inhibition.
3. Intermediary metabolism: Carbohydrate Metabolism, Glycolysis, TCA cycle & energy generation, HMP Shunt pathway, gluconeogenesis, glycogenesis, glycogenolysis, blood sugar regulation.
4. Lipids: Oxidation and biosynthesis of fatty acids (saturated & mono-unsaturated), Synthesis and utilization of ketone bodies, Ketosis, fatty livers, Essential Fatty acids, Cholesterol and its clinical significance.

**FNTA-CC10P: NUTRITIONAL BIOCHEMISTRY-I (PRACTICAL)**

**2 CREDITS**

1. Quantitative estimation of Sugars (Glucose, lactose, starch)
2. Estimation of acid value, iodine value, Saponification value of fats
3. Estimation of blood Glucose
4. Estimation of serum cholesterol

**FIFTH SEMESTER**

**[TOTAL CREDITS: 6 (THEORY-4, PRACTICAL-2)]**

**FNTA-CC11Th: DIET THERAPY-II**

**4 CREDITS**

1. Energy modifications and nutritional care for weight management: Assessment, etiology, complications, prevention and treatment of obesity and underweight.
2. Diet in disease of the endocrine pancreas: Diabetes Mellitus: Classification, symptoms, diagnosis, management -insulin therapy, oral hypoglycaemic agents, glucose monitoring at home, dietary care and nutrition therapy, meal plan (with and without insulin), special diabetic foods and artificial sweeteners.
3. Hypertension: classification, aetiology, symptoms and dietary management.  
Diseases of the cardiovascular system: Definition of infarct, ischemia, angina pectoris, myocardial infarction, heart attack and stroke.  
Atherosclerosis and hyperlipidaemias – classification, symptoms, dietary and lifestyle management. Prevention of cardiovascular diseases.
4. Renal Diseases: Etiology, symptoms and dietary management of acute and chronic Glomerulonephritis. Nephrotic syndrome - dietary management. Uraemia – dietary

Nephrolithiasis - dietary management. Use of sodium and potassium exchange list.

**FNTA-CC11P: DIET THERAPY-II (PRACTICAL)**

**2 CREDITS**

Planning and preparation of Diets for the following diseases:

- i) Obesity and Underweight
- ii) Diabetes mellitus
- iii) Hypertension and Atherosclerosis
- iv) Acute and chronic glomerulonephritis

**FNTA-CC12Th: NUTRITIONAL BIOCHEMISTRY-II**

**4 CREDITS**

1. Brief Introduction of biological membranes to understand molecular transport, Transport of Large molecules, Receptor mediated endocytosis, exocytosis, Molecular aspects of transport; Passive diffusion, facilitated diffusion, active transport.
2. Introduction to Nucleic acids: Structure, replication, transcription, genetic code (in brief) elementary knowledge of biosynthesis of proteins.
3. Proteins: General reaction of amino acid metabolism, urea cycle. Lipoproteins: Types, composition, role and significance in disease(in brief).
4. Vitamins: Chemistry and biochemical role of fat soluble vitamins. A. D. E. and K. Water soluble vitamins – B1, B2, B6 niacin and C.
5. Minerals: Biochemical role of inorganic elements.

**FNTA-CC12P: NUTRITIONAL BIOCHEMISTRY-II (PRACTICAL)**

**2 CREDITS**

1. Qualitative analysis of amino acids
2. Qualitative analysis of proteins
3. Estimation of serum Protein
4. Estimation of serum creatinine
5. Estimation of serum Urea
6. Estimation of serum Iron, phosphorus, calcium

**SIXTH SEMESTER**

**[TOTAL CREDITS: 6 (THEORY-4, PRACTICAL-2)]**

**FNTA-CC13Th: FOOD MICROBIOLOGY****4 CREDITS**

1. Brief history of food microbiology and introduction to important microorganisms in foods.
2. Cultivation of microorganisms, Nutritional requirements of microorganisms, types of media used, methods of isolation.
3. Primary sources of microorganisms in foods, physical and chemical methods used in the destruction of microorganism in foods: (Sterilisation & Disinfection).
4. Fundamentals of control of microorganism in foods: Extrinsic and intrinsic parameters affecting growth and survival of microbes, use of high and low temperature, dehydration, freezing, freeze-drying, irradiation and preservatives in food preservation.
5. Food Spoilage: Contamination and microorganisms in the spoilage of different kinds of foods and such as cereal and cereal products, vegetable and fruits, fish and other sea foods, meat and meat products, eggs and poultry, milk and products, canned foods.

**FNTA-CC13P: FOOD MICROBIOLOGY (PRACTICAL)****2 CREDITS**

1. Introduction to microbiology:
  - Use of equipment
  - Understanding and use of compound microscope
  - Use of Autoclave
  - Use of Incubator and Inoculation chamber
2. Microscopic identification of microorganisms (prepared slides) : Bacterial, fungal strains
3. Preparation of liquid and solid media for culture of microorganisms.
4. Staining Techniques to study of Morphology of bacterial cells:
  - Simple staining with methylene blue, methyl violet, carbolfuscin, etc.
  - Differential staining with Gram stain technique
5. Microbiological techniques: Pure culture technique-Spread plate, Pour plate and Streak plate.

**FNTA-CC14Th: FOOD PRESERVATION****4 CREDITS**

1. Food preservation: definition, objectives and principles of food preservation. Different methods of food preservation.

2. Preserved Products: Jam, Jelly, Marmalade, Sauces, Pickles, Squashes, Syrups-types, composition and manufacture, selection, cost, storage, uses and nutritional aspects.
3. Food Standards : ISI, Agmark, FPO, MPO, PFA, FSSAI.

#### **FNTA-CC14P: FOOD PRESERVATION (PRACTICAL)**

**2 CREDITS**

1. Different methods of Food preservation – Drying, Freezing, Frying, canning, bottling etc.
2. Aseptic handling: Sources of contamination of foods.
3. Preparation of pickles, tomato sauce, chili sauce, jelly, tomato puree, squashes etc.

### **DISCIPLINE SPECIFIC ELECTIVE (DSE ) SYLLABUS**

#### **FNTA- DSEA1Th: PUBLIC HEALTH**

**4 CREDITS**

1. Health and Dimension of Health: Positive health Versus Absence of disease
2. Secondary Sources of Community Health data :Sources of relevant vital statistics of infant, child & maternal mortality rates
3. Immunization: Importance and Immunization schedule for children, adults and for foreign travellers.
4. Community Water and Waste Management: Importance of water to the community, etiology and effects of toxic agents, water borne infectious agents, sources of water, safe drinking water, potable water, waste and waste disposal, sewage disposal and treatment, solid waste and disposal, liquid waste disposal.
5. Concept of Epidemiology: Study of the epidemiologic approach-determinants of disease preventive & social means.
6. Communicable and infective disease control: Nature of communicable and infectious diseases, infection, contamination, disinfections, decontamination, transmission-direct & indirect, vector borne disease infecting organisms and positive agents, environmental agents and epidemiological principles of disease control.
7. Public health hazards due to contaminated foods: Food borne infections and intoxications: symptoms, mode of transmission and methods of prevention, investigation and detection of food borne disease out-break.

**FNTA-DSE-A1P: PUBLIC HEALTH (PRACTICAL)****2 CREDITS**

1. Preparation of 3 audio visual aids like charts, posters, models related to health and nutrition education.
2. Formulation and preparation of low cost and medium cost nutritious/ supplementary recipe.
3. Field visit( health centre, immunization centre, ICDS, MCH centre, NGOs etc.).

**FNTA-DSE A2Th: MUSHROOM CULTURE****4 CREDITS**

- 1 Definition and characteristics of mushroom.
- 2 Morphology and life cycle of Mushroom.
- 3 Identification and classification of mushroom
- 4 Nutritional and medicinal value of edible mushrooms; poisonous mushrooms
- 5 Types of edible mushrooms available in India- *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.
- 6 Process of mushroom cultivation.
- 7 Storage and nutrition: short term storage (Refrigeration- upto 24 hours), long term storage (canning, pickles, papads), drying, storage in salt solutions.

**FNTA- DSE A2P: MUSHROOM CULTURE(PRACTICAL)****2 CREDITS**

- 1 Visit to Mushroom Culture Centers/ Farms for:
  - Process involved in mushroom cultivation
  - Types and varieties of mushroom
  - Visual Identification of edible and poisonous mushroom
  - Mushroom Marketing
- 2 Different Food preparation from mushroom

**FNTA-DSE A3Th : DIET COUNSELING AND PATIENT CARE****4 CREDITS**

1. Introduction to term Dietician: Definition of Dietician , Difference between registered dietician & Nutrition
2. Role of dietician in hospital : work area of hospital dietician, role of dietician in hospital
3. Role of dietician in community :- work area of community dietician, role of community dietician

4. Introduction to Nutrition Care Process: Definition of Nutrition Care Process .Steps of Nutrition Care Process
5. Nutrition Assessment:-Definition , Nutrition assessment component, Critical thinking
6. Nutrition Diagnosis: nutrition diagnosis domain:- intake, clinical, behavioral – environmental
7. Nutrition diagnosis component• nutrition vs. medical diagnosis
8. Nutrition Interventions: Definition and objectives
9. Nutrition Monitoring & Evaluation : Definition, Nutrition monitoring & evaluation components, nutrition goals & objectives. Evaluation of nutrition care

### **FNTA-DSE A3P: DIET COUNSELING AND PATIENT CARE (PRACTICAL) 2CREDITS**

Visit and training to hospitals/nursing homes for 7-15 days :

- 1 Taking Case history and study
- 2 Routine Hospital diet
- 3 Distribution of food from kitchen to individual patient with specific diet. 4
- Dietary management of patient in different diseases and diet chart for the particular patient.
- 5 Role of dietitian /nutritionist in diet counselling

### **FNTA-DSE A4Th: GERIATRIC NUTRITION**

**4 CREDITS**

1. Definition of ageing, senescence, old age or aged people, gerontology, geriatrics, and Geriatric nutrition. Classification of old population.
- 2 .Physiological and biochemical changes during old age.
3. Assessment of nutritional status of older adults.
4. Nutritional requirements and general dietary guidelines for elderly .
5. Major nutritional and health problems during old age.

### **FNTA-DSE- A4P: GERIATRIC NUTRITION(PRACTICAL)**

**2 CREDITS**

1. Visit to old- age homes.
2. Preparation of dishes suitable for older person- soft, semisolid and easily digestible balanced diet.

### **FNTA-DSE-B1Th: THEORIES OF HUMAN DEVELOPMENT**

**4 CREDITS**



1. Introduction to theories in Human Development: Key themes in the study of Human Development- Nature/nurture, active/ passive, continuity/discontinuity, individual differences and similarities. Understanding a theory, Role of theories in understanding Human Development.
2. Perspectives on Human Development : Evolutionary and Ethological /Biological: Darwin, Lorenz, Bowlby, Ecological: Bronfenbrenner, Behavioural: Pavlov, Skinner, Bandura
3. Selected theories of human development : Psychodynamic; psychosexual and psychosocial theories; Freud, Erikson, Cognition: Piaget, Vygotsky, Models and Theories of Intelligence: Guilford, Spearman and Gardner, Humanistic: Maslow and Rogers.
4. Theories in everyday life: Eclectic theoretical orientation, Ethno theories.

#### **FNTA-DSE-B1P: THEORIES OF HUMAN DEVELOPMENT ( PRACTICAL) 4 CREDITS**

1. Biography of a theorist with a focus on his/her family life and childhood experiences.
2. Depict the 'eco-cultural' network for a child using the ecological model of Bronfenbrenne .
3. Verification of selected theories using multiple methods
4. Observe/ analyze creation of media product for children or product such as toys/ clothes using theoretical base.
5. Locate a tool/ scale of psychometric tests and administer it
6. Autobiography

#### **FNTA-DSE-B2Th:NON-FORMAL ADULT AND LIFE LONG EDUCATION 4 CREDITS**

1. Non Formal Education, Difference between formal & Non-Formal Education, Significance of Non-Formal Education in India New education policy & NFE Scope of NFE in communities- Techniques of community study, Domains of Non-Formal Education
2. Organizing NFE programmes- target group; Physical aspects; organizing and implementation Publicity of Non-Formal Programme; Planning and implementing publicity plan.
3. Adult Education: Meaning, concept and scope of Adult Education, Adult Education programme in India, Adult Education and Extension, Characteristics of Adult Learners, Difference between Adult & Child learning Learning theories; Characteristics of Adult learning, developmental tasks of Adults, Factors associated with Adult learning, Motivating and sustaining Adult learners.
4. Life Long Education : Definition, meaning and concept of Life Long Education, Life Long Education: Historical and contemporary perspectives, Components and objectives of Life Long

Education, Significance of Life Long Education in contemporary society, Forms and domains of Life Long Education, Principles of Life Long Education

5. Methods and Material for Non Formal/Adult/ Life Long Education: Methods and approaches for organizing NFE programmes for different target groups, Scope of communication methods and materials for NFE objectives

6. Programmes of Non Formal/Adult/ Life Long and Continuing Education: National and international programmes. Local, State, National and international agencies- policy and programmes, Monitoring and evaluation of NFE /Adult/ Life Long and Continuing Education programmes .

#### **FNTA-DSE-B2P:NON-FORMAL ADULT AND LIFE LONG EDUCATION(PRACTICAL) 2 CREDITS**

1.Visits to different NGO's involved in Non Formal/Adult/Life Long Education

2.Inviting experts from Government/Universities/ NGO's to share their experience of Non Formal/Adult/Life Long Education.

3. Reporting of Literacy news, events from periodicals and news papers.

4. Planning and organizing NFE/ continuing education programmes

5. Monitoring and Evaluation of programmes.

#### **FNTA-DSE-B3Th: CHILDHOOD DISABILITY AND SOCIAL ACTION**

**4 CREDITS**

1. Understanding Disability and Inclusion: Defining and understanding disability, Rights of persons with disability and UNCRPD, Perspective on disability: Individual and social, Attitudes towards disability- family, school, society and media

2. Types of Disability: Identification, assessment and etiology with reference to: Physical disabilities, Intellectual disability, Sensory disabilities- Visual and auditory IV. Learning disability, Autism

3. Disability and society: Overview of practices and provisioning related to addressing disability in India, Prevention, therapy, education and management, Families of children with disabilities, Policy and laws

### **FNTA-DSE-B3P: CHILDHOOD DISABILITY AND SOCIAL ACTION ( PRACTICAL) 2 CREDITS**

1. Visits- Government and Private Institutions and Organisations (CGC, schools, NGO's, Hospitals)
2. Observe the context
3. Case profile of child with disability
4. Program planning
5. Planning developmentally appropriate material for children with disability

### **FNTA-DSE-B4Th: CHILD RIGHTS AND GENDER JUSTICE**

**4 CREDITS**

1. Introduction to Child Rights: Concept of Child rights, Demographic profile of Indian children, Disadvantage, deprivation and social exclusion with reference to children, Laws, policies and programmes for children in India, UNCRC.
2. Children in need of care and protection: Vulnerable groups: causes and consequences. Street, homeless, institutionalized and working children  
  
Child Abuse, Child Trafficking, Children in conflict with the law, Children living with: chronic illness, HIV.
3. Social construction of gender Socialization for gender: gender roles, stereotypes and identity, Gender in the workplace and in public spaces, Contemporary influences: media and popular culture, Demographic profile of women and children in India.
4. Gender and Indian society : Sex and Gender, Masculinity and Femininity, biological and cultural determinants, Patriarchy and social institutions, Being male and female in Indian society-social traditions and contemporary issues, Exploring the issues of violence against females, Laws, policies and programmes for children and women.

### **FNTA-DSE-B4P: CHILD RIGHTS AND GENDER JUSTICE(PRACTICAL)**

**2 CREDITS**

1. Visits to organizations working in the area of Child Rights and Gender to understand their objectives programmes and experiences.
2. Workshops on relevant issues like Gender, domestic violence, gendering of public spaces.
3. Understanding child rights and gender issues in diverse social groups through field visits and interactions
4. Media portrayals of women and children.

## **SKILL ENHANCEMENT COURSE(SEC)**

### **FNTA-SEC-A1Th: SPORTS NUTRITION**

**2 CREDITS**

1. Definition of physical activity, exercise, physical fitness, sports physiology and sports nutrition.
2. Benefits of physical activity and exercise.
3. Classification of Sports activities.
4. Nutritional requirements of sports person.
5. Pre- event meal.

### **FNTA-SEC-A2Th: FOOD SERVICE MANAGEMENT**

**2 CREDITS**

1. Organization of food service management: Definition, Various types of Food Service institutions, their characteristics and functions.
2. Planning a food service unit, layout design, planning of different work areas – preparation, cleaning, storing, serving and dining areas. Lighting and ventilation, working heights in relation to equipment.
3. Institutional Menu Planning: Factors influencing menu planning, principles of menu planning, different kinds of menus.
4. Quality food Service – types-Centralized, de-centralized objectives. Styles of service.
5. Importance of sanitation and hygiene in food, kitchen hygiene, Hygienic handling of Food, employee's health, hygiene of food service unit.
6. Personnel Management- selection, training and supervision of personnel, criteria for selection of Dietitian and Food Service staff.

### **FNTA-SEC- B1Th: NUTRITION AND HEALTH EDUCATION**

**2 CREDITS**

- 1 Concept, objectives and importance of nutrition and health education
- 2 Principles of health education.
- 3 Nutrition and health education communication process.
- 4 Steps in planning health and nutrition education.
- 5 Methods involved in nutrition and health education
- 6 Evaluation of nutrition and health education programmes.

**FNTA-SEC-B2Th: BAKERY SCIENCE****2 CREDITS**

- 1 Introduction and scope of bakery science.
  - 2 Common bakery terms
  - 3 Flours: Constituents of flour, water absorption power, gluten, grades of flour.
  - 4 Raw materials required for bread and cake making.
  - 5 Role of flour, water , yeast, salt, sugar, milk and fats in bakery. 6
- Bread and cake making process.
- 7 Bread improver.
  - 8 Knowledge of oven and baking temperatures.
  - 9 Preparation of basic cookies, biscuits and pastries

**SUGGESTED BOOKS AND JOURNALS****FOOD SCIENCE**

1. SrilakshmiB( 2017): Nutrition Science,6th Multicolour Ed. New Age International (P) Ltd.
2. RodayS(2012): Food Science and Nutrition, 2nd Ed. Oxford University Press.
3. Mann J and TruswellsS(2017) : Essentials of Human Nutrition, 5th Ed. Oxford University Press.
4. Wilson K and Walker J(2000): Principles and Techniques of Practical Biochemistry, 5th Ed. Oxford University Press.
5. Sadasivan S and ManikamK(2007): Biochemical Methods, 3rd Ed. New Age International (P) Ltd.
6. Oser B L(1965). Hawk's Physiological Chemistry, 14th Ed. McGraw -Hill Book
7. Nath RL and NathRK(1990). Practical biochemistry in clinical medicine, 2nd Ed. Academic Publishers.
8. Sen AR, Pramanik NK and Roy SK(2001): A treatise on analysis of food fat and oil, Oil Technologists Association of India (EZ), Kolkata, 76, 119.

9. Plummer D (2017): An introduction of Practical Biochemistry, 3rd Ed. McGraw Hill Education.
10. Swaminathan M (2007): Essentials of Food and Nutrition (Vol. I & II), 2nd Ed. Bappa Co.
11. Meyer LH (2004): Food Chemistry, CBS Publishers & Distributors.

## HUMAN NUTRITION

1. Srilakshmi B (2014): Dietetics, 7th Multicolour Ed. New Age International (P) Ltd.
2. Guthrie AH (1986): Introductory Nutrition, 6th Revised Ed., McGraw-Hill Inc., US.
3. Robinson CH and Lawler M (1990): Normal and Therapeutic Nutrition. 17th Revised Ed. Macmillan USA.
4. Swaminathan M (2007): Essentials of Food and Nutrition (Vol. I & II), 2nd Ed. Bappa Co.
5. Gopalan C, Rama Sastri BV and Balasubramanian SC (2016): Nutritive value of Indian Foods, Indian Council of Medical Research.
6. Nutrient Requirements and Recommended Dietary Allowance for Indians, Indian Council of Medical Research: New Delhi.
7. FAO/WHO/UNO: Technical Report Series, 724 (1985). Energy and Protein Requirement, Geneva.
8. Ghosh S (2007): Nutrition and Child Care, 2nd Ed. Jaypee Brothers Medical Publishers Private Limited.
9. WHO: A growth chart for International use In Maternal and Children Health Care, Geneva.
10. Mann J and Truswell S (2017): Essentials of Human Nutrition, 5th Ed. Oxford University Press.
11. Worthington- Roberts B and Williams SR (1999): Nutrition Throughout the Life Cycle, 4th Ed. McGraw-Hill Higher Education.
12. Elizabeth KE (2015): Nutrition and Child Development, 5th Ed. Paras Medical Publishers.
13. Geissler C and Powers H (2005): Human Nutrition, 11th Ed. Churchill Livingstone.
14. Zimmermann M (2001): Burgerstein's Handbook of Nutrition: Micronutrients in the Prevention and Therapy of Disease Thieme Stuttgart.
15. Samour PQ and King K (2010): Pediatric Nutrition, 4th Ed. Jones & Bartlett Learning.
16. Insel P, Ross D, McMahon K and Bernstein M (2016): Nutrition, 6th Ed. Jones & Bartlett Learning.

17. Mudambi SR (2018): Fundamentals of Foods, Nutrition and Diet Therapy, 6th Ed. New Age International (P) Ltd.
18. Williams SR (2001): Basic Nutrition and Diet Therapy, 11th Ed. Elsevier.
19. Proudfit FT and Robinson CH (1967): Normal and Therapeutic Nutrition, 13th Ed. Mamillan.
20. Guthrie H and Picciano MF (1994): Human Nutrition, WCB McGraw-Hill,
21. Smith A and Collene A (2015); Wardlaw's Contemporary Nutrition, 10th Ed. McGraw-Hill Education.
22. Sharlin J and Edelstein S (2010): Essentials of Life Cycle Nutrition, 1st Ed. Jones & Bartlett Learning.
23. Indian National Code for Protection of Breast Feeding: Govt. of India. Ministry of Social Welfare, New Delhi.

## HUMAN PHYSIOLOGY

1. Chatterjee CC (1988). Text Book of Physiology – Vol I & II.
2. Chaudhuri SK (2000). Concise Medical Physiology. New Central Book Agency (P) Ltd.
3. Guyton AC, Hall JE (1966). Text book of Medical Physiology. 9th Ed. Prism Books (Pvt.) Ltd. Bangalore..
4. Guyton AC (1985). Function of the Human Body, 4th Edition, W.B. Sanders Company, Philadelphia.
5. Hadley ME (2000). Endocrinology. 5th ed. Pearson Education.
6. Hoar WS (1984). General and comparative Physiology. 3rd ed. Prentice-Hall of India.
7. Wilson (1989). Anatomy and Physiology in Health and Illness. Edinburgh, Churchill Livingstone.
8. Winword (1988). Sear's Anatomy and Physiology for Nurses. London, Edward Arno.
9. Koeppen BM and Stanton BA (2017): Berne and Levy Physiology, 7<sup>th</sup> Ed. Elsevier
10. Rhoades R and Pflanzer R (2003): Human Physiology, 4<sup>th</sup> ed. Thomson.
12. Eroschenko VP (2007): diFore's Atlas of Histology, diFiore's Atlas of Histology with Functional Correlations, 11<sup>th</sup> Edition. Lippincott Williams & Wilkins.
13. McLaughlin D, [Stamford](#) J and White D (2006): Bios Instant Notes on Human Physiology,

Ed. Taylor & Francis;

## COMMUNITY NUTRITION

1. Jelliffe DB. Assessment of the Nutritional Status of the Community; World Health Organisation.
2. Sahn DE, Lockwood R, Scrimshaw NS (1988): Methods the Evaluation of the Impact of Food and Nutrition Programmes, 2nd Printing, United Nations University.
3. Ritchie, JAS (1979): Learning Better Nutrition, Nutritional Studies number 20, FAO, Rome.
4. Gopaldas T and Seshadri S (1988): Nutrition Monitoring and Assessment, Oxford University Press.
5. Mason JB, Habicht, JP, Tabatabai H and Valverde V (1984): Nutritional Surveillance, World Health Organisation.
6. Park K (2017): Textbook of Preventive and Social Medicine, 24th Ed. Banarsidas Bhanot Publishers.
7. King MH, King PMA, Morley D and AP Burgess (2015): Nutrition for Developing Countries, ELBS Oxford University Press.
8. Passmore R and Eastwood MA (1986): Davidson and Passmore's Human Nutrition & Dietetics, 8th Revised Ed. Churchill Livingstone.
9. Seshubabu VVR (2011): Review in Community Medicine, 2nd Ed, Paras Medical Books Pvt Ltd.
10. Mahajan BK, Roy RN, Saha I, Gupta, MC (2013): Text book of Preventive and Social Medicine, 4th Ed. Japee Brothers.
11. Vir SC (2011): Public Health Nutrition in Developing Countries, Woodhead Publishing India.
12. Bamji MS, Krishnaswamy K and Brahman GNV (2017): Textbook of Human Nutrition, 4th Ed. Oxford & IBH Publishing Co. Pvt. Ltd.

## FOOD COMMODITIES

1. Swaminathan MS Food Science, Chemistry and Experimental Foods, Bangalore Print & Publishing Company.
2. Srilakshmi B (2018): Food Science, 7th Colour Ed. New Age International (P) Ltd.



- 3.Lavies, S (1998): Food Commodities Ltd. London.
4. Hughes O and Bennion, M (1970): Introductory Foods, 5th Ed. Macmillan & Co., New York.
- 5.Parker R and Pace M(2016):Introduction to Food Science and Food Systems, 2nd Ed. Delmar Cengage Learning.
- 6.Meyer LH(2004): Food Chemistry, 1st Ed. CBS Publishers and Distributors, New Delhi.
- 7.Mudambi SR, Rao SM and Rajagopal MV(2006): Food Science, 2nd Ed. New Age International (P) Ltd.
- 8.Manay SN and ShadaksharaswamyM( 2008): Foods: facts and principles , 3rd Ed. New Age International (P) Ltd.
9. Potter NN and Hotchkiss JH(1999): Food science,5th Ed , Springer.
- 10.PruthiJS(2011):Spices and Condiments, National Book trust, New Delhi.
- 11.Pyke M and Murrey J (1974): Catering Service and Technology, John MurreyPube, London.

#### DIET THERAPY

- 1.Anderson L, Dibble MV, Turkki PR, Mitchall HS, and Rynbergin HJ(1983): Nutrition in Health and Disease, 17th Ed. J. B. Lipincott & Co. Philadelphia.
- 2.Anita FP and Abraham P: Clinical Dietetics and Nutrition, 4th Ed. Oxford University Press, Delhi.
- 3.Mahan LK and Escott-Stump S(2007): Krause's Food and Nutrition Therapy. 12th Ed. WB Saunders Company, London.
- 4.Robinson. CH, Lawler MR, Chenoweth WL and Garwick, AE(1986): Normal and Therapeutic Nutrition. 17th Ed.,Macmilian Publishing Co.
- 5.Williams SR (1989): Nutrition & Diet Therapy, 6th Ed. Times Mirror/Mosby College Publishing, St. Louis.
- 6.Begum RM (2009): A textbook of Food, Nutrition and Dietetics, 3rd Ed. Sterling Publishers, New Delhi.
- 7.Joshi SA(2017): Nutrition and Dietetics, 4th Ed. Tata McGraw Hill Publications, New Delhi.
- 8.Hutchison, R(2010)Food And The Principles Of Dietetics , Kessinger Publishing, LLC.

#### NUTRITIONAL BIOCHEMISTRY

- 1.Murray RK, Bender DA, Botham KA, Mayes PA and RodwellVW(2015):Harper's Biochemistry, 30th Ed. Lange Medical Book.
- 2.Handler P, Smith EI, Stelten DW: Principles of Biochemistry, McGraw Hill Book Co.
- 3.Nelson DL and Cox MM (2017): Lehninger Principles of Biochemistry. 7th Ed. WH Freeman.
- 4.Devlin TM (2010): Text Book of Biochemistry with Clinical Correlations. John Wiley and Sons.
- 5.Berg JM,Tymoczko JL, Gatto GJ and Stryer L(2015): Biochemistry, 8th Ed WH Freeman and Co.

#### FOOD MICROBIOLOGY

- 1.Frazier WC and Westhoff D C and Vanitha NM (2017): Food Microbiology, 5th Ed. MaGraw Hill Education..
2. Jay JM (2005): Modern Food Microbiology, 3rd Ed. CBS Publishers & Distributors.
- 3.Pelczar M, Chan ECS, Krieg N(2009): Microbiology : Application Based Approach, Tata McGraw Hill Education.
- 4.Benson HJ(2001): Microbiological Applications: Complete Version: A Laboratory Manual in General Microbiology, 8th Ed. McGraw-Hill Publishing Co.
- 5.Colling CE and Lyne PM (1976): Microbiological Methods, Butterworth. London.
- 6.Bamrart G(2012): Basic food Microbiology, 2nd Ed. (Reprint), Springer.
- 7.Wood BJ(1998):Microbiology of Fermented Foods, Vol I & II, 2nd Ed. Springer.
- 8.Joshi VK(2009): Biotechnology: Food Fermentation Microbiology, Biochemistry & Technology, Vol I &Vol II , Educational Publishers & Distributors.
- 9.Tortora GJ, FunkeBR and Case CL(2016): Mocrobiology, 11th Ed. Pearson Education India.
- 10.Black JG (2008 ): Microbiology: Principles and Explorations, 7th Ed. John Wiley &

#### Sons. FOOD PRESERVATION

- 1.Subalakshmi, G and Udipi, SA(2006):Food processing and preservation, 1st Ed. New Age International (P)Ltd.
- 2.SrilakshmiB(2018): Food Science, 7th Colour Ed. New Age International (P) Lt
3. Potter NN and Hotchkiss JH(1999): Food science,5th Ed , Springer.

- 4.Srivastava RPO and Kumar S (2014): Fruit and Vegetable Preservation Principles and Practices, 3rd Ed. International Book distribution Company.
- 5.McWilliamsM and Paine H(1984): Modern Food preservation. Surjeet Publications,.
- 6.CruessWV(2004):Commercial Fruits and Vegetable Products, Agrobios India.
- 7.Desrosier NW and Desrosier JN(2006):The Technology Of Food Preservation, 4th Ed. CBS Publishers and Distributors, New Delhi.
- 8.Adams M and NoutMJR(2001): Fermentation and Food Safety, Springer.

### DISCIPLINE SPECIFIC ELECTIVES(DSE)

#### PUBLIC HEALTH

- 1.Smith, G.W.: Preventive Medicine and public health. 2nd edition. McMillan Co. New York.
- 2.Park: Park's Textbook of preventive and Social Medicine. 9th edition.M/s. BanarasidasBhanot. Jabalpur.
- 3.SeshubabuVVR(2011): Review in Community Medicine, 2nd Ed, Paras Medical Books Pvt Ltd.
- 4.Mahajan BK, Roy RN , Saha I, Gupta, MC (2013):Text book of Preventive and Social Medicine, 4th Ed. Japee Brothers.
- 5.Vir SC(2011): Public Health Nutrition in Developing Countries, Woodhead Publishing India.
- 6.Willett W(2012): Nutritional Epidemiology, 3rd Ed. Oxford University Press,USA.

#### MUSHROOM CULTURE

1. Staff E(2007):Hand Book of Mushroom Cultivation, Processing and Packaging Import, Educa Books.
2. Pandey RK and Ghosh SK(1999): A Handbook Of Mushroom Cultivation, Emkay Publications.
3. Patil NN(2010):Mushroom : Cultivation, Processing and Uses, 1<sup>st</sup> Ed. Universal Prakashan.

## DIET COUNSELING AND PATIENT CARE

1. Mahan LK and Escott-Stump S(2007): Krause's Food and Nutrition Therapy. 12th Ed. WB Saunders Company, London.
2. Robinson. CH, Lawler MR, Chenoweth WL and Garwick, AE(1986): Normal and Therapeutic Nutrition. 17th Ed.,Macmilian Publishing Co.
- 3.Williams SR (1989): Nutrition & Diet Therapy, 6th Ed. Times Mirror/Mosby College Publishing, St. Louis

## GERIATRIC NUTRITION

- 1.Human Nutrition by H. Guthrie and M.F. Piccianom, WCB McGrawHill,1995.
- 2.Robinson CH, Lawler MR, Chenoweth WL, GarwickAE(199!): Normal And Therapeutic Nutrition, 17th Ed, MacMillan Publishing Company, New York,
- 3.Insel PM, Turner RE and RossD (2004): Nutrition ,Jones & Bartlett Learning,
4. Morley JE and Thomas DR(2007): Geriatric Nutrition, 1st Ed. CRC Press.
- 5.Watson RR (2008):Handbook of Nutrition in the Aged, 4th Ed. CRC Press.
- 6.Chernoff R(2013):Geriatric Nutrition : The Health Professional's Handbook, 4th Revised Ed. Jones and Bartlett Publishers.

## THEORIES OF HUMAN DEVELOPMENT

- 1.Berger JM (2010): Personality, 8th Ed. Thomson-Wadswort: Berger Belmont, CA.
- 2.Allen BP (2006): Personality theories: Development, growth and diversity , 5th Ed. Pearson Education / Allyn& Bacon.
- 3.Santrock JW(2007): Lifespan Development, 3rd Ed. Tata- McGraw Hill, New Delhi.
- 4.Rice FP(1995): Human Development: A Lifespan Approach. New Jersey, Prentice-Hall

## NON-FORMAL ADULT AND LIFE LONG EDUCATION

- 1.Mishra L(2010):Adult Education, A study of the trials, APH Publishing Corporation, New Delhi.
- 2.Chandra A and Shah A(1987): Non Formal Education for All, Sterling Publishers, New Delhi.

3.Singh M (2007):New Companion to Adult Educators, International Institute of Adult and Life Long Education, New Delhi.

4.Singh NK( 2010): Adult Education, Saurabh Publishing House, New Delhi.

5.KhajuriaDP:New Trends in Indian Education, Narendra Publishing House, Jalandhar.

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## CHILDHOOD DISABILITY AND SOCIAL ACTION

1.Chopra G (2012): Early Detection of Disabilities and persons with disabilities in the community, Engage publications , New Delhi.

2.Chopra G (2012): Stimulating Development of Young Children with Disabilities At Anganwadi and at Home: A Practical Guide, Engage publications,New Delhi.

3.Sharma N (2010): The Social Ecology of Disability-Technical Series -3, Academic Excellence, Lady Irwin College, Delhi.

4.Mangal SK (2007):Exceptional children: An introduction to special education, Prentice Hall of India, New Delhi.

5.Jangira NK(1997): “Special Educational Needs of Children and Young Adults: AnUnfinished Agenda,” Education and Children with Special Needs: From Segregationto Inclusion, Ed. Seamus Hegarty, MithuAlur, Thousand Oaks: Sage Publications Inc.

5.Karna GN (1999): United Nations and rights of disabled persons: A study in IndianPerspective, APH Publishing Corporation,New Delhi.

6.Mani R(1988): Physically handicapped in India, Ashish Publishing House, Delhi.

8.Mastropieri MA and Scruggs TE (2004): The inclusive classroom: Strategies foreffective instruction., Pearson, NY.

## CHILD RIGHTS AND GENDER JUSTICE

1.Agarwal A and Rao BV (2007): Education of Disabled Children, Eastern Book Corporation, New Delhi.

2.Agnes F(1999):Law and Gender Inequality: The politics of Women’s Rights in India. Oxford University Press.

3.Bajpai A(2006):Child Rights in India: Law, Policy and Practice. Oxford University Press.

4.KishwarM(1999): Off the Beaten Track: Rethinking Gender Justice for Indian Women Oxford University Press, New Delhi.

5.Satyarthi K and Zutshi B(Ed) (2006):Globalization, Development and Child Rights. Shipra Publication, New Delhi.

6.Saikia N (2008): Indian women: A socio-legal perspective, Serials Publication India, New Delhi.

## SKILL ENHANCEMENT COURSES( SEC)

### SPORTS NUTRITION

1.Campbell B (2017): Sports Nutrition: Enhancing Athletic Performance, CRC Press, Taylor & Francis.

2.HaffGG(2008): Essentials of Sports Nutrition Study Guide, Humana Press.

3.Dunford M and Doyle JA(2008):Nutrition for Sport and Exercise, Thomson Wadsworth,

4.BrounsF(2002):Essentials of Sports Nutrition, 2nd Revised Ed. Wiley-Blackwell.

5.Bean A(2017):The Complete Guide to Sports Nutrition, 8th Ed. Bloomsbury Sport.

6.BenardotD(2011):Advanced Sports Nutrition,2nd Ed. Human Kinetics Publishers.

7.SrilakshmiB(2014): Dietetics, 7th Multicolour Ed. New Age International (P) Ltd.

### FOOD SERVICE MANAGEMENT

1.Khan MA (1987):Food Service Operations, Avi Publication Co.

2.Tompkins D(1969):Table Layout and Decoration, Ward Lock Co. Ltd.

3.Kinton R and CaseraniV(1989): The Theory of Catering, 6th Ed. ELBS.

4.Edward K(1997): Food Service Facilities Planning 3rd Ed, John Wiley & Sons.

5. Sethi M (2015):Catering Management: An Integrated Approach,3rd Ed. New Age International(P) Ltd.

6.RodayS(2017): Food Hygiene and Sanitation with Case Studies, 2nd Ed. McGraw Hill Education.

### NUTRITION AND HEALTH EDUCATION

1. Park K(2017): Textbook of Preventive and Social Medicine, 24th Ed. Banarsidas Bhanot Publishers
2. Mahajan BK, Roy RN, Saha I, Gupta, MC (2013): Text book of Preventive and Social Medicine, 4th Ed. Japee Brothers
3. Pandya R(2010): Community Health Education, Rawat Publications.

#### BAKERY SCIENCE

1. Edwards WP(2006): The Science of Bakery Products, 1st Ed. Royal Society of Chemistry.
2. Khetarpaul N, Grewal Rajbala and Jood S(2005): Bakery Science and Cereal Technology, Daya Publishing House.
3. Hui YH(2005): Bakery Products: Science and Technology, 1st Ed. Wiley India.

4.







7.

**COURSE CURRICULUM FOR UNDERGRADUATE  
COURSES UNDER CHOICE BASED CREDIT SYSTEM**

**REVISED SYLLABUS**

**FOR**

**B. Sc. (GENERAL)  
IN  
FOOD AND NUTRITION**



**UNIVERSITY OF CALCUTTA**

**2018**

**SCHEME AND SYLLABUS FOR CHOICE BASED CREDIT SYSTEM FOR  
B.Sc. FOOD AND NUTRITION GENERAL**

<b>SE M ES TE R</b>	<b>CORE COURSE (CC) (12)</b>	<b>ABILITY ENHANCEMENT COMPULSORY COURSE (AECC) (2)</b>	<b>SKILL ENHANCEMENT COURSE(SEC) (2)</b>	<b>DISCIPLINE SPECIFIC ELECTIVE(DSE) (6)</b>
<b>I</b>	<b>FNT-G-CC/GE-1-1-Th: ELEMENTARY CHEMISTRY</b>			
	<b>FNT-G-CC/GE-1-1-P: ELEMENTARY CHEMISTRY (PRACTICAL)</b>			
	CC/GE-2ATh: FROM OTHER DISCIPLINE OF CHOICE			
	CC/GE-2AP: FROM OTHER DISCIPLINE OF CHOICE			
<b>II</b>	<b>FNT-G-CC/GE-2-2 -Th: ELEMENTARY PHYSICS</b>			
	<b>FNT-G-CC/GE-2-2-P: ELEMENTARY PPHYSICS (PRACTICAL)</b>			
	CC/GE-2BTh: FROM OTHER DISCIPLINE OF CHOICE			
	CC/GE-2BP: FROM OTHER DISCIPLINE OF CHOICE			
<b>III</b>	<b>FNT-G-CC/GE-3-3-Th: ELEMENTARY PHYSIOLOGY</b>		<b>SEC-1</b>	
	<b>FNT-G-CC/GE-3-3-P-ELEMENTARYPHYSIOLOGY (PRACTICAL)</b>			
	CC-2CT: FROM OTHER DISCIPLINE OF CHOICE			
	CC/GE-3CTh: FROM OTHER DISCIPLINE OF CHOICE			
<b>IV</b>	<b>FNT-G-CC/GE-4-4-Th: BASIC NUTRITION AND FOOD SCIENCE</b>		<b>SEC-2</b>	
	<b>FNT-G-CC/GE-4-4-P: BASIC NUTRITION AND FOOD SCIENCE (PRACTICAL)</b>			
	CC/GE-2DTh: FROM OTHER DISCIPLINE OF CHOICE			
	CC/GE-2DP: FROM OTHER DISCIPLINE OF CHOICE			
<b>V</b>	<b>CC/GE-3DTh: FROM OTHER DISCIPLINE OF CHOICE</b>	<b>DSE-2A</b>	<b>SEC-3DSE-1A</b>	
	<b>CC/GE-3DP: FROM OTHER DISCIPLINE OF CHOICE</b>			
				<b>DSE-3A</b>

VI			SEC-4	DSE-1 B
				DSE- 2B
				DSE-3B

### DISTRIBUTION OF CREDITS IN THE COURSE CURRICULUM

Semester	NAME OF THE COURSE				Total Credits
	Core Course (CC)	Ability Enhancement Compulsory Course (AECC)	Skill Enhancement Course (SEC)	Discipline Specific Elective (DSE)	
I	6x3= 18	2x1=2			20
II	6x3= 18	2x1=2			20
III	6x3= 18		2x1=2		20
IV	6x3= 18		2x1=2		20
V			2x1=2	6x3=18	20
VI			2x1=2	6x3=18	20
<b>Total credits</b>	<b>CC (18x4=72)</b>	<b>AECC (2x2=4)</b>	<b>SEC (4x2=8)</b>	<b>DSE (6X6=36)</b>	<b>120</b>

**NOTE:**

1. 12 papers for Core Courses (CCs) from 03 Disciplines of Choice(DSC) should be compulsorily studied for BSc. General students. 4 courses from each of the DSC subjects are to be studied by the BSc General students.
2. The CC or DSC is equivalent to Generic Elective (GE) for BSc. (Honours) students of other discipline .
3. 6 DSE & 1/2 SEC to be chosen by the Food and Nutrition(General) students (Choice based).
4. GE subjects in Food and Nutrition Syllabus are to be studied by other discipline students.

### **SEMISTER -WISE COURSES FOR BSc GENERAL**

	<b>Sem-1</b>	<b>Sem-2</b>	<b>Sem-3</b>	<b>Sem-4</b>	<b>Sem-5</b>	<b>Sem-6</b>
<b>Core Course (CC/GE)</b>	3TH+3P/TU  <b>CC/GE-1</b>	3TH+3P/TU  <b>CC/GE-2</b>	3TH+3P/TU  <b>CC/GE-3</b>	3TH+3P/TU  <b>CC/GE-4</b>		
<b>Discipline Specific Elective (DSE)</b>					3TH+3P/TU  <b>DSE-A</b>  (1A+2A+3A)	3TH+3P/TU  <b>DSE-B</b>  (1B+2B+3B)
<b>Ability Enhancement Compulsory Course (AECC)</b>	1TH+0P/T  <b>AECC-1</b>	1TH+0P/TU  <b>AECC-2</b>				
<b>Skill Enhancement Elective (SEC)</b>			1TH+0P/TU  <b>SEC-A</b>	1TH+0P/TU  <b>SEC-B</b>	1TH+0P/TU  <b>SEC-A</b>	1TH+0P/TU  <b>SEC-B</b>
<b>Total No. of  Courses and Marks</b>	<b>4 ×100</b>  <b>=400</b>	<b>4 ×100</b>  <b>=400</b>	<b>4 ×100</b>  <b>=400</b>	<b>4 ×100</b>  <b>=400</b>	<b>4 ×100 =400</b>	<b>4 ×100 =400</b>
<b>Total Credits</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>

[Th= Theory P= Practical]

**N.B:**

- CC/DSE : Each Theory and Practical Course have 4 and 2 Credits respectively/ Each Theory and Tutorial Course have 5 and 1 Credit(s) respectively
- CC : 4 courses each from 3 subjects (one course from each subject under each semester)
- DSE : 2 courses each from 3 subjects (one course from each subject under each semester)
- AECC/SEC : Each Course has 2 credits
- AECC-1 : Communicative English/ MIL; AECC-2: Environmental Studies
- SEC: 4 courses; two courses each from two subjects

**DSE/SEC : Group (A & B) for specified semesters**

## **GENERIC ELECTIVE (GE)**

### **FNT-G-CC/GE-1-1Th: ELEMENTARY CHEMISTRY**

**4 CREDITS**

1. Law of conservation of mass, chemical and physical changes, Mechanical mixtures and chemical compounds
2. Common Laboratory Processes: Sedimentation, Decantation, Filtration, Solution, Evaporation, Boiling, Desiccation, Distillation, Sublimation, Fusion, Ignition, Crystallisation, Efflorescence, Deliquescence.
3. Symbol, Valency, Formula, Equation, Naming of Compounds, Radicals.
4. General concept of acids, bases and salts, conjugate acids and bases, Classification of salts, Hydrolysis of salts, pH, Buffer solution. Equivalent weight of acids, bases and salts, neutralisation, Acid-Base indicators, Molar solution, Normal solution and Formula solution.
5. Diffusion and Osmosis, Osmotic pressure, Isotonic solution, Definition and examples.
6. Colloids: Definition, Types of colloidal systems, Important properties of colloidal sols, Dialysis.
7. Structure of atom: Discovery of atomic nucleus, Rutherford's atomic model, concept of Stationary orbit, Electronic arrangement of elements ( Hydrogen to calcium), Atomic number, Isotopes, Chemical bonds – Electrovalent, Covalent and coordinate – covalent bonds, Hydrogen bonds.
8. Chemistry of carbon compounds: Classification of organic compounds based on structural characteristics and functional groups, isomerism, Concept of optical isomerism. General methods of preparation, properties and reactions of structured and unstructured hydrocarbons, Aliphatic monohydric alcohols, Glycerol, Aldehyde, Ketones and fatty acids upto 3 atoms with nomenclature.

### **FNT-G-CC/GE-1-1 P: ELEMENTARY CHEMISTRY (PRACTICALS)**

**2 CREDITS**



1. Fitting of simple apparatus, experiment involving solution, filtration, distillation, and crystallization. Separation of constituents of mixture.
2. Titration of acids and bases. Determination of total hardness of water by soda reagent. Estimation of glucose.
3. Simple chemical tests for carbohydrate- Starch, glucose, cane sugar, lactose, and dextrin.
4. Qualitative tests-Protein in milk and egg, Calcium, phosphorus, and iron in foodstuff.

### **FNT-G-CC/GE-2-2-Th: ELEMENTARY PHYSICS**

**4 CREDITS**

1. Units –C.G.S. and F.P.S. system
2. Measurement of mass and weight, common and spring balance.
3. Motion of body – displacement, velocity, acceleration units.
4. Gravity – Acceleration due to gravity.
5. Hydrostatics–Pressure at a point, Archimedes Principles, Specific gravity, viscosity and surface tension.
6. Thermometry.
7. Calorimetry.
8. Transmission of heat, Thermoflask.
9. Three types of matter, changes of state, pressure cooker, Ice-machine.
10. Static electricity – Changing by friction, conductor and Insulator.
11. Primary cell, storage cell.
12. Electroplating.
13. Definition of Potential, Current-relation between two.
14. Measurement of current by ammeter and potential differential by voltmeter.
15. Electricity and its application in daily life – lamp, Toaster, Geyser, iron, Micro-oven.
16. Refrigerator, cold storage.
17. Electric fuse.

### **FNT-G-CC/GE-2-2-P:ELEMENTARY PHYSICS (PRACTICAL)**

**2 CREDITS**

1. Use of balance( Weighing a body)
2. Determination of specific gravity of a solid (heavier and insoluble in water).
3. Determination of specific gravity of a liquid by hydrostatic balance.
4. Determination of specific gravity of a liquid by specific gravity bottle.
5. Reading of barometer.
6. Determination of lower and upper fixed point of a thermometer.
7. Fitting of electric fuses.

### **FNT-G-CC/GE-3-3Th: ELEMENTARY PHYSIOLOGY**

**4 CREDITS**

1. Animal cell: Structure and function.
2. Tissue: Definition, structure and functions of different types of tissue, e.g. epithelial, connective, nervous and muscular tissue ( special emphasis on blood and bone) .

3. Digestive system: Structure involve in digestive system (mouth, esophagus, stomach, small intestine, large intestine, liver, pancreas, gall bladder) and their functions. Digestion and absorption of Carbohydrate, protein and fat.
4. Elementary idea of metabolism, enzymes and hormones- name and their important functions. Metabolism in brief (Glycolysis, Glycogenesis, Gluconeogenesis, Cori's cycle, Kreb's cycle, Deamination, Transamination. Role of hormones in carbohydrate metabolism.

**FNT-G- CC/GE-3-3-P: ELEMENTARY PHYSIOLOGY (PRACTICAL)      2CREDITS**

1. Demonstration for determination of blood pressure of humans being- (a) systolic and b) diastolic.
2. Identification of slides ( Blood cells, Stomach, Small intestine, large intestine, Liver, pancreas).
3. Determination of Bleeding Time (BT) and Clotting Time (CT).
4. Detection of Blood group.

**FNT-G- CC/GE-4-4-Th: BASIC NUTRITION AND FOOD SCIENCE      4 CREDITS**

1. Definition of Food, Nutrition, Nutrient, Nutritional status, Dietetics, Balance diet, Malnutrition, Energy (Unit of energy – Joule, Kilocalorie).
2. Carbohydrate, Protein, Fat, Vitamins and Minerals (calcium, phosphorus, sodium, potassium, iron, iodine, fluorine)- sources, classification, functions, deficiencies of these nutrients. Functions of water and dietary fiber.
3. B.M.R: Definition, factors affecting B.M.R. and Total Energy Requirement (Calculation of energy of individuals).
4. Basic five food groups: Nutritional significance of cereals, pulses, milk, meat, fish, vegetable, egg, nuts, oils, sugar.
5. Principles and objectives of meal planning. Diet for an infant (Breast feeding versus Bottle feeding).Preschool child, school child, Normal male and female of different occupation.

**FNT-G-CC/GE-4-4-P: BASIC NUTRITION AND FOOD SCIENCE (PRACTI CAL)      2 CREDITS**

1. Elementary idea of weight and measure.
2. Preparation of cereals, pulses, vegetable, egg, milk, fish, nuts.

3. Demonstration of jam, jelly, squash, pickles.
4. Planning and preparation of diet often adult male/female Modification of diet during pregnancy and lactation.

### **DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES**

#### **FNT-G-DSE-A-5-1-Th: COMMUNITY NUTRITION**

**4 CREDITS**

1. Concept and types of Community. Concept of community nutrition.
2. Nutritional Assessment: Meaning, need, objectives and importance. A brief idea on methods of nutritional assessment.
3. Elementary idea of health agencies - FAO, WHO, ICMR, ICDS, ICAR, CSIR, ANP, VHAI, NIN and CFTRI. Role of voluntary health organisation in the improvement of Community health.
4. Nutritional Intervention programmes to combat malnutrition. Concept of food fortification and food enrichment.
5. Nutrition Education: Definition, objectives of nutrition education. Methods of imparting nutrition education.

#### **FNT-G-DSE-A-5-1-P: COMMUNITY NUTRITION (PRACTICAL)**

**2CREDITS**

1. Preparation of homemade ORS.
2. Preparation of weaning foods for infants.
3. Preparation of low cost and medium cost school tiffin.
4. Diet survey by 24 hours recall method.

#### **FNT-G-DSE-A-5-2-Th: PUBLIC HEALTH**

**4 CREDITS**

1. Concept of health and community health. Factors affecting Community health.
2. Maternal and Child mortality: Definitions and causes, Role of health workers in the improvement of maternal and child health.
3. Immunization: Importance and Immunization schedule for children and adults.

4. General idea about the contamination of food (Chemical and microbial)-Sources and transmission, Elementary ideas about food toxins, aflatoxin& food toxicology with reference to Lead, Cadmium & Zinc.
5. Contamination of water and prevention of contamination, different methods of water purification, water –borne diseases, elementary idea of microbiology of water-borne pathogens, diarrhoea, dysentery, typhoid, hepatitis, preventive measures and dietary management of such diseases.

**FNT-G-DSE-A-5-2-P: PUBLIC HEALTH (PRACTICAL)**

**2 CREDITS**

1. Calculation of BMI of an individual and interpretation of result.
2. Growth charts - plotting of growth charts for growth monitoring.
3. Formulation and demonstration of nutrition education tools such as charts, posters, models related to health and nutrition education.

**FNT-G-DSE-B-6-1-Th: CLINICAL NUTRITION**

**4 CREDITS**

1. Definition of Dietetics, dietitian, Goals of Diet Therapy.
2. Basic concepts of Diet Therapy: Therapeutic adaptations of the normal diet. Routine hospital diets –Regular, soft, full fluid, clear fluid diet. Specially modified therapeutic diets.
3. Obesity and underweight: Causes, risk factors, dietary and general management of overweight and underweight.
4. Diarrhoea, Constipation and Jaundice: Causes, symptoms and dietary management.
5. Anaemia: Definition, causes, classification, and dietary management of Nutritional anaemia.
6. Hypertension, Atherosclerosis and Diabetes mellitus: Definition, Causes, Types, risk factors, Signs, Symptoms and dietary Management.
7. Fever: Definition, causes, types, symptoms and dietary management.

**FNT-G-DSE-B-6-1-P: CLINICAL NUTRITION (PRACTICAL)**

**2 CREDITS**

1. Planning and preparation of Therapeutic Diets for the following diseases:
  - i) Diabetes mellitus
  - ii) Hepatitis
  - iii) Hypertensi
  - iv)Obesity

**FNT-G-DSE-B-6-2-Th: FOOD SAFETY AND QUALITY CONTROL      4 CREDITS**

1. The relationship of microorganisms to sanitation, Effects of microorganisms on food degradation and food-borne illnesses.
2. Importance of personal hygiene of food handlers: Habits, clothes, illness, education of food handler in handling and serving food. Concept of food contamination.
3. Food Safety: Definition and factors affecting food safety, safety of left over foods. Control of Food spoilage.
4. Food Adulteration: Definition, reasons and types. Adulterants in common food items.
5. Food Laws and Standards:
  - i) Codex Alimentations
  - ii) Prevention of Food Adulteration (PFA) Act
  - iii) Agmark
  - iv) Fruit Products Order (FPO)
  - v) Meat Products Order (MPO)
  - vi) Bureau of Indian Standards (BIS)
  - vii) Food Standards and Safety Authority of India( FSSAI)

**FNT-G- DSE-B-6-2-P: FOOD SAFETY AND QUALITY CONTROL (PRACTICAL)2 CREDITS**

1. Detection of common adulterant in food:
  - i) Khesari flour in besan
  - ii) Vanaspati in Ghee/Butter.
  - iii) Dried papaya seeds in black pepper
  - iv) Metanil yellow in turmeric or coloured sweet products.
  - v) Artificially foreign matter in tea (dust/leaves).

**FNT-G-SEC- A-3-1-Th: FOOD PRESERVATION****2 CREDITS**

1. Elementary idea on food preservation: principles and different methods – drying, freezing, frying, canning etc.
2. Methods of preparation and packaging of jam, jelly, chilli sauce, tomato ketchup, squash, pickles etc.

**FNT-G-SEC-A-3-2-Th: NUTRITION AND FITNESS****2 CREDITS**

1. Understanding Fitness: Definition of fitness, health and related terms. Assessment of fitness, Approaches for keeping fit.
2. Importance and benefits of physical activity: Physical Activity – frequency, intensity, time and type with examples Physical Activity, physical activity guidelines and physical activity pyramid.
3. Importance of nutrition Role of nutrition in fitness, Nutritional guidelines for health and fitness, Nutritional supplements.
4. Importance of diet and exercise for weight management.

**FNT-G-SEC-B-4-1-Th: GERIATRIC NUTRITION****2 CREDITS**

1. Definition of ageing, senescence, old age or aged people, gerontology, geriatrics, and Geriatric nutrition.
- 2 .Physiological changes during old age.
4. Nutritional requirements and general dietary guidelines for elderly .
5. Major nutritional and health problems during old age.

**FNT-G-SEC-B-4-2-Th: BAKERY SCIENCE****2 CREDITS**

1. Introduction and scope of bakery science.
2. Common bakery terms
3. Flours: Constituents of flour, water absorption power, gluten, grades of flour.
4. Raw materials required for bread and cake making.
5. Role of flour, water , yeast, salt, sugar, milk and fats in bakery.
6. Bread and cake making process.
7. Bread improver.
8. Knowledge of oven and baking temperatures.
9. Preparation of basic cookies, biscuits and pastries

**REFERENCE BOOKS FOR FOOD AND NUTRITION GENERAL COURSE**

## **CHEMISTRY AND PHYSICS**

1. Maity S and Ganguly M (2010): Elements of chemistry (part- I & part-II) for H. S. Publishing Syndicate.
2. PalitSR(1975): Elementary Physical Chemistry, New Delhi: Book Syndicate Private Limited.
3. Rakshit PC (2004): Physical Chemistry. 7<sup>th</sup> ed. Sarat Book Distributers.
4. Mondal AK (2001). Degree Bhouto O SadharanRasayan. Sarat Book Distributers
5. Bahl BS and Bahl A (2012): Advanced Organic Chemistry.21<sup>st</sup> ed. New Delhi: S. Chand Publishing.
6. Avery M. (1955).Household Physics: A Textbook for College Students in Home Economics. 3<sup>rd</sup> ed. Macmillan, Indiana University.
7. Guha S and Dutta S, AdhunikBabhaharykRasayan, Book Sindicate Pvt. Ltd.

## **PHYSIOLOGY:**

1. Pearce Evelyn (2010): Anatomy and Physiology for Nurse, London: Faber & Faber Ltd.
2. Wilson (1989): Anatomy and Physiology in Health and Illness, Edinburgh, Churchill Livingstone.
3. Hoar WS (1984): General and comparative Physiology. 3<sup>rd</sup> ed. Prentice-Hall of India.
4. WinWord (1988): Sear's Anatomy and Physiology for Nurses. London, Edward Arno ll.

## **BASIC NUTRITION AND FOOD SCIENCE**

1. Chattopadhyay Ghosh S and Base N. (2015). UcchaMadhaymikKhadda O Pusti, Calcutta Book House.
2. Raut SK, Mitra K and Chowdhury P. AdhunikPustibigyan, Book India Academic Publishers.
3. Arora K (2008). Theory Of Cookery, Frank Brothers.
4. Srilakshmi B.( 2018).Nutrition Science. New Delhi: New Age International.

5. Sahoo S and Sahoo SK. (2016). Pustibigyan, Kolkata: Chaya Prakashani.
6. Sohi D. A Comprehensive Textbook of Nutrition & Therapeutic Diets, New Delhi: Jaypee Brothers Medical Publishers.
7. Mudambi SR and Rajagopal MV.(2012). Fundamentals of Foods, Nutrition and Diet Therapy. 6<sup>th</sup>ed. New Delhi: New Age International.
8. Mudambi SR, Rao SM and Rajagopal MV.(2006). Food Science, 2<sup>nd</sup>ed. New Delhi. New Age International.
9. Roday S. Food Science & Nutrition, Oxford University Press.
10. Mann and Truswell: Essentials of Human Nutrition, Oxford University Press.

## **COMMUNITY NUTRITION AND PUBLIC HEALTH**

1. Chattopadhyay Ghosh S and Basu N.( 2015). UchhaMadhaymikKhadda O Pusti, Calcutta Book House.
2. SrilakshmiB. (2018). Nutrition Science, 6<sup>th</sup>ed. New Delhi: New Age International Publishers
3. Park K (2017).Textbook of Preventive and Social Medicine, 24<sup>th</sup> Ed. Jabalpur: Bhanot Pub.
4. VVR Seshubabu (2006).Review in Community Medicine, 2nd ed. Hyderabad: Paras Medical Books Publishing Ltd.

## **CLINICAL NUTRITION**

1. Joshi SA. (2010). Nutrition and Dietetics. 3<sup>rd</sup> Ed. New Delhi: McGraw Hill Education (India) Put Ltd.
2. Raut SK., Mitra K and Chowdhury P., AdhunikPustibigyan, Academic Publishers.



3. Srilakshmi B.( 2018). Dietetics,. New Delhi: New Age International.
4. Sahoo S and Sahoo SK. (2016). Pustibigyan, Kolkata: Chaya Prakashani.
5. Sohi D. A Comprehensive Textbook of Nutrition & Therapeutic Diets, New Delhi: Jaypee Brothers Medical Publishers.
6. Mudambi SR and Rajagopal MV.(2012). Fundamentals of Foods, Nutrition and Diet Therapy. 6<sup>th</sup>ed. New Delhi: New Age International.
7. Begum MR, A Textbook Of Foods- Nutrition And Dietetics. Sterling Publishers Pvt. Ltd.

### **FOOD SAFETY AND QUALITY CONTROL**

1. Srilakshmi B.( 2018). Food Science. New Delhi: New Age International.
2. Roday S.(1998). Food Hygiene and Sanitation 10<sup>th</sup> Reprint. New Delhi: Tata McGraw-Hill Education.
3. Chattopaday Ghosh S and Basu N.( 2015). UcchaMadhaymikKhadda O Pusti, Calcutta Book House

### **FOOD PRESERVATION**

1. Srilakshmi B.( 2018). Food Science. New Delhi: New Age International.
2. Manay SN and Shadaksharaswamy M. Foods: facts and principles New Age International.
3. Potter NN. (2007). Food science . 5<sup>th</sup> ed. New Delhi :CBS.

### **NUTRITION AND FITNESS**

1. Campbell BI. (2014). Sports Nutrition: Enhancing Athletic Performance, CRC Press, Taylor& Francis,
2. Haff GG. (2008). Essentials of Sports Nutrition Study Guide, Humana Press.
3. Dunford M and Doyle JA. (2008). Nutrition for Sport and Exercise, Thomson Wadsworth.
4. Srilakshmi B. (2018). Dietetics, New Delhi: New Age International.

## BAKERY SCIENCE

1. Edwards WP(2006): The Science of Bakery Products, 1st Ed. Royal Society of Chemistry.
2. Khetarpaul N, Grewal Rajbala and Jood S(2005): Bakery Science and Cereal Technology, Daya Publishing House.
3. Hui YH(2005): Bakery Products: Science and Technology, 1st Ed. Wiley

## India. MUSHROOM CULTURE

1. Staff E(2007): Hand Book of Mushroom Cultivation, Processing and Packaging Import, Educa Books.
2. Pandey RK and Ghosh SK(1999): A Handbook Of Mushroom Cultivation, Emkay Publications.
3. Patil NN(2010): Mushroom : Cultivation, Processing and Uses, 1st Ed. Universal Prakashan.



# **UNIVERSITY OF CALCUTTA**

## **SYLLABI**

**F  
O  
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**THREE-YEAR HONOURS AND GENERAL  
DEGREE COURSES OF STUDIES**



**PHYSIOLOGY**

**2010**

**HONOURS****PART –I  
Theoretical****Paper – I (F.M. 100)****Unit -01 : 50 Marks****Lectures required**  
(Each period of 45 minutes duration)

1.	Cell Biology I	08
2.	Cell Biology II	12
3.	Biophysics	16
4.	Enzyme	10
5.	Digestive System	14

**Unit- 02 : 50 Marks**

1.	Biochemistry-I	10
2.	Biochemistry-II	12
3.	Vitamins and Minerals	14
4.	Muscle Physiology	12
5.	Nerve Physiology	12

**Paper – II A: (F.M. 50)****Unit – 03 : 50 Marks****Lectures required**  
(Each period of 45 minutes duration)

1.	Blood	14
2.	Cardiovascular System I	14
3.	Cardiovascular System II	10
4.	Body Fluids and Regional Circulation	08
5.	Respiratory System	14

**Paper – II B Practical (F.M. 50)****(One practical class is of 3 periods)**

(Each period of 45 minutes duration)

**Classes required 50****Unit – 04 : 50 Marks**

1.	Histology	
	Haematological Experiments	15 marks
	Permanent slide identification	15 marks
2.	Biochemistry	
	Qualitative Experiments	10 marks
3.	<i>Viva – Voce</i>	5 marks
4.	Laboratory Note Books	5 marks

## PART – II

### Theoretical

#### Paper – III (F.M. 100)

##### Unit -05 : 50 Marks

##### Lectures required

(Each period of 45 minutes duration)

- |    |                        |    |
|----|------------------------|----|
| 1. | Nervous System I       | 10 |
| 2. | Nervous System II      | 14 |
| 3. | Nervous System III     | 14 |
| 4. | Nervous System IV      | 14 |
| 5. | Molecular neurobiology | 08 |

##### Unit – 06 : 50 Marks

- |    |  |    |
|----|--|----|
| 1. | Instrumentation                          | 12 |
| 2. | Renal Physiology                         | 14 |
| 3. | Sensory Receptors, Olfaction & Gustation | 10 |
| 4. | Audition                                 | 10 |
| 5. | Vision                                   | 14 |

#### Paper – IV A (F.M. 50)

##### Unit – 07 50 Marks

##### Lectures required

(Each period of 45 minutes duration)

- |    |  |    |
|----|--|----|
| 1. | Biological Oxidation and Carbohydrate Metabolism | 12 |
| 2. | Amino acids and Purine & Pyrimidine Metabolism   | 10 |
| 3. | Lipid Metabolism and Reactive Oxygen Species     | 12 |
| 4. | Methodologies                                    | 10 |
| 5. | Molecular Biology                                | 16 |

### Practical

#### Paper – IVB (F.M. 50)

(One Practical class is of 3 periods)

(Each period of 45 minutes duration)

Classes required 50

##### Unit – 08 : 50 Marks

- |    |  |          |
|----|--|----------|
| 1. | Histology                              |          |
|    | Fresh Tissue Experiments               | 10 marks |
| 2. | Biochemistry                           |          |
|    | Quantitative Estimations               | 15 marks |
| 3. | Experimental Physiology                | 15 marks |
|    | Amphibian skeletal muscle experiments  |          |
|    | Amphibian unperfused heart experiments |          |
| 4. | Viva – Voce                            | 5 marks  |
| 5. | Laboratory Note Books                  | 5 marks  |

## **PART –III**

### **Theoretical**

#### **Paper –V (F.M. 100)**

##### **Unit – 09 : 50 Marks**

**Lectures required**  
(Each period of 45 minutes duration)

1. General Endocrinolgy I	14
2. General Endocrinolgy II	12
3. General Endocrinolgy III	12
4. General Endocrinolgy IV	14
5. Chronobiology	08

##### **Unit – 10 : 50 Marks**

**Lectures required**  
(Each period of 45 minutes duration)

1. Reproductive Physiology I	14
2. Reproductive Physiology II	14
3. Developmental Biology	12
4. Nutrition and Dietetics	12
5. Social Physiology	08

#### **Paper VI (F.M. 100)**

##### **Unit- 11 : 50 Marks**

**Lectures required**  
(Each period of 45 minutes duration)

1. Work Physiology and Ergonomics	15
2. Sports Physiology	15
3. Skin and Body Temperature Regulation	10
4. Human and Environment I	10
5. Human and Environment II	10

##### **Unit - 12 : 50 Marks**

1. Microbiology I	12
2. Microbiology II	10
3. Immunology	14
4. Pharmacology	12
5. Biostatistics	12

## Practical

### Paper – VII (F.M.100)

(One Practical class is of 3 periods)

(Each period of 45 minutes duration)

**Classes Required 70**

#### Unit - 13

1.	Biochemistry	40 Marks
2.	Experimental Physiology	25 Marks
3.	Microbiology & Biochemical Technique	10 Marks
4.	<i>Viva – Voce</i>	15 Marks
5.	Laboratory Note Books	10 marks

### Paper VIII (F.M. 100)

(One Practical class is of 3 periods)

(Each period of 45 minutes duration)

**Classes Required 70**

#### Unit - 14

1.	Histology	15 Marks
2.	Experimental Physiology	20 Marks
3.	Experiments on Work Physiology and Ergonomics using human subjects	15 Marks
4.	Biostatistics	10 Marks
5.	Social Physiology	
	Diet Survey	08 Marks
	Field Study Record	07 Marks
6.	<i>Viva – Voce</i>	15 Marks
7.	Laboratory Note Books	10 Marks



## **PART-I**

### **Theoretical**

#### **PAPER – I (F.M. 100)**

##### **UNIT : 01 (50 Marks)**

###### **1. Cell Biology I :**

Electron microscopic structure and functions of eukaryotic endoplasmic reticuli, ribosome, golgi bodies, mitochondria, lysosomes, peroxisomes cytoskeletal elements, centrosomes and plasma membrane and subcellular membrane. Ion pores, ion pumps, ion channels, ionophores, passive transport – facilitated diffusion, uniport, symport, antiport. Active transport. Artificial membrane – liposome and erythrocyte ghost. Basic idea of tight junctions, gap junctions and cell adhesion molecules.

**(08 lectures)**

###### **2. Cell Biology II :**

###### **(a) Genetics :**

Chromosome structure – morphology. Chromosomal DNA packaging – nucleosomes and higher levels of organization of chromatin. Euchromatin and heterochromatin. Human genome and its characteristics. Nuclear and mitochondrial DNA. Cell cycle – events and regulatory role of cyclin. Elementary idea of apoptosis.

###### **(b) Cell Signalling :**

Cell surface receptor proteins – ion channel coupled, G-protein coupled and enzyme-coupled. Intracellular messengers – cAMP, cGMP, IP<sub>3</sub>, DAG, Protein kinases, Ca<sup>2+</sup>, CO, NO. Signal transduction pathways – Phosphatidylinositides, MAP kinase, JAK-STAT, SMAD.

**(12 lectures)**

###### **3. Biophysics :**

Diffusion, surface tension and viscosity – their characteristics, factors influencing and biological applications. Osmosis: osmotic pressure – laws, determination – freezing point depression method and biological applications. Protolysis of water, pH, acid-base neutralization curves, Buffer action: Henderson-Hasselbalch equation. Regulation of pH by blood buffers. Determination of pH – Basic concept of indicators, principle of pH meter- hydrogen electrode and glass electrode. Colloids : Classification, properties – optical, electrical, electrokinetic. Biological importance of colloids. Dialysis and ultrafiltration. Gibbs-Donnan membrane equilibrium. Thermodynamics : Type of surroundings and systems. First Law– Internal energy, enthalpy. Second Law – Entropy, Free energy change, Endergonic and Exergonic reactions, Reversible and Irreversible processes, Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system.

**(16 lectures)**

###### **4. Enzymes :**

Classification- EC nomenclature, Concept of apoenzyme, holoenzyme, coenzyme, cofactors and prosthetic group. Mechanism of enzyme action : Activation energy, Enzyme-substrate complex, Transition state and Products. Models of enzyme-substrate interactions. Specificity of enzymes. Concept of initial rate, maximum velocity and steady-state kinetics. Michaelis constant, Michaelis-Menten equation, Graphical representation of hyperbolic kinetics– Lineweaver-Burk plot. Significance of K<sub>m</sub> and V<sub>max</sub>. Factors influencing enzyme-catalyzed reactions : substrate concentration, enzyme concentration, pH, temperature. Competitive, non-competitive and uncompetitive inhibitions. Regulation of enzyme activities – covalent modifications, allosteric modifications – Sigmoid kinetics and Hill equation : K- and M- series, Feed-back inhibition. Rate-limiting enzymes. Isozymes, Ribozymes and Abzymes.

**(10 Lectures)**

## 5. Digestive System :

Anatomy and histology of alimentary canal. Digestive glands – histological structures of salivary glands, pancreas, liver. Deglutition. Movements of alimentary canal and their regulations. Composition, functions and regulation of the secretion of salivary, gastric, pancreatic and intestinal juices and bile. Synthesis of Bile acids. Enterohepatic circulation. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Defecation. Feces. GALT. Basic concepts of Peptic Ulcer, Jaundice and Gall-stones. **(14 Lectures)**

## UNIT :02 (50 MARKS)

### 1. Biochemistry I :

**Carbohydrates :** Definition and classification.

*Monosaccharides* – Classification, structure, stereoisomerism, optical isomerism, optical activity, epimerism. Cyclic structures- Pyranose and furanose forms, anomerism, mutarotation and its mechanism. Chemical reactions of monosaccharides (Glucose & Fructose) — Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance. Derivatives of monosaccharides —Amino sugars, deoxy sugars, sugar alcohols, sugar acids, sugar esters, their biochemical and physiological importance.

*Disaccharides* – Maltose, Lactose and Sucrose : Structure, Occurrence and Physiological importance.

*Polysaccharides* – Starch, Glycogen, Dextrin, Cellulose, Glycosaminoglycans, Glycoproteins, Sialic acids, Lectins, Blood group polysaccharides.

**Lipids :** Definition and classification. Fatty acids — Classification, systemic nomenclature and structure. Mono-, Di- and Triglycerides. Properties of Fat and Fatty acids —Hydrolysis, Saponification, Saponification number, Iodine number, Acetylation - Acetyl number. Hydrogenation, Rancidity-Acid number, Reichert-Meissl number. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Cholesterol & its ester — their structure and physiological importance. Lipoproteins —Structure and classification. **(10 Lectures)**

### 2. Biochemistry II :

**Amino acids :** Classification, Structure, Nomenclature and Optical properties. Protonic equilibria of amino acids – Zwitterions, Isoelectric point, titration curve of amino acids. Reactions with ninhydrin and formaldehyde.

**Peptides and Proteins :** Structure and properties of peptide bonds — Phi and Psi angles. Reactions with Sanger's and Edman's reagent. Biuret reaction. Different levels of protein structure — Primary, Secondary ( $\alpha$ -helix and  $\beta$ -pleated sheet), Tertiary and Quaternary. Forces stabilizing the structures. Denaturation and Renaturation.

**Purine and Pyrimidine :** Structure, nomenclature and tautomerism.

**Nucleic acids :** Nucleosides and Nucleotides — structure. Polynucleotides. DNA double helix — Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. RNA — Structure and types. Denaturation and annealing of DNA. Hyperchromicity, melting temperature and half  $C_{0t}$  value. **(12 Lectures)**

### 3. Vitamins and Minerals :

Vitamins: Thiamin, Riboflavin, Niacin, Pyridoxine, Pantothenic Acid, Biotin, Cyanocobalamin, Folic Acid, Ascorbic Acid, Inositol. Vitamins A, D, E and K. Chemistry, dietary sources, daily requirements, biochemical roles and functions, deficiency symptoms, hypervitaminosis, antivitaminosis. Minerals: Sources, biological functions, metabolism and regulation of sodium, potassium, calcium, phosphorus, iron, zinc, iodine and fluoride. **(14 Lectures)**

#### 4. Muscle Physiology :

Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles.

The sarcotubular system. Red and white striated muscle fibers. Single-unit and multi-unit smooth muscle.

Muscle groups : antagonists and agonists. Properties of skeletal muscle: excitability, contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility and elasticity. Optimal load, optimal length of fibers. Muscle proteins. Mechanism of skeletal and smooth muscle contraction and relaxation : Excitation-contraction coupling. Dihydropyridine receptors & Ryanodine receptors. Mechanical components of muscle. Isometric and isotonic contractions – muscle length, tension and velocity relationships. Chemical, thermal and electrical changes in skeletal muscle during contraction and relaxation. Electromyography. **(12 Lectures)**

#### 5. Nerve Physiology:

Structure, classification and functions of neurons and neuroglia. Cytoskeletal elements and axoplasmic flow. Myelinogenesis. The resting membrane potential. The action potential. Electrotonic potentials. Current of injury. Propagation of nerve impulse in different types of nerve fibers. Compound action potentials. Properties of nerve fibers : excitability, conductivity, all or none law, accommodation, adaptation, summation, refractory period, indefatigability. Chronaxie, rheobase and utilization time. Synapses : types, structure, synaptic transmission of the impulse, synaptic potentials, neurotransmitters, cotransmitters, neuromodulators. The neuromuscular junction : structure, transmission, end-plate potential, MEPP, post-tetanic potentiation. Motor unit. Motor point. Injury to peripheral nerves – degeneration and regeneration in nerve fiber, changes in the nerve cell body, transneuronal degeneration, changes in receptors and motor end-plates, denervation hypersensitivity. Thermal changes of nerve during activity. Nerve growth factors. **(12 Lectures)**

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2. Candidates have to **attempt all five** questions from each unit amongst the alternatives.

## **PAPER – II A (F.M. 50)**

**UNIT : 03 (50 MARKS)**

### **1. Blood :**

Bone marrow. Formed elements of blood—origin, formation, functions and fate Plasma proteins—normal values, origin and functions. Haemoglobin – Structure, reactions, biosynthesis and catabolism. Foetal haemoglobin. Abnormal haemoglobins- Sickle-cell anemia and Thalassemia. Different types of anaemia and their causes. Blood volume – normal values, regulation and determination by dye and radioisotope methods. Hemostasis – factors, mechanism, anticoagulants, procoagulants. Disorders of hemostasis-Hemophilia, Thrombosis and Embolism. Blood group – ABO and Rh. Erythroblastosis foetalis. Blood transfusion and its hazards. **(14 Lectures)**

### **2. Cardiovascular System – I :**

Anatomy of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Stannius ligature. The cardiac cycle- pressure and volume changes. Heart sounds. Murmurs. Cardiac output – measurement by application of Fick's principle and dye dilution method, factors affecting. Starling's law of heart. Electrocardiography – the normal electrocardiogram, electrocardiographic leads, vectorial analysis, the vectorcardiogram, the mean electrical axis of heart. The His bundle electrogram. Principles of Echocardiography. Cardiac Arrhythmias – Normal cardiac rate. Myocardial Infarctions. **(14 Lectures)**

### **3. Cardiovascular System – II :**

Functional morphology of arteries, arterioles, capillaries, venules and veins, sinusoids. General pattern of circulation and significance of branching of blood vessels. The pulse – arterial and venous. Hemodynamics of blood flow. Blood pressure – its measurement and factors affecting. Cardiovascular homeostasis – neural and chemical control of cardiac functions and blood vessels. Cardiac and vasomotor centers, baroreceptors and chemoreceptors, innervation of the heart and blood vessels, cardiac and vasomotor reflexes. Cardiovascular adjustment after haemorrhage. **(10 Lectures)**

### **4. Body Fluids and Regional Circulation :**

Lymph and tissue fluids – formation, circulation, functions and fate. Lymphatic organs- Histological structures and functions of lymph gland and spleen. Regional circulations – cerebral, coronary, pulmonary and hepatic, skeletal muscle. **(08 Lectures)**

### **5. Respiratory System :**

Anatomy and histology of the lung and airways. Mechanics of breathing – role of respiratory muscles, glottis. Lung volumes and capacity. Compliance of lungs and chest wall, pressure-volume relationships, alveolar surface tension and surfactant, work of breathing. Ventilation- perfusion ratio. Dead space and uneven ventilation. Spirometry. Transport of gases in body - Partial pressure and composition of normal atmospheric gases in inspired, expired, alveolar airs and blood. Oxygen dissociation curve of hemoglobin and myoglobin – factors affecting. Carbon dioxide dissociation curve. Regulation of respiration – neural and chemical, respiratory centers, chemoreceptors, baroreceptors, pulmonary receptors. Hypoxia – types, effects. Asphyxia, Voluntary hyperpnoea, Apnoea, Cyanosis, Periodic breathing, Asthma, Emphysema. Lung function tests. Artificial respiration. Concept of non-respiratory functions of lung. **(14 Lectures)**

### **DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPER**

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## Practical

### PAPER – IIB (F.M. 50)

#### Unit – 04 : 50 Marks

##### 1. Histology :

30 Marks

- (a) Haematological experiments : Preparation and staining of blood film with Leishman's stain. Identification of blood corpuscles. Differential count of WBC. Total count of RBC and WBC. Haemoglobin estimation. Preparation of haemin crystals. Preparation and staining of bone marrow smear. Measurement of diameter of megakaryocyte. Reticulocyte staining. Blood group determination.

Demonstration: Haematocrit, MCV, MCH and MCHC. Bleeding time, Clotting time, ESR.

15 Marks

- (b) Study and identification of stained section of different mammalian tissues and organs : Bone, Hyaline cartilage, Trachea, Lung, Spleen, Lymph gland, Parotid gland, Submaxillary gland, Sublingual gland, Tongue, Oesophagus, Stomach, Duodenum, Jejunum, Ileum, Large intestine, Liver, Kidney, Ureter, Pancreas, Adrenal gland, Thyroid gland, Testis, Ovary, Spinal cord, Cerebral cortex, Cerebellum, Skin, Cardiac muscle, Skeletal muscle, Smooth muscle, Artery, Vein, Uterus.

10 Slides-15 Marks

##### 2. Biochemistry Qualitative :

10 Marks

Tests for identification of physiologically important substances : hydrochloric acid, lactic acid, uric acid, albumin, gelatin, peptone, starch, dextrin, glucose, fructose, lactose, sucrose, urea, acetone, glycerol, bile salts.

##### 3. Viva – Voce :

5 Marks

##### 4. Laboratory Note -Books :

5 Marks

## **PART – II**

### **Theoretical**

#### **PAPER – III (F.M. 100)**

##### **UNIT : 05 (50 Marks)**

###### **1. Nervous System I :**

A brief outline of organization and basic functions (sensory, motor and association) of the nervous system ( central and peripheral). Structural organization of different parts of brain and spinal cord. Reflex action – definition, reflex arc, classification and properties. Autonomic nervous system : organization, outflow, ganglia, centers and functions. Chemical transmission in autonomic nervous systems. Central control of autonomic nervous system. CSF: formation, circulation and functions. Blood-CSF and Blood-Brain barrier. **(10 Lectures)**

###### **2. Nervous System II :**

Ascending and descending tracts : origin, courses, termination and functions. Lower and upper motor neurones. Functions of the spinal cord with special reference to functional changes following hemisection and complete section of spinal cord – Brown-Sequard syndrome. Spinal animal. Pain production, perception and regulation. Referred pain. **(14 Lectures)**

###### **3. Nervous System III :**

Decerebrate rigidity, decorticate rigidity. Postural reflexes. Muscle spindle and golgi tendon organ: their structure, innervations and functions, regulation of muscle tone. Structure, connections and functions of cerebellum. Structure and functions of vestibular apparatus. Nuclei, connections and functions of thalamus and hypothalamus. Basal nuclei : structure, connections and functions. Cerebral cortex : histological structure, localization of functions. **(14 Lectures)**

###### **4. Nervous System IV :**

Limbic system: structure, connections and functions. Physiology of emotion. Electrophysiology of brain: spontaneous electrical activity of brain, EEG and ECoG, evoked potential, DC potential. Isolated cortex. Higher functions of nervous system: conditioning, learning and short-term and long-term memory. Speech. Aphasia. Asymmetrical organization of certain cognitive functions-split brain. Reticular formation: organization, connection and functions of ascending and descending reticular formation. Physiological basis of sleep and wakefulness. **(14 Lectures)**

###### **5. Molecular neurobiology :**

General concept of ionotropic and metabotropic receptors. Structure, sub-types, and functions of nicotinic and muscarinic acetylcholine receptors, adrenoceptors, glutamate receptors (NMDA and AMPA receptors), GABA, opiate, serotonin, dopamine and histamine receptors. **(08 Lecturers)**

## UNIT : 06 (50 MARKS)

### 1. Instruments :

Principles of construction and uses of compound microscope, phase contrast microscope, fluorescence microscope, polarizing microscope, confocal microscopy, transmission and scanning electron microscope, photoelectric colorimeter. Brief idea of CRO, CT scan, fMRI and PET. (12 Lectures)

### 2. Renal Physiology :

Anatomy of kidney. Histology of nephron. Renal circulation – peculiarities and autoregulation. Formation of urine – glomerular function and tubular functions. Counter-current multiplier and exchanger. Renal regulation of osmolarity and volume of blood fluids. Diabetes insipidus. Formation of hypertonic urine. Renal regulation of acid-base balance, acidification of urine. Renal function tests – creatinine, inulin, urea, and PAH clearance tests. Physiology of urinary bladder and micturition. Composition of urine. Abnormal constituents of urine, their detection and significance. Renal dialysis. Non-excretory functions of kidney. (14 Lectures)

### 3. Sensory Receptors, Olfaction & Gustation :

Classification of general and special senses. Receptors as biological transducers. Muller's law of specific nerve energies. Weber-Fechner law, Steven's power law. Sensory transduction in Pacinian corpuscle. Adaptation of receptors – phasic and tonic adaptations. Olfaction and Gustation : Structure and functions of the receptor organs, nerve pathways, centers. Properties of olfactory and gustatory sensation and their transduction & coding. Electro-olfactogram. Abnormalities of olfactory and taste sensation. (10 Lectures)

### 4. Audition :

Audition : Sound waves, decibel. Structure and functional significance of auditory apparatus – external, middle and internal ears. Organ of Corti. Auditory transduction. Auditory pathways and centers. Mechanism of hearing and its modern theories. Different electrical potentials of internal ear. Discrimination of sound frequency and loudness. Localization of sound source. Audiometry. Deafness. (10 Lectures)

### 5. Vision :

Structure of the eyeball. Structure of lens. Cataract. Formation, circulation and functions of aqueous humour, glaucoma. Mechanism of accommodation. Pupillary reflexes light reflex, near response. Argyll-Robertson pupil. Errors of refraction and their corrections. Histological details of retina, peripheral retina, fovea and blind spot. Retinal detachment. Visual pathway and centers. Effects of lesion in visual pathway. Photopic and scotopic vision. Chemical and electrical changes in retina on exposure to light. Visual processing in the retina. Electroretinogram. Positive and negative after-images. Contrast phenomenon. Light and dark adaptation. Colour vision and its modern concept. Colour blindness. Visual field— perimetry. Visual acuity – measurement, mechanism and factors affecting. Critical fusion frequency. (14 Lectures)

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## PAPER – IV A (F.M. 50)

### UNIT : 07 (50 MARKS)

#### 1. Biological Oxidation and Carbohydrate Metabolism :

Biological oxidation – Redox Potential, Mitochondrial Electron Transport Chain,

Oxidative Phosphorylation – Inhibitors and uncouplers.

Carbohydrate - Glycolysis, R-L cycle, TCA cycle, Gluconeogenesis - Cori cycle, Glucose-Alanine cycle. Anaplerotic reactions and Amphibolic nature of TCA cycle. Pentose Phosphate Pathway.

Glycogenesis and Glycogenolysis.

*Hormonal regulation of the above mentioned biochemical pathways/cycle not required. (12 Lectures)*

#### 2. Amino acids and Purine & Pyrimidine Metabolism :

Amino acids - Amino acid pool. Deamination, transamination, amination and decarboxylation.

Synthesis of Urea and Nitric oxide. Basic idea of glucogenic and ketogenic amino acids. Metabolism of glycine, sulfur-containing amino acids, tryptophan and phenylalanine.

Purines and Pyrimidines – Biosynthesis : *de novo* and salvage pathways. Catabolism.

*Regulation of the above mentioned biochemical pathways/cycle not required. (10 Lectures)*

#### 3. Lipid Metabolism and Reactive Oxygen Species :

Lipid –  $\beta$ -oxidation and biosynthesis of saturated and monounsaturated fatty acids. Metabolism of Triglycerides. Biosynthesis of Lecithin, Cephalin and Cholesterol. Metabolism of Adipose Tissue. Role of lipoproteins in transport and storage of lipids.

Formation of Reactive Oxygen Species and the role of Catalase, Superoxide Dismutase, Glutathione Peroxidase and Glutathione Reductase in combating oxidative stress – role of vitamins.

*Hormonal regulation of the above mentioned biochemical pathways/cycle not required.*

**(12 Lectures)**

#### 4. Methodologies :

Chromatography: Principles and uses of : TLC, Gel filtration, Affinity chromatography ion-exchange chromatography. Electrophoresis: Principles and method, uses of Agarose gel electrophoresis, SDS – PAGE. Ultracentrifugation: moving boundary and density gradient ultracentrifugation. Radioactivity – Classification and properties. Their use – radiolabelling of biomolecules and its detection by autoradiography. Principles of radioimmunoassay (RIA), ELISA. Immunoblotting.

**(10 Lectures)**

#### 5. Molecular Biology :

DNA replication—Meselson and Stahl Experiment, DNA Polymerases, Ligases and other regulatory proteins. Transcription – RNA Polymerase and other regulatory mechanism in prokaryotes.

Genetic code – properties and wobble hypothesis. Translation – codon-anticodon interaction and

mechanism in prokaryotes. Regulation of gene expression : operon concept – the lac operon. Gene

mutation – agents and types. DNA repairing processes. Concept of oncogenes and properties of cancer

cells. Elementary idea of recombinant DNA technology and its applications – gene therapy,

transgenic animal. Northern and Southern blotting.

**(16 Lectures)**

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2. Candidates have to **attempt all five** questions from each unit amongst the alternatives.



**Practical**  
**PAPER – IV B (F.M. 50)**

**UNIT : 08**

**1. Histology :**

**10 Marks**

Fresh tissue experiments : Suitable staining and examination of fresh tissues – epithelial, areolar, adipose (Sudan III or IV) and muscle tissues. Silver nitrate preparation of cornea and urinary bladder for cell spaces and sciatic nerve for nodes of Ranvier.

**2. Biochemistry Quantitative :**

**15 Marks**

Quantitative estimation of glucose and sucrose by Benedict's method. Quantitative estimation of amino nitrogen (Sorensen's formol titration method). *Percentage and total quantity to be done.* Estimation of percentage quantity of lactose in milk by Benedict's method.

**3. Experimental Physiology:**

**15 Marks**

- a) Study and use of kymograph, induction coil, key and tuning fork.
- b) Gastrocnemius-sciatic preparation and kymographic recording of isotonic muscle twitch.
- c) Effect of temperature on muscle twitch.
- d) Effect of two successive stimuli on muscle twitch.
- e) Effect of load (after-load) on muscle twitch. Calculation of work done by the muscle.
- f) Normal tracing of unperfused heart beat of toad.
- g) Effects of temperature on unperfused heart beat toad.

Demonstration : 1. Gastrocnemius-sciatic preparation and its use in recording effects of make and break shocks of progressively rising intensity.  
2. Effect of load (free-load) on muscle twitch.  
3. Determination of nerve conduction velocity by kymographic recording of simple twitches.

**3. Viva-Voce :**

**5 Marks**

**4. Laboratory Note-Books :**

**5 Marks**

## **PART – III**

### **Theoretical**

#### **PAPER – V (F.M. 100)**

#### **UNIT : 09 (50 MARKS)**

##### **1. General Endocrinology I :**

Classification of endocrine glands and hormones. Methods of study of endocrine functions. Hypothalamus as a neuroendocrine organ. Anterior and posterior pituitary – histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of their hormones. Hypo- and hyperactive states of the gland. Pineal gland – histological structure. Chemical nature, biosynthesis, mode of actions, functions and regulation of secretion of melatonin. **(14 Lectures)**

##### **2. General Endocrinology II :**

Thyroid and parathyroid – histological structure of the glands. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hypo- and hyperactive states of the glands. Thymus – histological structure of the gland. Chemical nature, mode of action and functions of thymic hormones. **(12 Lectures)**

##### **3. General Endocrinology III :**

Adrenal cortex and medulla – histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Biosynthesis and catabolism of catecholamines. Hypo- and hyperactive states of the gland. Heart as an endocrine organ. Prostaglandins and Kinins. **(12 Lectures)**

##### **4. General Endocrinology IV :**

Pancreatic islets – histological structure. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hormonal control of blood sugar. Hyperinsulinism and diabetes mellitus. Growth factors – EGF, TGF, PDGF, IGF and FGF. Chemical nature, mode of action, functions. Gastro-intestinal hormones – Chemical nature, mode of action, functions and regulation of secretion of the hormones. **(14 Lectures)**

##### **5. Chronobiology :**

Different types of physiological rhythms – ultradian, circadian, infradian. Different zeitgebers and their relation with circadian clock. Hormonal biorhythms and their significance: adrenocortical, pineal and prolactin. Body temperature rhythm. Neural basis of biological clock and role of suprachiasmatic nuclei. Sleep-wakefulness cycle. Time keeping genes. Jet-lag and shift work. **(08 Lectures)**

## **UNIT : 10 (50 MARKS)**

### **1.Reproductive Physiology I :**

Primary and accessory sex organs and secondary sex characters. Histology of testis. Endocrine functions of testis. Spermatogenesis. Hypothalamic control of testicular functions. Histology of ovary. Ovarian hormones and their functions. Oogenesis and ovulation. Formation and functions of corpus luteum. Hypothalamic control of ovarian functions. Physiology of puberty. **(14 Lectures)**

### **2. Reproductive Physiology II :**

Estrous cycle. Menstrual cycle and its regulation. Abnormalities in menstrual cycle. Onset of menopause and post-menopausal changes. Structure and functions of placenta. Maintenance of pregnancy and the bodily changes during pregnancy. Parturition. Pregnancy tests. Development of mammary glands, lactation and their hormonal control. **(14 Lectures)**

### **3. Developmental Biology :**

Basic concepts of stem cells : Totipotency, Differentiation - Committed stem cell. Fertilization, Blastulation, Implantation, Gastrulation, Placentation. Development of alimentary canal, heart, urinary system and genital system. Foetal circulation. Ossification of bone. **(12 Lectures)**

### **4. Nutrition and Dietetics :**

Constituents of food and their significance. Basal metabolic rate -factors, determination by Benedict-Roth apparatus. Respiratory quotient. Specific dynamic action. Calorific value of foods. Body calorie requirements – adult consumption unit. Dietary requirements of carbohydrate, protein, lipid and other nutrients. Balanced diet and principles of formulation of balanced diets for growing child, adult man and woman, pregnant woman and lactating woman. Nitrogen balance, essential amino acids, biological value of proteins – measurement and factors affecting. Proteins spacers. Supplementary value of protein. Protein efficiency ratio and net protein utilization of dietary proteins. Dietary fibres. Principle of diet survey. Composition and nutritional value of common food stuffs. Physiology of starvation and obesity. **(12 Lectures)**

### **5. Social Physiology :**

Population problem – principles and methods of family planning,. Problem of infertility and Assisted Reproductive Technologies. Malnutrition – PCM, marasmus, kwashiorkor, marasmic kwashiorkor, endemic goiter, nutritional anemias, rickets, osteomalacia, xerophthalmia, beriberi and their social implications. Principles and social importance of immunization against diseases. Epidemiology and prevention of cholera, malaria, hepatitis and AIDS. **(08 Lectures)**

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## **PAPER –VI (F.M. 100)**

### **UNIT :11 (50 MARKS)**

#### **1. Work Physiology and Ergonomics :**

Physical work—its definition and nature—isotonic, isometric and isokinetic, positive and negative work. Concept of physiological work. Power and capacity relation. Work-load – light, moderate(submaximal) and heavy (maximal) depending on intensity and duration of work. Exercise inducing equipment – bicycle ergometer, treadmill and stepping stool. Energetics of work – sources of energy and energy demand for different activities. Assessment of energy cost of various physical work – direct and indirect methods with their limitations. Physiological responses to work – cardiovascular, respiratory, metabolic and muscular – short-term and long-term. Work-rest cycle and importance of rest pause. Ergogenics aids. Basic concept of ergonomics and its application in industry to improve efficiency and industrial safety as well as to restrict occupational health hazards. Anthropometry and its implication in ergonomics in general. **(15 Lectures)**

#### **2. Sports Physiology:**

Concept of endurance, strength and speed in sports activities. Physical training – principles and their impact on performance level in sports with reference to cardiovascular, respiratory and muscular changes. Overtraining and detraining. Warm up and cool down. Brief general idea about nutritional aspects of sports. Aerobic and anaerobic power—concept, factors affecting, methods of measurement and significance of maximal oxygen consumption and excess post exercise oxygen consumption. Lactate threshold, lactate tolerance and their usefulness. Concept of recovery processes and occurrence of fatigue in physical work. Concept of physical fitness and its assessment by Harvard and modified Harvard Step Tests. **(15 Lectures)**

#### **3. Skin and Body Temperature Regulation :**

Structure and functions of skin. Cutaneous circulation. Sweat glands –structure and composition of sweat. Sweat formation, secretion and its regulation. Insensible perspiration. Regulation of body temperature in homeotherms – its physical and physiological processes, roles of neural and hormonal processes. Pyrexia, hyperthermia and hypothermia. **(10 Lectures)**

#### **4. Human and Environment I :**

Environment – Physical and biological aspects. Effects of exposure to hot and cold environment. Acclimatization to hot and cold environment. Heat disorders and its preventive measures. Effects of hypobaric and hyperbaric environment. Caisson disease. Preventive measure for hypobaric and hyperbaric effects. Acclimatization to high altitudes. **(10 Lectures)**

#### **5. Human and Environment II :**

G force, ionizing and non-ionizing radiations - physiological effects and preventive measures. Air, noise and water pollutions – causes, effects, prevention measures and control. Brief idea of the hazards of pesticides, carcinogens, mutagens, neurotoxins and war gases. Impact of green house effects on life. **(10 Lectures)**

## **UNIT : 12 (50 MARKS)**

### **1. Microbiology I:**

Classification of microorganisms. Techniques employed for the identification of microorganisms – microscopic and biochemical methods. Control of microbial growth : Physical and Chemical methods used in sterilization, disinfection and pasteurization. Bacteriology : Bacterial classification based on staining techniques (Gram stain and Acid-fast stain) and morphological aspect. Bacterial structure : cell-wall, LPS layer, pili, flagella, chromosome, plasmid spores and cysts. Culture of bacteria : nutritional requirement – complex and synthetic media, preparation of media ; physical factors required for growth (temperature, pH and gaseous requirement) ; bacterial growth curve : different phases and their significance ; quantitative estimation of bacterial growth ; continuous growth culture and its utility.

Food microbiology : beneficial and harmful microorganisms in food, causative organisms of food-borne infections- mode of transmission and methods of prevention. **(12 Lectures)**

### **2. Microbiology II :**

Bacterial metabolism: fermentation, glyoxalate cycle and Entner-Doudoroff pathway. Bacterial genetics : transformation, conjugation and transduction. Treatment of bacterial infection : chemotherapeutic agents, antibiotics- definition, bactericidal and bacteriostatic and their mechanism of action.

Virology : Viral structure – virion, prion and bacteriophages ; classification of viruses based on nucleic acid composition and host system, replication of bacteriophages – lytic and lysogenic cycles. **(10 Lectures)**

### **3. Immunology :**

Overview of innate and acquired immunity. Elements of acquired immunity : characteristics of immune response, cells and organs involved in immune response. Immunogens and antigens : requirements of immunogenicity, epitopes recognized by B- & T- cells, haptens, adjuvants, cross-reactivity. Antibody structure, classification and functions. Kinetics of antibody responses : primary & secondary. Antigen - antibody interactions - Primary interaction : association constant, affinity & avidity. Secondary interaction : precipitation & agglutination. B-cell receptor. MHC molecules : structure of class I and II molecules, brief idea of peptide binding by MHC molecules, cellular distribution. Antigen processing and presentation. T-cell receptor. T-cell maturation and differentiation - thymic selection in brief. B-cell activation & differentiation : thymus dependent and independent antibodies, T-B co-operation, the carrier effect. Cytokines : produced by  $T_{H1}$  &  $T_{H2}$  cells, regulating specific immune response only. Complement : Activation components – classical, alternative and lectin. Biological consequence of complement activation. Cell-mediated effector responses : CTLs, NK cells, K cells. Immune responses in allergy. Brief idea of autoimmunity and AIDS. Vaccination : Passive and active immunization, types and uses of vaccine. Toxins and toxoids. Hybridoma technology. **(14 Lectures)**

#### 4. Pharmacology :

The importance of pharmacology in the study of physiological processes. Definition of drug, agonist and antagonist. Drug delivery Drug reactivity. Pharmacokinetics : Drug-receptor interaction, Desensitization of receptors, Absorption, Distribution, Permeation, Elimination, Clearance, Half-life. Pharmacodynamics: dose-response curves. Beneficial versus toxic effects of drugs. Drug biotransformation. Bioavailability. Drug accumulation. Drug toxicity – LD50, ED50, therapeutic index.

Anaesthetics : types and mechanism of action of general anaesthetics.

Sedatives - hypnotics: benzodiazepine, zolpidem.

Diuretics - Carbonic anhydrase inhibitor, loop diuretic, potassium sparing and osmotic diuretics.

Neuromuscular blockers : Tubocurarine and succinyl choline.

Organ system effects and mechanism of action of adrenoceptor agonists and antagonists:

*Adrenergic stimulants* : Amphetamine and ephedrine.  $\alpha$ - adrenergic stimulants – Methoxamine and clonidine.  $\beta$ - adrenergic stimulants – Metaproterenol and salbutamol.

*Adrenergic antagonists* : Labetolol.  $\alpha$ - adrenergic blockers – Phenoxybenzamine and phentolamine.  $\beta$ - adrenergic blockers – Propranolol and atenolol.

Antianginal drugs : Nitroglycerine and calcium-channel blocker – Nifedipine and verapamil. **(12 Lectures)**

#### 5. Biostatistics :

Scope of statistics – utility and misuse. Principles of statistical analysis of biological data.

Basic concepts – variable, parameter, statistics. Sampling. Presentation of data-frequency distribution, frequency polygon, histogram, bar diagram and pie diagram. Parameters. Different classes of statistics- mean, median, mode, mean deviation, variance, standard deviation, standard error of the mean. Standard score. Degrees of freedom. Probability. Normal distribution. Student's t-distribution.

Testing of hypothesis - Null hypothesis, errors of inference, levels of significance, t-test and z score for significance of difference. Distribution-free test - Chi-square test. Linear correlation and linear regression.

**(12 Lectures)**

#### DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPERS

1. From each unit, **five** questions of 10 marks each with one alternative are to be set from the same sub-unit. The 10 marks question may be subdivided.

2. Candidates have to **attempt all five** questions from each sub-unit amongst the alternatives

## Practical

### PAPER – VII (F.M. 100)

#### UNIT : 13

##### 1. Biochemical Estimation :

40 Marks

- i) Blood Sugar by Folin-Wu Method ; ii) Serum Protein by Biuret Method ; iii) Serum Albumin using Bromocresyl Green ; iv) Estimation of RNA by orcinol method ; v) Blood Uric Acid by cyanide-free method ; vi) Serum urea by DAM method.

##### 2. Experimental Physiology :

25 Marks

Preparation of amphibian Ringer solution. Kymographic recording of perfused heart beat of toad. Study of the effects of changes in perfusion fluid pressure, excess calcium and potassium ion concentration, acetylcholine, adrenaline.

##### 3. Microbiology & Biochemical Technique :

10 Marks

- (a) Gram staining of bacteria and identification of Gram positive and Gram negative bacteria.  
Demonstration: Spore Staining, Immuno-diffusion.  
(b) Isolation of amino acids from an artificial mixture using paper chromatography.

##### 4. Viva - Voce :

15 Marks

##### 5. Laboratory Note - Books :

10 Marks

### PAPER –VIII (F.M. 100)

#### UNIT : 14

##### 1. Histology :

15 Marks

Staining of sections by haematoxylin-eosin and iron-haematoxylin.

Demonstration : Preparation of permanent slides – fixation, dehydration, paraffin embedding, block preparation, cutting and staining.

##### 2. Experimental Physiology:

20 Marks

Kymographic recording of normal movements of rat's intestine in Dale's apparatus.  
Effects of hypoxia, acetylcholine and adrenaline on normal intestinal movements.

**3. Experiments on Work Physiology and Ergonomics using human subjects : 15 Marks**

- a) Sphygmomanometric measurement of arterial blood pressure at rest and after exercise.
- b) Modified Harvard step test and determination of physical fitness. Recording of recovery heart-rate after standard exercise and graphical plotting.
- c) Pneumographic recording of effects of talking, drinking, laughing, coughing, exercise, hyperventilation and breath - holding.
- d) Spirometric measurement of vital capacity.
- e) Measurement of some common anthropometric parameters- stature, weight, eye height, shoulder height, eye height (sitting), elbow height, sitting height, elbow rest height (sitting), knee height (sitting), shoulder elbow length, arm reach from wall, elbow-to-elbow breadth, knee-to-knee breadth (sitting), shoulder breadth, head length, head breadth, head circumference and neck circumference, mid-arm circumference, waist circumference, hip circumference, chest circumference.
- f) Calculation of Body Surface Area (using nomogram), Body Mass Index and Ponderal Index from anthropometric measurements.

**2. Biostatistics :**

**10 Marks**

Computation of mean, median, mode, standard deviation and standard error of the mean with physiological data like body temperature, pulse rate, respiratory rate, height and weight of human subjects. Graphical representation of data in frequency polygon and histogram. Student's t test for significance of difference between means.

Demonstration: Statistical analysis and graphical representation of biological data with computer application program (Microsoft Excel).

**3. Social Physiology : Diet survey and Field Study record :**

**15 Marks**

- a) Diet survey report (hand-written) of a family (as per ICMR specification) : Each student has to submit a report on his/her own family. 8 Marks
- b) A report (hand-written) on the basis of field survey from ONE of the followings: 7 Marks
  1. Physiological parameters of human (at least three parameters).
  2. Anthropometric measurements on human (at least three parameters).
  3. Epidemiological studies on human.
  4. Project work on animals involving physiological parameters (at least three parameters).
- c) Optional : Visit to Institute of national importance engaged in physiological, biomedical, biochemical and nutritional research.

**4. Viva Voce :**

**15 Marks**

**5. Laboratory Note - Books :**

**10 Marks**



### **RECOMMENDED BOOKS FOR PHYSIOLOGY ( HONOURS) Parts I, II & III Courses**

(The latest edition available should be used for all books)

1. Text book of Medical Physiology, by A.C. Guyton. W.B. Saunders Co.
2. Best & Taylor's Physiological Basis of Medical Practices, edited by B.K. Brobeck. The William and Wilkins Co.
3. Review of Medical Physiology. By W.F. Ganong, Lange Medical Book. Prentice-Hall International.
4. Harper's Biochemistry, by R.K. Murry and others. Lange Medical Book. Prentice-Hall International.
5. Lehninger's Principles of Biochemistry. By D.L. Nelson and M. M. Cox, Worth Publishers Inc.
6. Text Book of Biochemistry, by E.S. West. W.R. Todd. H.S. Mason. J.T. Van Bruggen. The Macmillan Company.
7. Biochemistry. By D.Das, Academic Publishers.
8. Biophysics and Biophysical Chemistry, by D.Das. Academic Publishers.
9. Samson Wright's Applied Physiology. Edited by C.A. Keele. E Neil & N. Toels. Oxford University Press.
10. Physiology, by R.M. Berne & M.N. Levy, C.V. Mosby Co.
11. Basic Histology, by L.C. Junqueira & J Carneiro, McGraw- Hill .
12. Histology- A Text and Atlas, by M.H. Ross & E.J. Reith. The Williams and Wilkins Company.
13. Bailey's Text Book of Histology, revised by W.M. Copenhaver; The Williams and Wilkins Company.
14. The Cell – A Molecular Approach, G.M. Cooper & R.E.Hausman, ASM Press SINAUER.
15. Core Text Book of Neuro-Anatomy, by M.B. Carpenter; the Williams and Wilkins Company.
16. The Human Nervous System, by Charles Nobach, Mc Graw Hill Book Co.
17. Biomedical Instrumentation & Measurements, by L. Cromwell, F.J. Weibell & E.A. Pfeiffer; Prentice-Hall of India Pvt Ltd.
18. The Human Nervous System. By M.L. Barr & J.A. Kierman, Harper & Row.
19. Essential Food and Nutrition, by M. Swaminathan. The Bangalore Printing & Publishing Co. Ltd.
20. Essential Immunology, by I.M. Roitt, Blackwell Scientific Publications.
21. Kuby Immunology, by R.A. Goldsby. T.J. Kindt and B.A. Osborne, W.H. Freeman and Co.
22. Microbiology, by M.J. Pelczer & Others; Tata McGraw Hill Publishing Co Ltd.
23. Cellular & Molecular Biology, by EDP De Robertis & EMF De Robertis; Lea & Febiger.
24. Molecular Biology of the Gene, by J.D. Watson, H.H. Nancy & others; Benjamin-Cummings.
25. Molecular Biology of the Cell, by B. Alberts and others, Garland.
26. Textbook of Medical Physiology, Indu Khurana, Elsevier.
27. Carleton's Histological Techniques, by R.A.B. Drury & E.A. Wellington, Oxford University Press.
28. Handbook of Experimental Physiology and Biochemistry, by P.V. Chadha; Jaypee Brothers Medical publishers.
29. Neurobiology, by G.M. Shepherd, Oxford University Press
30. Biochemistry, by L. Stryer, W.H. Freeman and Co.
31. Molecular Cell Biology, by H. Lodish, D. Baltimore & others. Scientific American Book.

32. Genetics: Analysis of Genes and Genomes, by DL Hartl and EW Jones & Burtlet Publishers.
33. William's Text Book of Endocrinology Larsen *et al.*,; An Imprint of Elsevier.
34. Endocrinology, Mac E. Hadley, Pearson Education.
35. The Kidney-An outline of Normal and Abnormal Functions, by H.E. Dewardener, ELBS.
36. Physiology of Respiration by J.H. Comroe. Year Book Medical Publihsers.
37. Text Book of Physiology. Vols. I & II by H.D. Patton. A.F. Ruchs. B.Hille. A.M. Scher and R. Sleiner. W.B. Saunders of Co.
38. The Physiological Basis of Physical Education and Athletics by E.L. Fox and D.K. Mathews. Saunders College Publishing.
39. Statistics in Biology and Psychology by D.Das Academic Publishers.
40. An Introduction to Biostatistics, N. Gurumani, M.J.P. Publishers, Chennai.
41. Pesticides by P.K. Gupta, Interprint.
42. Environmental Chemistry by P.V. De. Wiley Eastern Ltd.
43. Exercise Physiology – Energy, Nutrition and Human Performance by W.D. McArdle, F.Katch and V.L. Katch. Lippincott, Williams and Wilkins.
44. Essentials of Exercise Physiology by L.G. Shaver, Surjeet Publications.
45. Text Book of Environmental Physiology by C. Edger Folk Jr. Lea and Febiger.
46. Goodman & Gilman's The Pharmacological Basis of Therapeutics, McGraw-Hill.
47. Quintessence of Medical Pharmacology, S.K. Chaudhuri, New Central Book Agency.
48. Essentials of Medical Pharmacology, KD Tripathi, Jaypee.
49. Text book of Work Physiology by P.O. Astrand and K. Rodahl. Mc Graw- Hill Book Co.
50. Human Factors in Engineering and Design by E.O. McCormick and M. Sanders. Tata McGraw Hill.
51. Energy, Work and Leisure J.V.G.A.Durin and R.Passmore, Heinemann Educational Books.
52. Sports Physiology by E.L. Fox, Saunders College Publishing. Holt-Saunders.
53. Vander's Human Physiology, E.P. Widmaier *et al.*, McGraw-Hill, Higher Education.
54. Concise Medical Physiology by S.K. Chaudhuri, New Central Book Agency.
55. Medical Physiology by A.B. Mahapatra, Current Books International.
56. Endocrinology. Vols.I, II and III by L.O. DeGroot. W.B. Saunders Co.
57. The Physiology of Reproduction, Vols.I & II, by E. Knobil and J.D. Neil. Raven Press.
58. Park's Text Book of Preventive and Social Medicine by K. Park, M/s. Banarsidas Bhanot Publishers.
59. Langman's Medical Embryology by J.W. Sadler, Lippincott, Williams and Wilkins.
60. Essentials of Human Embryology by A.K. Datta. Current Books International.
61. Human Embryology by I. Singh & G.P.Pal, McMillan.
62. The Circadian System of Man by R.A. Wever, Springer-Verlag.
63. The Clocks That Time Us, by M.C. Moore- Ede and others, Harvard University Press.
64. Circadian Rhythms and the Human, by D.S. Minors and J.M. Waterhouse. Wright. PSG.
65. The Physiological Clock: Circadian Rhythms and Biological Chronometry, E. Bunning, Springer-Verlag.
66. Textbook of Pharmacology, SD Seth, B.I. Churchill Livingstone.
67. Basic and Clinical Pharmacology by E.G. Katzung. Appleton and Lange.
68. An Introduction to Biological Rhythms, by D. Palmer, Academic Press
69. Medical Statistics by B.K. Mahajan. Jaypee Brothers, Medical Publishers Pvt. Ltd.
70. Statistical Methods by G.W. Snecedor and W.G. Cochran, Oxford & IBH Publishing Co. Pvt. Ltd.
71. Theory and Practice of Histological Techniques by J.D. Bancroft & A. Stevens, Churchill Livingstone.

72. Practical Biochemistry in Medicine by Srinivas Rao., Academic Publishers.  
73. Practical Physiology, by M.K. Manna, Sritara Prakashani, Kolkata

Note Books of Practical Biochemistry, Experimental Physiology and Histology  
(Published by the Physiological Society of India, Kolkata)

**Note :** In order to maintain the uniformity of practical knowledge among the students of different Colleges, Physiological Society of India has published Practical Note Books in Physiology comprising syllabi of different Universities including Calcutta University with the help of experienced teachers including dignitaries of both Honours and General teaching degree colleges. Hence, members of the Undergraduate Board of Studies in Physiology recommend the aforesaid Note Books (Experimental, Biochemistry and Histology) for use by the students in undergraduate degree course (Honours practical) in Physiology.

## **GENERAL**

### **PART - I**

#### **THEORETICAL**

Paper I (F.M. 100)

Unit - 01: 50 Marks

Lectures required  
(Each period of 45 minutes duration)

1. Units of human system	06
2. Biophysical and Biochemical Principles	10
3. Digestive System	12
4. Biochemistry and Metabolism	14
5. Nutrition and Dietetics	08

Unit – 02 : 50 Marks

1. Blood and Body Fluids	10
2. Heart	10
3. Circulation	10
4. Respiratory system	10
5. Renal Physiology	10

### **PART - II**

#### **THEORETICAL**

Paper – II (F.M. 100)

Lectures required  
(Each period of 45 minutes duration)

Unit - 03: 50 Marks

1. Muscle Physiology	08
2. Nerve Physiology	10
3. Nervous system I	10
4. Nervous system II	10
5. Sensory Physiology	12

Unit – 04 : 50 Marks

1. Skin and Regulation of Body Temperature	08
2. Endocrine system I	12
3. Endocrine system II	12
4. Reproductive Physiology I	09
5. Reproductive Physiology II	09

## PRACTICAL

Paper – III ( F.M.100)

(One practical class is of 3 periods)  
(Each period of 45 minutes duration)

Classes required 70

Unit 05

- |   |          |
|---|----------|
| 1. Histology :  | 30 Marks |
| a) Haematological Experiments                                   |          |
| b) Fresh tissue experiments (except haematological experiments) | 20 Marks |
| c) Identification of histological permanent slides              | 10 marks |
| 2. Biochemistry :   | 30 Marks |
| a) Qualitative Experiments                                      | 10 marks |
| b) Quantitative Experiments                                     | 20 marks |
| 3. Experimental Physiology (Including Human Experiments)        | 15 Marks |
| a) Amphibian skeletal muscle and heart experiments              |          |
| b) Experiments on Human   |          |
| 4. <i>Viva voce</i>   | 15 Marks |
| 5. Laboratory note books  | 10 Marks |

## PART - III

## THEORETICAL

Paper – IV A (F.M. 70)

Lectures required  
(Each period of 45 minutes duration)

Unit – 06: 70 Marks

- |                                     |    |
|-------------------------------------|----|
| 1. Haematology                      | 10 |
| 2. Biochemistry & Molecular Biology | 14 |
| 3. Microbiology and Immunology      | 10 |
| 4. Social Physiology                | 08 |
| 5. Work Physiology                  | 10 |
| 6. Environmental Physiology         | 10 |
| 7. Biostatistics                    | 08 |

## PRACTICAL

Paper - IVB

(One practical class is of 3 periods)  
(Each period of 45 minutes duration)

F.M. 30

Classes required 20

Unit – 07: 30 Marks

- |                          |          |
|--------------------------|----------|
| 1. a) Haematology        |          |
| b) Biochemistry          | }        |
| c) Human Experiments     | 18 Marks |
| 2. Field Study Report    | 4 Marks  |
| 3. <i>Viva voce</i>      | 5 Marks  |
| 4. Laboratory Note-Books | 3 Marks  |

## PART - I

## THEORETICAL

### Paper I (F.M. 100)

#### Unit - 01: 50 Marks

##### 1. Units of Human System :

Structure and functions of plasma membrane, nucleus and different cell organelles – Endoplasmic reticulum, Golgi bodies, Mitochondria, Lysosome and Peroxisome. Structure, function and classification of Epithelial, Connective, Muscular and Nervous tissues. (06 lectures)

##### 2. Biophysical and Biochemical Principles:

Physiological importance of the following physical processes: Diffusion, Osmosis, Dialysis, Ultrafiltration, Surface tension, Adsorption and Absorption. A brief idea about acids, bases, buffers, indicators. pH – definition, significance and maintenance of pH in the blood. Colloids - definition, classification and physiological importance. Enzymes: definition, classification, factors affecting enzyme action. Concept of coenzymes and isozymes. (10 lectures)

##### 3. Digestive System :

Structure in relation to functions of alimentary canal and digestive glands. Composition, functions and regulation of secretion of digestive juices including bile. Digestion and absorption of carbohydrate, protein and lipid. Movements of the stomach and small intestine. (12 lectures)

##### 4. Biochemistry and Metabolism :

**Carbohydrates :** Definition and classification.

*Monosaccharides* – Classification, structure. Chemical reactions of monosaccharides (Glucose & Fructose) — Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance.

*Disaccharides* – Maltose, Lactose and Sucrose: Structure, occurrence and physiological importance.

*Polysaccharides* – Starch, Glycogen, Dextrin, Cellulose.

**Lipids :** Definition and classification. Fatty acids — Classification. Properties of Fat and Fatty acids—Hydrolysis, Saponification, Saponification number, Iodine number, Hydrogenation, Rancidity-Acid number. Phospholipids, Cholesterol & its ester – physiological importance.

**Amino acids, Peptides and Proteins :** Classification and structure. Structure of peptide bonds. Glycolysis, TCA cycle, Glycogenesis, Glycogenolysis. Gluconeogenesis. Depot fat. Beta oxidation of saturated fatty acid. Ketone bodies – formation and significance. Deamination, Transamination. Amino acid pool - fate and functions of amino acids in the body. Formation of urea and its importance. (10 lectures)

##### 5. Nutrition :

Basic constituents of food and their nutritional significance. Vitamins: definition, classification, functions, deficiency symptoms and daily requirements. Hypervitaminosis. Mineral metabolism - Ca, P, Fe. BMR: definition, factors affecting, determination by Benedict-Roth apparatus. Respiratory quotient: definition, factors affecting and significance. Biological value of proteins. Essential and non-essential amino acids, Nitrogen equilibrium. Minimum protein requirement-Positive and negative nitrogen balance. SDA : definition and importance. (08 lectures)

1. Blood and Body Fluids :

Blood: composition and functions. Plasma proteins: origin and functions. Plasmapheresis. Bone marrow. Formed elements of blood - their morphology and functions. Erythropoiesis and leucopoiesis. Haemoglobin : different types of compounds and derivatives. Blood volume and its determination (dye method and radioisotope method) and regulation. Coagulation of blood : mechanism, factors affecting, procoagulants, anticoagulants, and disorders of coagulation. Lymph and tissue fluids: composition, formation, and functions. (10 lectures)

2 Cardiovascular Physiology I :

Anatomy and histology of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Cardiac cycle : events. Heart sounds. Heart rate. Cardiac output: methods of determination (dye dilution and Fick principle), factors affecting, regulation. (10 lectures)

3. Cardiovascular Physiology II :

Structure of arteries, arterioles, capillaries, venules and veins. Pulse - arterial and venous. Blood pressure and its regulation and factors controlling. Baro- and chemoreceptors. Vasomotor reflexes. Methods of measurement of blood pressure. Peculiarities of regional circulations: coronary, pulmonary, renal, hepatic and cerebral. (10 lectures)

4. Respiratory Physiology :

Anatomy and histology of the respiratory passage and organs. Role of respiratory muscles in breathing. Artificial respiration. Significance of physiological and anatomical dead space. Lung volumes and capacities. Exchange of respiratory gases between lung and blood and between blood and tissues. Transport of oxygen and carbon dioxide in blood. Regulation of respiration - neural and chemical. Hypoxia. (10 lectures)

5. Renal Physiology :

Relationship between structure and functions of kidney. Mechanism of formation of urine. Normal and abnormal constituents of urine. Physiology of urine storage and micturition. Renal regulation of acid-base balance. Non-excretory functions of kidney. (10 lectures)

**DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPER**

1. From each unit, **five** questions of 10 marks each with one alternative will be set from the same sub-unit . Each 10 marks question may be sub-divided.

2. Candidates have to **attempt all five** questions from the unit amongst the alternatives.

## PART - II

### THEORETICAL

#### Paper II (F.M. 100)

Unit – 03 : 50 Marks

1. Muscle Physiology :

Different types of muscle and their structure. Red and white muscle. Muscular contraction: structural, mechanical and chemical changes in skeletal muscle during contraction and relaxation. Isotonic and isometric contractions. Properties of muscle: all or none law, beneficial effect, summation, refractory period, tetanus, fatigue. A brief idea about the muscle spindle.

(08 lectures)

2. Nerve Physiology :

Structure and classification of nerves. Origin and propagation of nerve impulse. Velocity of impulse in different types of nerve fiber. Properties of nerve fibers: all or none law, rheobase and chronaxie, refractory period, indefatigability. Synapses: structure, different types, mechanism of synaptic transmission. Motor unit. Myoneural junction: structure, mechanism of impulse transmission. Degeneration and regeneration in nerve fibers.

(10 lectures)

3. Nervous System I :

A brief outline of organization and basic functions (sensory, motor and association) of the nervous system, central and peripheral nervous system. (emphasis on the structure of spinal cord and brain stem). Ascending tracts carrying touch, kinaesthetic, temperature and pain sensations. Descending tracts: pyramidal tract and brief outline of the extra-pyramidal tracts. Pain. Reflex action - definition, reflex arc, classification, properties. Functions of the spinal cord. Outline of functions of brain stem.

(10 lectures)

4. Nervous System II :

A brief idea of the structure, connections and functions of cerebellum. Different nuclei and functions of thalamus and hypothalamus. Cerebral cortex: histological structure and localization of functions. CSF : composition, formation, circulation and functions. A brief description of the organization of the autonomic (sympathetic and parasympathetic) nervous system. Functions of sympathetic and parasympathetic nervous system. A brief idea of speech, aphasia, conditioning, learning and memory.

(10 lectures)

5. Sensory Physiology :

Classification of general and special senses and their receptors. Receptors as biological transducer.

(a) *Olfaction and Gustation*: Structure of sensory organ, neural pathway of olfactory and gustatory sensation. Physiology of olfactory and gustatory sensation. Olfactory and gustatory adaptation. After-taste.

(b) *Audition*: Structure of ear, auditory pathway, mechanism of hearing.

(c) *Vision*: Structure of the eye. Histology of retina. Visual pathway. Light reflex. Chemical changes in retina on exposure to light. Accommodation - mechanism and pathway. Errors of refraction. Positive and negative after-image. Light and dark adaptation. Elementary idea of colour vision and colour blindness.

(12 lectures)



1. Skin and Regulation of Body Temperature:

Structure and functions of skin. Insensible and sensible perspiration Regulation of body temperature — physical and physiological processes involved in it. Physiology of sweat secretion and its regulation. (08 lectures)

2. Endocrine System I :

Anatomy of endocrine system. Hormones - classification. Basic concept of regulation of hormone actions. Positive and negative feedback mechanism. Elementary idea of hormone action.

*Hypothalamus* : Basic concept of neurohormone. Hypothalamo-hypophyseal tract and portal system.

*Pituitary*: Histological structure, hormones, functions. Hypo and hyperactive states of pituitary gland.

*Thyroid*: Histological structure. Functions of thyroid hormones ( $T_4T_3$ ) Thyrocalcitonin. Hypo and hyper-active states of thyroid.

*Parathyroid*: Histological structure, functions of parathyroid hormone. Tetany. (12 lectures)

3. Endocrine System II :

*Adrenal Cortex*: Histological structure and functions of different hormones. Hypo and hyper-active states of adrenal cortex.

*Adrenal Medulla*: Histological structure and functions of medullary hormones. The relation of adrenal medulla with the sympathetic nervous system.

*Pancreas*: Histology of islets of Langerhans. Origin and functions of pancreatic hormones. Diabetes mellitus.

Brief idea of the origin and functions of renin-angiotensin, prostaglandins. erythropoietin and melatonin. Elementary idea of gastrointestinal hormone. (12 lectures)

4. Reproductive Physiology I :

Primary and accessory sex organs and secondary sex characters. Testis: histology, spermatogenesis, testicular hormones and their functions. Ovary: histology, oogenesis, ovarian hormones and their functions. (09 lectures)

5. Reproductive Physiology II :

Oestrus and menstrual cycles and their hormonal control. Fertilization, implantation and structure and functions of placenta.

Maintenance of pregnancy – role of hormones. Development of mammary gland and lactation - role of hormones.

(09 lectures)

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2. Candidates have to **attempt all five** questions from the unit amongst the alternatives.

# Practical

## Paper III

(F.M. 100)

Unit – 05

### 1. Histology :

**30 Marks**

Only ONE question will be set from the following two groups [ i) & ii) ] in the examination (20 Marks) :

#### i) *Haematological experiments :*

- a) Leishman's staining of human blood film and identification of different types of blood corpuscles.
- b) Preparation of Haemin crystals.

#### ii) *Fresh tissue experiments:*

- a) Examination and staining of fresh tissues (other than blood) squamous, cornified, ciliated and columnar epithelium, skeletal muscle, cardiac muscle by methylene blue stain.
- b) Silver nitrate preparation of node of Ranvier.

Demonstration: Staining of adipose tissue by Sudan III or IV.

- iii) *Identification of permanent slides:* Bone, Lung, Trachea, Spleen, Lymph gland, Liver, Salivary gland, Pancreas, Adrenal gland, Thyroid gland, Spinal cord, Cerebellum, Cerebral cortex, Kidney, Skin, Testis, Ovary, Tongue, Oesophagus, Stomach, Small intestine, Large intestine. (5 slides - 10 Marks)

### 2. Biochemistry :

**30 Marks**

#### *Qualitative Experiments:*

10 Marks

Qualitative tests for identification of starch, dextrin, lactose, sucrose, glucose, fructose, albumin, gelatin, peptone, lactic acid, hydrochloric acid, uric acid, acetone, glycerol, bile salts, urea.

#### *Quantitative Experiments:*

20 Marks

- a) Quantitative estimation of glucose by Benedict's method.
- b) Quantitative estimation of amino-nitrogen by Sorensen's formal titration method.  
*Percentage and total quantity to be done.*

#### Demonstration:

- a) Quantitative estimation of Sucrose by Benedict's method.
- b) Analysis of wheat, rice, milk and oil to test the presence of carbohydrate, protein and fat.
- c) Salivary amylase activity on starch at body temperature (37.5 C), above 40°C and in presence of HCl.

### 3. Experimental Physiology with Human Experiment :

**15 Marks**

- a) Use of kymograph, induction coil and key.
- b) Recording of simple muscle curve with sciatic-gastrocnemius muscle preparation of toad and determination of latent period, period of contraction and period of relaxation and maximum height of contraction.
- c) Normal tracing of toad's unperfused heart beat.
- d) Effect of warm saline on toad's unperfused heart beat.
- e) Measurement of systolic and diastolic arterial pressure by sphygmomanometer and determination of pulse pressure and mean pressure during rest and exercise.

#### Demonstration :

- a) Effect of temperature on simple muscle twitch.
- b) Effect of calcium and potassium ions on unperfused toad's heart beat.
- c) Effect of adrenaline/acetylcholine on unperfused toad's heart beat.

### 4. Laboratory Note Books :

**10 Marks**

- i) Biochemistry - 4 marks; ii) Histology - 3 marks; iii) Experimental - 3 marks

### 5. Viva – voce

**15 Marks**

- a) Questions are to be asked from the experiments given in the examination.
  - i) From Biochemistry - 4 marks; ii) From Histology - 4 marks;
  - iii) From Experimental - 3 marks ; iv) From Instruments – 4 marks(Questions are to be asked on the different instruments used in the practical classes.)

## PART - III

### THEORETICAL

Paper IV A (F.M. 70)

Unit – 06 : 70 Marks

#### 1. Haematology :

Blood groups - ABO and Rh. Blood transfusion - precaution and hazards. Immunological basis of identification of ABO and Rh blood groups. Functions and estimation of haemoglobin. Abnormal haemoglobins - thalassaemia and sickle-cell anaemia. Definition, determination and significance of TC, DC, ESR, Arneth count, PCV, MCV, MHC, MCHC, bleeding time, clotting time and prothrombin time. Anaemia - types (definition and causes). Leucocytosis, leucopenia and leukaemia. Purpura. (10lectures)

#### 2. Biochemistry and Molecular Biology :

Brief idea of HMP shunt and its significance (detailed enzymatic reactions are not required). Lipoproteins - types and functions. Purine and pyrimidine bases, nucleosides, nucleotides and polynucleotides. Structure of DNA and RNA. Elementary idea of gene, genome, transcription, genetic code, translation and genetic engineering. (10 lectures)  
Pathophysiological significance of the following blood constituents: glucose, urea, creatinine, uric acid, cholesterol, bilirubin, SGPT and SGOT, alkaline and acid phosphatases and ketone bodies. (4 lectures)

#### 3. Microbiology and Immunology :

Virus - DNA virus and RNA virus. Bacteriophage. Bacteria-structure and morphological classification. Gram positive and Gram negative and acid-fast bacteria. Pathogenic and non-pathogenic bacteria - definition with a few examples. Sterilization and Pasteurization. A brief idea of antibiotics. Elementary knowledge of innate and acquired immunity. Humoral and cell mediated immunity Vaccination - principles and importance of immunization. Basic principle of immunological detection of pregnancy. (10 lectures)

#### 4. Social Physiology :

Composition and nutritional value of common Indian foodstuffs – rice, wheat, pulses, egg, meat, fish and milk. Dietary fibers. Calorie requirement. Concept of ACU. Principle of balanced diet formulation of individuals - infants, growing children, students, pregnant women, lactating women and aged persons. Dietary management of obese, diabetic person, hypertensive person and athlete. Diet survey. Malnutrition and its causes - PCM, marasmus, kwashiorkor their prevention. Iron and iodine deficiency.  
Population problem and its control. Problem of infertility and brief idea about *in vitro* fertilization and intrauterine gamete transfer. Brief idea of AIDS and hepatitis B and their preventions. (08 lectures)

#### 5. Work Physiology :

Physical work - definition and units of measurement. Concept and classification of physical work – static and dynamic work, positive & negative work. Cardiovascular and respiratory changes during physical exercise. Brief idea of maximal aerobic power and excess post-exercise oxygen consumption. Basic idea of doping. EMG. Physical fitness index - Harvard step test. ECG – normal waves and leads. Anthropometry and its uses. (10 lectures)

#### 6. Environmental Physiology :

Environment - its physiological aspects. Effect of extreme temperature on humans. Hypobaric environment - effects on physiological system, acclimatization. Hyperbaric conditions and Caisson disease. Brief idea of cyanosis, dyspnoea, hyperpnoea, apnoea and asphyxia. Some common pollutants and their effects - carbon monoxide, lead and arsenic. Effects of noise on human body and preventive measures. (10 lectures)

#### 7. Biostatistics :

Basic concepts – variable, population, parameter, sample, statistic. Classification of data – qualitative and quantitative, continuous and discontinuous. Presentation of data–frequency distribution, bar diagram, pie diagram, frequency polygon and histogram. Mean, median, mode, standard deviation and standard error. (08 Lectures)

### **DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPER**

1. From each unit, **seven** questions of 10 marks each with one alternative will be set from the same sub-unit. Each 10 marks question may be sub-divided.
2. Candidates have to **attempt all seven** questions from the unit amongst the alternatives.

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### **PRACTICAL**

#### **Paper IV B (F.M. 30)**

Unit – 07 : 30 Marks

1. Any two questions from the following three groups (A, B and C) are to be set in the examination:  
9 x 2 = **18 marks**

**A. Haematology:**

- a) DC of WBC, estimation of haemoglobin, blood group determination, bleeding time and coagulation time.

Demonstration: Haematocrit, MCV, TC of RBC and WBC, ESR.

**B. Biochemistry:**

- a) Identification of normal constituents of urine - chloride, sulphate, phosphate, creatinine and urea. Identification of abnormal constituents of urine - glucose, protein, acetone blood and bile salts.

Demonstration: Blood sugar estimation (Folin -Wu method )

**C. Human Experiments:**

- a) Determination of Physical Fitness Index (PFI) of an individual by modified Harvard step test and recording of recovery heart-rate after standard exercise.
- b) Pneumographic recording of respiratory movements along with the effect of drinking of water, talking, forced hyperventilation and breath holding.
- c) Measurement of some common anthropometric parameters : stature, weight, eye height, shoulder height, elbow height, sitting height, elbow rest height (sitting), knee height (sitting), arm reach from wall, mid-arm circumference, waist circumference, hip circumference, neck circumference, head circumference, chest circumference.
- d) Calculation of Body Surface Area (using a nomogram) and Body Mass Index from anthropometric measurements.

Demonstration:

- a) Tests for colour blindness, test for visual acuity using Snellen's Chart. Exploration of conductive and perceptive deafness by tuning fork method.
- b) Ergographic recording of muscular fatigue by 'Moss's ergograph'. Clinical classification of reflexes : superficial reflex - planter reflex, Deep reflex – knee jerk, Visceral reflex - pupillary light reflex.

2. Field Study Report: **4 Marks**

Any one of the followings:

- a) Diet survey of a family as per ICMR specification.
- b) Population study of physiological parameters such as height, weight, heart-rate, blood pressure, respiratory rate, PFI, TC of RBC, estimation of haemoglobin, DC of WBC as far as practicable.

3. Viva- Voce: **5 Marks**

4. Laboratory Note- Book : **3 Marks**

RECOMMENDED TEXT AND REFERENCE BOOKS FOR PHYSIOLOGY (GENERAL) COURSE  
(The latest edition available should be used for all books)

1. *Human Physiology Vol. 1 & 2*, C. C. Chatterjee, Medical Allied Agency.
2. *Sharirbigyan (Bengali) Vol. 1 & 2*, J. Debnath, Sridhar Prakashani.
3. *Principles of Physiology*, D.Pramanik, Academic Publishers, Kolkata.
4. *Concise Medical Physiology*, S. K. Chaudhuri, New Central Book Agency.
5. *Biochemistry*, D. Das, Academic Publishers.
6. *Paripak, Bipak 0 Pusti*, D. Das, Paschim Banga Rajya Pustak Parshad.
7. *Bailey's Text Book of Histology*, W. M. Compnhaver, Williams and Wilkins.
8. *Atlas of Human Histology*, M. S. H Di Fiore, Lea & Febiger.
9. *Essentials of Exercise Physiology*, L.G. Shaver, Surjeet Publications.
10. I. *Text Book of Medical Physiology*, A.C.Guyton, W.B. Saunders Co.  
II. *The Living Body*, O.H Best & N.B Taylor, Williams & Wilkins.
11. *Human Physiology Vol 1 &2*, T. K. Basu, Biomed Publications.
12. *Biomedical Instruments and Measurements*, L. Cromwell, FJ Weibell,  
E.A.Pfaiffer, Prentice-Hall of India Pvt. Ltd.
13. *A Text Book of Practical Physiology*, C.L. Ghai, Jaypee Brothers Medical  
Publishers Pvt. Ltd.
14. *Medical Physiology*, A.K. Das, Books and Allied (P) Ltd.
15. *Medical Physiology*, A.B. Singha Mahapatra, Current Books International.
16. *Essentials of Medical Physiology*: K. Sembulingam and P. Sembulingam, Jaypee  
Brothers Medical Publishers Pvt. Ltd.
17. *ImmunoLogy* by D. M. Weir, ELBS.
18. *Park's Text Book of Preventive and Social Medicine* by K. Park, *MI*s Banarsi Bhanot  
Publishers.
19. *Nutritive Value of Indian Foods* by C. Gopalan and other, NIN, Hyderabad.
20. *Practical Physiology*, by M.K. Manna, Sritara Prakashani, Kolkata
21. Note Books on Practical Biochemistry, Experimental Physiology and Histology  
(Published by the Physiological Society of India, Kolkata.)

*Note:* In order to maintain the uniformity of practical knowledge among the students of different Colleges, Physiological Society of India has published Practical Note Books on Physiology comprising syllabi of different Universities, including Calcutta University with the help of experienced teachers of both Honours and General teaching degree colleges. Hence, members of Undergraduate Board of Studies in Physiology recommend the aforesaid Note Books (Experimental, Biochemistry and Histology) for use by the students in undergraduate degree course (General) practical in Physiology.



# UNIVERSITY OF CALCUTTA

## Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

### List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies ( General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE  
KOLKATA-700073  
The 4<sup>th</sup> June, 2018

*Paul*  
4/6/18  
(Dr. Santanu Paul)  
Deputy Registrar

**CBCS SYLLABUS**  
**IN**  
**HISTORY (HONOURS)**

**CALCUTTA UNIVERSITY**

**2018**

# University of Calcutta

## HIS – A

The Three - year B.A. Honours in History will comprise 6 Semesters. The curriculum will consist of 14 Core Courses (CC), 4 Discipline Specific Elective (DSE) courses, 2 Ability Enhancement Compulsory Courses (AECC), 2 Skill Enhancement Courses (SEC) Each course will be of 100 Marks. Attendance: 10 marks per Paper, Internal Assessment: 10 marks per paper.

### ➤ **Core Courses CC**

[Fourteen courses. Each course: 6 credits (5 theoretical segments TH+ 1 for tutorial related segment TU). Total: 84 credits.

- Each course carries 80 marks. Teaching time: 6x14 = 84 hrs  
Minimum 60 classes
- 65 marks for theoretical segment.
- Question Pattern for subjective/descriptive segment of 65 marks: 3 questions out of 6 (within 500 words) (10 x3 = 30) + 4 questions out of 8 within 250 words; 5x4 =20) + 15 objective type questions carrying 1 mark each (15 x 1 = 15).
- 15 marks for tutorial - related segments as suggested below (any one from each mode):
- Any one of the following modes: upto 1000 words for one Term Paper/upto 500 words for each of the two Term Papers/ equivalent Book Review/ --based on syllabus -related and/or current topics .[The modes and themes and/or topics are be decided by the concerned faculty of respective colleges.]
- Core courses: 2 each in Semesters 1 and 2; three each in Semesters 3 and 4; 2 each in Semesters 5 and 6.
- **IMPORTANT NOTES:**  
The Readings provided below include many of those of the UGC Model CBCS Syllabus in History. For further details of Course Objectives and additional references it is advised that the UGC model CBCS syllabus concerning relevant courses and topics should be given due importance and primarily consulted.
- Cited advanced texts in Bengali are not necessarily substitutes, but supplementary to the English books.



- The format is subject to the common structural CBCS format of the University.
- 

### ➤ **Discipline- specific Elective Courses DSE**

Each course: 6 credits 5 for theoretical segment + 1 for tutorial-related segment. **(TH -5 TU-1)**

#### **DSE-A for Semester -5/6, DSE-B for Semester 5/6**

- Each course carries 80 marks. Minimum 60 classes.
  - 65 marks for theoretical segment.
  - Question Pattern for subjective/descriptive segment of 65 marks: 3 questions out of 6 (within 500 words;  $10 \times 3 = 30$ ) + 4 questions out of 8 (within 250 words;  $5 \times 4 = 20$ ) and 15 objective type questions carrying 1 mark each ( $15 \times 1 = 15$ ).
  - 15 marks for tutorial-related segments as suggested below (any one from each mode): Any one of the following modes: upto 1000 words for one Term Paper/upto 500 words for each of the two Term Papers/ equivalent Book Review/ based on syllabus related and/or current topics [The modes and themes and/or topics of a. and b. to be decided by the concerned faculty of respective colleges.]
- 
- **HIS-A: Skill Enhancement/Skill-based Courses SEC** Each Course: 2 credits . **(Only theoretical.)**  
**SEC –A in Semester 3, SEC –B in Semester 4.**
    - Each course carries 80 marks. Teaching time: 2 hrs per week or  $2 \times 14 = 28$  hrs
    - 80 marks for theoretical segment.
    - Question Pattern for subjective/descriptive segment of 80 marks: 4 questions out of 8 (within 500 words;  $10 \times 4 = 40$ ) + 5 questions out of 10 (within 250 words;  $5 \times 5 = 25$ ) and 15 objective type questions carrying 1 mark each ( $15 \times 1 = 15$ ).
  - **HIS-A: Ability Enhancement Compulsory Courses ( AECC )** Each Course 2 credits
    - AECC -1** : Communicative English/ MIL
    - AECC-2** : Environmental Studies
    - AECC -1 in Semester 1, AECC -2 in Semester 2**

### **IMPORTANT NOTES:**

## LIST OF COURSES FOR HISTORY HONOURS PROGRAMME

- The Readings provided below include many of those of the UGC Model CBCS Syllabus in History. For Course Objectives and references it is advised that the UGC model CBCS syllabus concerning relevant courses and topics should be given due importance and primarily consulted.
- \*Website: BA History (Honours):
- Cited advanced texts in Bengali are not necessarily substitutes, but supplementary to the English books.
- The format is subject to the common structural CBCS format of the University.

### HIS-A COURSES SEMESTER WISE

	<b>SEM-1</b>	<b>SEM-2</b>	<b>SEM-3</b>	<b>SEM-4</b>	<b>SEM-5</b>	<b>SEM-6</b>
<b>CC</b>	CC- 2TH/ 2TU <b>1&amp; 2</b>	CC- 2TH/2TU <b>3&amp;4</b>	CC- 3TH/3TU <b>5,6&amp;7</b>	CC- 3TH/3TU <b>8,9&amp;10</b>	CC-2TH/2TU <b>11,&amp;12</b>	CC- 2TH/2TU <b>13&amp;14</b>
<b>DSE</b>					DSE-A* DSE-B 2TH/2TU	DSE-A* DSE-B 2TH/2TU
<b>**GE</b>	GE-1 1TH/ 1TU	GE-2 1TH/ 1TU	GE-3 1TH/ 1TU	GE-4 1TH/ 1TU		
<b>AECC</b>	AECC-1 1TH/0 TU	AECC-2 1TH/ 0TU				
<b>SEC</b>			SEC-A 1TH/0 TU	SEC-B 1TH/0 TU		
<b>Total No. of Courses and Marks</b>	4x100= 400	4x100= 400	5x100= 500	5x100= 500	4x100= 400	4x100= 400
<b>Total Credits</b>	20	20	26	26	24	24

**\*HIS-A- DSE** – Candidates can choose any one paper in Semester -5 and another in Semester 6 taking one from Group –A and the other from Group –B

**\*\*HIS-A Generic Elective (GE):** The four Generic Elective papers (courses) for History (Honours) students will be from any subject other than History. Similarly History as Generic Elective will be offered to students having Honours in any subject other than History. The Generic Elective papers in History, for Honours students (for students having Honours in any subject other than History.) will be treated as Core Papers in History, for General students (for BA General Students having History. as a General paper)

COURSE CODE	(6 Credits per Core Course)
<b>Subject-Hon-Core-Semester-Paper-TH&amp;TU</b>	<b>CORE COURSES</b>
HIS-A-CC -1-1-TH&TU	
HIS-A-CC -1-2-TH&TU	
HIS-A-CC -2-3-TH&TU	
HIS-A-CC -2-4-TH&TU	
HIS-A-CC -3-5-TH&TU	
HIS-A-CC -3-6-TH&TU	
HIS-A-CC -3-7-TH&TU	
HIS-A-CC -4-8-TH&TU	
HIS-A-CC -4-9-TH&TU	
HIS-A-CC -4-10-TH&TU	
HIS-A-CC -5-11-TH&TU	
HIS-A-CC -5-12-TH&TU	
HIS-A-CC -6-13-TH&TU	
HIS-A-CC -6-14-TH&TU	
<b>Skill Enhancement Course (2 Credits per Course)</b>	
<b>GROUP-A</b>	<b>HIS-G-SEC-3-A(1) or A(2)-TH</b>
SEC-A-(1)	
SEC-A-(2)	
<b>GROUP-B</b>	<b>HIS-G-SEC-4-B(1) or B(2)-TH</b>
SEC-B-(1)	
SEC-B-(2)	
<b>DISCIPLINE SPECIFIC ELECTIVE (6 Credits per Course)</b>	
<b>GROUP-A</b>	<b>Semester 5: DSE A-1/ A-2 &amp; Semester-6: DSE A-3/A4TH&amp;TU</b>
DSE-A-(1)	HIS-A-DSE-A-1-5 TH&TU
DSE-A-(2)	HIS-A-DSE-A-2 -5TH&TU
DSE-A-(3)	HIS-A-DSE-A-3-6 TH&TU
DSE-A-(4)	HIS-A-DSE-A-4 -6 TH&TU
<b>GROUP-B</b>	<b>Semester 5: DSE B-1/ B-2 &amp; Semester-6: DSE A3/A4 TH&amp;TU</b>
DSE-B-(1)	HIS-A-DSE-B--1 -5TH&TU
DSE-B-(2)	HIS-A-DSE-B-2 -5TH&TU
DSE-B-(3)	HIS-A-DSE-B-3-6 TH&TU
DSE-B-(4)	HIS-A-DSE-B-4-6 TH&TU
<b>➤ DISCIPLINE SPECIFIC ELECTIVE</b>	
➤ Note: Choose any one paper in Semester -5 and another in Semester 6 taking one from Group –A and the other from Group –B	
<b>GENERIC ELECTIVE (6 Credits per Course)</b>	
➤ Note: Core Courses Designed for General Programme will be offered as Generic Elective courses for students of other Disciplines.	

## **Structure of B.A (Hons. ) History Course under CBCS** **HIS-A-CC-1-14- TH & TU**

- Paper 1 **SEM -1:** History of India (From the Earliest times to C 300 BCE)
- Paper 2 **SEM-1:** Social Formations and Cultural Patterns of the Ancient World other than India
- Paper 3 **SEM-2:** History of India (c 300 BCE to c.750 CE)
- Paper 4 **SEM-2:** Social Formations and Cultural Patterns of the Medieval World other than India
- Paper 5 **SEM-3:** History of India (c.750 – 1206)
- Paper 6 **SEM-3:** Rise of the Modern West –I
- Paper 7 **SEM-3:** History of India (c.1206 – 1526)
- Paper 8 **SEM-4:** Rise of the Modern West – II
- Paper 9 **SEM-4:** History of India (c.1526-1605)
- Paper 10 **SEM-4:** History of India (c.1605 – 1750s)
- Paper 11 **SEM-5:** History of Modern Europe (c.1780-1939)
- Paper 12 **SEM-5:** History of India (c.1750s– 1857)
- Paper 13 **SEM-6:** History of India (c. 1857 – 1964)
- Paper 14 **SEM-6 :** History of World Politics: (1945-1994)

### **HIS-A- DSE TH & TU**

**Discipline Specific Elective DSE (Any Four) Choosing any one paper in Semester -5 and another in Semester 6 taking one from Group –A and the other from Group –B**

- Paper 1 **DSE-A-1 SEM -5:** History of Bengal (c.1757-1905)
- Paper 2 **DSE-A-3 SEM -6:** History of Bengal (c.1905-1947)
- Paper 3 **DSE-B-2 SEM -5:** History of Southeast Asia – The 19<sup>th</sup> Century
- Paper 4 **DSE-B-4 SEM -6:** History of Southeast Asia – The 20<sup>th</sup> Century
- Paper 5 **DSE-B-1 SEM -5:** History of Modern East Asia – I China (c.1840 – 1949)
- Paper 6 **DSE-B-3 SEM -6:** History of Modern East Asia – II Japan (c.1868 – 1945)
- Paper 7 **DSE-A-2 SEM -5:** History of United States of America – I (c.1776 – 1945)
- Paper 8 **DSE-A-4 SEM -6:** History of United States of America – II (c.1776-1945)

**Skill Enhancement Courses SEC –A & B (Any Two) Choosing one from group-A and one from group-B) in Semester 3 and 4**

- SEC -A 1: **SEM-3** Archives and museums
- SEC -B 1: **SEM-4** Understanding Popular Culture
- SEC-A 2: **SEM-3** Understanding Heritage
- SEC-B 2: **SEM-4** Art Appreciation: an Introduction to Indian Art

**\*Generic Elective Courses (GE) - Same as Core courses (CC) offered in the BA General Syllabus.**

**Detailed Syllabus History Honours**  
**HIS-A CC –1- 14 TH&TU**  
**CC 1 : History of India From the earliest times to C 300 BCE**

**I. Reconstructing Ancient Indian History:**

- a) Early Indian notions of History
- b) Sources and tools of historical reconstruction.
- c) Historical interpretations (with special reference to gender, environment, technology and regions)

**II. Hunter-gatherers and the advent of food products**

- a) Paleolithic cultures- sequence and distribution; stone industries and other technological developments.
- b) Mesolithic cultures – regional and chronological distribution; new developments in technology and economy; rock art.
- c) Neolithic and Chalcolithic cultures: distribution and subsistence pattern

**III. The Harappan civilization:**

Origins; settlement patterns and town planning; agrarian base; craft productions and trade; social and political organization; religious beliefs and practices; art; the problem of urban decline and the late/post-Harappan traditions.

**IV. Cultures in transition**

Settlement patterns, technological and economic developments; social stratification; political relations; religion and philosophy; the Aryan problem.

- a) North India (circa 1500 BCE – 300 BCE)
- b) Central India and the Deccan (circa 1000 BCE – circa 300 BCE)

**Essential Readings**

Agarwal D.P, The Archaeology of India, London, 1982.  
Basham A.L, The Wonder That Was India, London, 1954.  
Chakrabarti Dilip Kumar, An Oxford Companion to Indian Archaeology, New Delhi, 2006.  
Chakrabarti Dilip Kumar, India, An Archaeological History, Delhi, 1999  
Sharma R.S, Looking for the Aryans, 1995.  
Sharma R.S, Material Cultures and Social Formations in Ancient India, New Delhi, 1983.  
Thapar Romila, Early India: From the Origins to AD 1300, London, 2002

**Suggested Readings**

Basham A.L ed. A Cultural History of India, New Delhi, 1975.  
Ghosh Amalananda, The City in Early Historic India, Shimla, 1973.  
Altekar A.S, The Position of Women in Hindu Civilization from Pre-historic times to the Present Day, New Delhi, 1962.  
Chattopadhyaya B.D, Studying Early India: Archaeology, Texts and Historical Issues. New Delhi, 2003.  
Sircar D.C, Indian Epigraphy, New Delhi, 1965.  
Kosambi D.D, An Introduction to the Study of Indian History, Bombay, 1956  
Kosambi D.D, Combined Methods in Indology and Other Writings, Edited and Introduced By B.D Chattopadhyaya  
Jha D.N, Ancient India: An Introduction, New Delhi, 1998  
Chattopadhyay D.P, Science and Society in Ancient India, Calcutta, 1977.  
Erdosy George, Urbanization in Early Historic India, Oxford, 1988.

Allchin F.R. (ed). The Archaeology of Early Historic South Asia: The Emergence of Cities and States, Cambridge, 1995.

Staal Frits, Discovering the Vedas : Origins, Mantras, Rituals Insights, New Delhi, 2008.

Possehl G.L, ed. Harappan Civilization- A Recent Perspective, Delhi, 1993 (second edition).

Michell George, The Penguin Guide to the Monuments of India. London, 1989.

Raychaudhuri H.C, Political History of Ancient India with a commentary by B.N.Mukherjee, New Delhi, 1996 (8th edition)

Habib Irfan (General Editor), A People's History of India (Volume 1,2,3), New Delhi.

Shastri K.A Nilakantha, A History of South India, Madras, 1974 (4th Edition)

Lahiri Nayanjyot, The Decline and Fall of the Indus Civilization, New Delhi, 2000.

Ray Nihar Ranjan, Brajadulal Chattopadhyaya, V.R. Mani and Ranabii Chakravarti eds. A Source Book of Indian Civilization, Kolkata, 2000.

Sahu Bhairabi Prasad (ed.). Iron and Social Change in Early India. New Delhi: Oxford University Press, 2006.

Chakraborty Ranabir, Exploring early India, upto circa AD 1300

Kochar R., The Vedic People, New Delhi. 2000.

Majumdar R.C (General Editor), The History & Culture of the Indian People, Volumes I – III, Bombay, 1951,1968, 1970

Sharma R.S, Advent of the Aryans, Manohar, 1999.

Sharma R.S, Aspects of Political Ideas and Institutions in Ancient India. New Delhi, 2005 (reprint).

Sharma R.S, India's Ancient Past, New Delhi, 2005.

Sharma R.S, Perspectives in the Social and Economic History of Early India, New Delhi, 1983.

Sharma R.S, Sudras in Ancient India.

Salomon Richard, Indian Epigraphy: A Guide to the Study of Inscriptions in Sanskrit, Prakrit, and Other Indo-Aryan Languages. New York, 1998.

Thapar Romila (et al). India: Historical Beginnings and the Concept of the Aryan, New Delhi, 2006

Thapar Romila, From Lineage to State, Delhi, 1996 (2nd Edition)

Ratnagar Shireen, (ed), Women in Early Indian Societies. New Delhi, 1999.

Ratnagar Shireen, The End of the Great Harappan Tradition, Delhi, 2000

Roy Kumkum, The Emergence of Monarchy in North India: eighth to fourth centuries BC, NewDelhi, 1994

Ratnagar Shireen, Understanding Harappa, Delhi 2001

Saraswati S.K, A Survey of Indian Sculpture, New Delhi, 1975 (second edition)

Bhattacharji Sukumar, Women and Society in Ancient India. Calcutta, 1994.

Singh Upinder, A History of Ancient and Early Medieval India. Delhi, 2008.

বাসাম এ এল, অতীতের উজ্জ্বল ভারত, (The Wonder That Was India), প্রগ্রেসিভ পাবলিশার্স, কলকাতা, ২০০৫

চক্রবর্তী রণবীর, ভারত ইতিহাসের আদি পর্ব, কলকাতা, ২০০৭

হাবিব ইরফান, ভারতবর্ষের সাধারণ মানুষের ইতিহাস

প্রথম খন্ড – প্রাক-ইতিহাস, (Pre-history) এন বি এ, কলকাতা, ২০০২

দ্বিতীয় খন্ড: সিন্ধু সভ্যতা, (The Indus Civilisation) এন বি এ, কলকাতা, ২০০২

তৃতীয় খন্ড – বৈদিক সভ্যতা, (The Vedic Age) এন বি এ, কলকাতা, ২০০২

ঝা ডি এন, আদি ভারত – একটি সংক্ষিপ্ত ইতিহাস, (Ancient India: An Introduction), প্রগ্রেসিভ পাবলিশার্স, কলকাতা

কোশাম্বী ডি ডি, ভারত ইতিহাস চর্চার ভূমিকা (An Introduction to the Study of Indian History) বাগচিকে পি এন্ড কোং, কলকাতা, ২০০২

রত্নাগর শিরিণ, হরপ্পা সভ্যতার সন্ধানে (Understanding Harappa) এন বি এ, কলকাতা, ২০০৩  
 রায়চৌধুরী হেমচন্দ্র, প্রাচীন ভারতের রাজনৈতিক ইতিহাস, (Political History of Ancient India),  
 পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা  
 থাপার রোমিলা, ভারতবর্ষের ইতিহাস, ওরিয়েন্ট লংম্যান, কলকাতা  
 ভট্টাচার্য নরেন্দ্রনাথ, প্রাচীন ভারতে ধর্ম, কলকাতা, ১৯৮৮  
 ভট্টাচার্য নরেন্দ্রনাথ, প্রাচীন ভারতীয় সমাজ, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা  
 ভট্টাচার্য সুকুমারী, ইতিহাসের আলোকে বৈদিক সাহিত্য, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা  
 ভট্টাচার্য সুকুমারী, প্রাচীন ভারত- সমাজ ও সাহিত্য, আনন্দ পাবলিশার্স, কলকাতা  
 চক্রবর্তী দিলীপ কুমার - ভারতবর্ষের প্রাক ইতিহাস আনন্দ পাবলিশার্স, কলকাতা, ১৯৯৯  
 গঙ্গোপাধ্যায় দিলীপ কুমার - ভারত ইতিহাসের সন্ধানে, (২ খন্ডে), ২০০৭  
 চক্রবর্তী রণবীর, প্রাচীন ভারতের অর্থনৈতিক ইতিহাসের সন্ধানে, আনন্দ পাবলিশার্স, কলকাতা ২০০২  
 (সংশোধিত সংস্করণ)  
 চানানা দেবরাজ, প্রাচীন ভারতে দাস প্রথা, (Slavery in Ancient India as depicted in Pali and  
 Sanskrit Texts), কে পি বাগচি এন্ড কোং, কলকাতা ১৯৯৫  
 রায় নীহাররঞ্জন, বাঙালির ইতিহাস, কলকাতা, ১৯৮০ (দ্বিতীয় সংস্করণ)  
 শর্মা রামশরণ, প্রাচীন ভারতে বস্তুগত সংস্কৃতি ও সমাজ সংগঠন, (Material Cultures and Social  
 Formations in Ancient India), ওরিয়েন্ট লংম্যান, ১৯৯৮  
 শর্মা রামশরণ, আদি মধ্যযুগের ভারতীয় সমাজ : সমস্ত-প্রক্রিয়া বিষয়ে এক সমীক্ষা (Early  
 Medieval Indian Society : A Study in Feudalism) ওরিয়েন্ট লংম্যান, ২০০৩  
 শর্মা রামশরণ, ভারতের সমাজতন্ত্র, (Indian Feudalism), কে পি বাগচি এন্ড কোং, কলকাতা  
 শর্মা রামশরণ, আর্যদের অনুসন্ধান, (Looking for the Aryans), প্রগ্রেসিভ পাবলিশার্স, কলকাতা  
 শর্মা রামশরণ, আর্যদের ভারতে আগমন, (Advent of the Aryans), ওরিয়েন্ট লংম্যান, ২০০১  
 শর্মা রামশরণ, প্রাচীন ভারতে শূদ্র, (Sudras in Ancient India), কে পি বাগচি এন্ড কোং, কলকাতা  
 থাপার রোমিলা, অশোক ও মৌর্যদের পতন, (Asoka and the Decline of the Mauryas), কে পি  
 বাগচি এন্ড কোং, কলকাতা  
 চট্টোপাধ্যায় সুনীল, প্রাচীন ভারতের ইতিহাস (১ম খন্ড), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, একাদশ  
 মুদ্রণ, এপ্রিল ২০০৪  
 চট্টোপাধ্যায় সুনীল, প্রাচীন ভারতের ইতিহাস (২য় খন্ড), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ৮ম মুদ্রণ,  
 ফেব্রুয়ারি ২০০৪  
 মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস (১ম খন্ড) (প্রাচীন ও মধ্যযুগ), পশ্চিমবঙ্গ রাজ্য  
 পুস্তক পর্ষদ, প্রথম মুদ্রণ নভেম্বর ১৯৯৭

## **CC-2 : Social Formations and Cultural Patterns of the ancient world other than India**

**I. Evolution of human kind:** Paleolithic and Mesolithic cultures – Role of kinship social institutions in the development of early societies.

**II. Food production :** beginnings of agriculture and animal husbandry.

**III. Bronze Age civilizations,** with reference to any one of the following : i) Egypt (Old Kingdom); ii) China (Shang), economy, social stratification, state structure, religion.

**IV. Nomadic groups in Central and West Asia;** Debate on the advent of iron and its implications.

**V. Slave society in ancient Greece & Rome:** agrarian economy, urbanization, trade.

**VI. Polis in ancient Greece:** Athens and Sparta; Greek culture.

### **Essential Readings**

Farooqui Amar, Early Social Formations. Manak Publications Pvt. Ltd. 2002

B.Fagan, People of the Earth. : an introduction to world prehistory

New York, NY HarperCollins College Publishers 1977

B.Trigger, Ancient Egypt : A Social History. Cambridge University Press, 1983

Bai Shaoyi, An Outline History of China. Beijing : Foreign Languages Press, 1982.

Burns and Ralph, World Civilisations.

Cambridge History of Africa, Vol.I. Cambridge University Press ,1982

G.Clark, World Prehistory: A New Perspective Cambridge University Press, 1977.

Jacquetta Hawkes, First Civilisations. life in Mesopotamia, the Indus Valley and Egypt. The history of human society. New York: Knopf, 1973.

M.I.Finley, The Ancient Economy. University of California Press 1999.

R.J.Wenke, Patterns in Prehistory Oxford University Press, USA; 5th edition 2006

UNESCO Series: History of Mankind, Vols. I –III/ or New ed. History of Humanity.1963

V.Gordon Childe, What happened in History. Peregrine Books 1985

### **Suggested Readings**

A.Hauser, A Social History of Art, Vol I. Routledge, 1999.

Glyn Daniel, First Civilisations. New. York: Thomas Y. Crowell (Apollo. Editions), 1968

J.D. Bernal, Science in History, Vol.I. Cambridge: The MIT Press, Massachusetts Institute of Technology, 1971

Salia Ikram, Death & Burial in Ancient Egypt (American University in Cairo Press, 2015)

V.Gordon Childe, Social Evolution.

Martin Bernal, Black Athena; the Afro Asiatic Roots of Classical Civilization Brunswick: Rutgers University Press, 1991.

গৰ্ডন চাইল্ড, সোশ্যাল ইভলিউশন, অসিত চৌধুৰী (ভাষান্তৰ), দীপায়ন, কলকাতা, ১৪০৫ বঙ্গাব্দ।

গৰ্ডন চাইল্ড, ম্যান মেক্স হিমসেলফ, মগন দাস (ভাষান্তৰ), দীপায়ন, কলকাতা, ১৯৯৯।

গৰ্ডন চাইল্ড, হোয়াট হ্যাপেনড ইন হিষ্ট্রি, দীপায়ন, কলকাতা।

জন ডেসমন্ড বার্নাল, ইতিহাসে বিজ্ঞান, আনন্দ, কলকাতা।

কুণাল চট্টোপাধ্যায় ও সুজাত ভদ্র, প্রাচীন গ্রীসের সমাজ ও স্নগস্কৃতি, প্রগ্রেসিভ, কলকাতা ।

সুপ্রতিম দাস, গ্রীস অনুসন্ধান, প্রগ্রেসিভ, কলকাতা ।



## **CC-3 : History of India C 300 BCE to C 750 CE**

### **I. Economy and Society (circa 300 BCE to circa CE 300)**

- a) Expansion of agrarian economy : production relations
- b) Urban growth: north India, central India and the Deccan; craft Production: trade and trade routes; coinage
- c) Social stratification: class, Varna, Jati, untouchability; gender; marriage and property relations.

### **II. Changing political formations (circa 300 BCE to circa CE 300) :**

- a) The Mauryan Empire
- b) Post-Mauryan Polities with special reference to the Kushanas and the Satavahanas; Gana-Sanghas

### **III. Towards early medieval India (circa CE fourth century to CE 750):**

- a) Agrarian expansion: land grants, changing production relations; graded land rights and peasantry.
- b) The problem of urban decline: patterns of trade, currency, and urban settlements.
- c) Varna, proliferation of Jatis: changing norms of marriage and property
- d) The nature of polities: the Gupta empire and its contemporaries: post-Gupta polities- Pallavas, Chalukyas, and Vardhanas.

### **IV. Religion, philosophy and society (circa 300 BCE – CE 750)**

- a) Consolidation of the Brahmanical tradition : dharma, Varnashram, Purushastras, Samskaras.
- b) Theistic cults (from circa second century BC): Mahayana; the Puranic tradition.
- c) The beginnings of Tantricism.

### **V. Cultural developments (circa 300 BCE to circa CE 750):**

- a) A brief survey of Sanskrit, Pali, Prakrit and Tamil literature. Scientific and technical treatises.
- b) Art and architecture and forms and patronage; Mauryan , Post-Mauryan, Gupta , Post-Gupta

### **Essential Readings**

- Chattopadhyaya B.D, The making of early Medieval India, 1994.  
Chattopadhyaya B.D, Bharatvarsha and other Essays, Permanent Black, Delhi, 2017.  
Chattopadhyaya D.P, History of Science and Technology in Ancient India, 1986.  
Chakravarti Ranabir, Exploring Early India upto AD 1300, Primus, Delhi, 2016.  
Huntington Susan, The Art of Ancient India: Buddhist, Hindu, and Jain, New York, 1985.  
Kosambi D.D, An Introduction to the Study of Indian History, 1975.  
Maity S.K, Economic Life in Northern India in the Gupta Period, 1970.  
Sahu B.P (ed.), Land System and Rural Society in Early India, 1997.  
Sastri K.A.N, A History of South India.  
Sharma R.S, Indian Feudalism, 1980.  
Sharma R.S, Urban Decay in India, c.300- c1000, Delhi, Munshiram Manohar Lal, 1987  
Singh Upinder, A history of Ancient and early Medieval India, 2008.  
Thapar Romila, Asoka and the Decline of the Mauryas, 1997

### **Suggested Readings**

- Agarwal Asvini, The Rise and Fall of the Imperial Guptas, New Delhi, 1988.  
Bhattacharya N.N, Ancient Indian Rituals and Their Social Contents, 2nd ed., 1996.  
Bhattacharya N.N, History of Tantric Religion, 1982

Chakravarti Uma, The Social Dimensions of Buddhism. New Delhi: Oxford University Press, 1987.

Chakravarti Uma, Trade and Traders in Early Indian Society, New Delhi, 2007 (revised edition)

Champakalakshmi R, Trade, Ideology and Urbanization: South India: 300BC to AD 1300, Delhi, 1996.

Chanana D., Slavery in Ancient India as Depicted in Pali and Sanskrit Texts, Delhi, 1960.

Gupta P.L, Coins, 4th ed., 1996.

Harle J.C, The Art and Architecture of the Indian Subcontinent, 1987.

Lahiri Nayanjot, Ashoka in Ancient India, 2015

Majumdar R.C and Altekar A.S eds. The Vakataka Gupta Age, Varanasi, 1955.

Mukherjee B.N, Kushana Studies, New Perspectives, Kolkata, 2004

Mukherjee B.N, The Character of the Maurya Empire, Kolkata, 2000

Mukherjee B.N, The Rise and Fall of the Kushana Empire, Calcutta, 1989.

Pollock Sheldon, The Language of the Gods in the World of Men. Sanskrit, Culture and Power in Pre-modern India. New Delhi, 2006.

Ray H.P, Winds of Change, 1994.

Ray Nihar Ranjan, Maurya and Post Maurya Art, New Delhi, 1975.

Sharma R.S, Perspectives in the Social and Economic History of Early India, New Delhi, 1983.

Shastri A.M ed. The Age of the Vakatakas, Delhi, 1992.

Singh Upinder, A History of Ancient and Early Medieval India. Delhi, 2008.

Smith Bardwell ed., Essays in Gupta Culture, New Delhi, 1983.

Thapar Romila, Asoka and the Decline of the Mauryas, New Delhi, 2000

Thapar Romila, Early India: From the origins to 1300, London, 2002

Thapar Romila, The Mauryas Revisited, Calcutta, 1987.

Veluthat Kesavan, The Early Medieval in South India, New Delhi, 2009

রোমিলা থাপার, অশোক ও মৌর্যদের পতন, (Asoka and the Decline of the Mauryas), কে পি বাগচি এন্ড কোং, কলকাতা

সুনীল চট্টোপাধ্যায়, প্রাচীন ভারতের ইতিহাস (১ম খন্ড), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, একাদশ মুদ্রণ, এপ্রিল ২০০৪

সুনীল চট্টোপাধ্যায়, প্রাচীন ভারতের ইতিহাস (২য় খন্ড), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ৮ম মুদ্রণ, ফেব্রুয়ারি ২০০৪

হীরেন্দ্রনাথ মুখোপাধ্যায়, ভারতবর্ষের ইতিহাস (১ম খন্ড) (প্রাচীন ও মধ্যযুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, প্রথম মুদ্রণ নভেম্বর ১৯৯৭

## **CC-4 : Social Formations and Cultural patterns of the Medieval World other than India**

- **CANDIDATES CAN CHOOSE EITHER GROUP- A OR B, GROUP –C IS COMPULSORY**

### **GROUP- A**

#### **I. Arabia: Bedouin Society:**

- a) Tribal Organization (families and clans)
- b) System of Alliances
- c) Economic Structure
- d) Language and poetry

#### **II. The Steppes:**

- a) A brief outline of Central Asia (Geography and History)
- b) Mongols :
  - (i) The strategic location of Mongolia;
  - (ii) Mongol Society: Tribal organization, different tribal formations, unification of the tribes under Chenghiz Khan
  - (iii) Brief outlines of the Mongol Empire: Case Study: The Golden Horde, Tatar rule in Russia
- c) The Turks:
  - (i) Conversion of the Turks to Islam from Buddhism
  - (ii) Brief history of the Seljuks and the Ottomans
  - (iii) The rise of the Ottoman Empire
  - (iv) Ottoman Society and Administration.

### **GROUP- B**

#### **III. Crisis of the Roman Empire and its principal causes: Historiography**

#### **IV. Religion and Culture in Medieval Europe:** Society, Religious organizations (Church and Monastery), Carolingian renaissance 12<sup>th</sup> century renaissance, Position of Women in Medieval Europe, Witchcraft and Magic, Urbanization, Rise of University, Medieval art and architecture.

#### **V. The feudal society its origins and its crisis: Historiography**

### **GROUP- C**

#### **VI. Judaism and Christianity under Islam**

#### **Essential Reading:**

- Ali, Syed Ameer, A Short History of the Saracens, Macmillan, 1900.
- Allsen, Thomas T., Culture and Conquest in Mongol Eurasia (Cambridge), Cambridge University Press, March 2004.
- Baker, Simon, Ancient Rome The Rise and Fall of an Empire, Ebury Publishing, 2006.
- Barthold, V., A Secret History of the Mongols, Cheng & Tsui Co, June 1999.
- Biran Michael, The Empire of the Qara Khitai in Eurasian History Between China and the Islamic World, Cambridge University Press, June 2008.
- Bloch, Marc, Feudal Society (2 Vols), Aakar Books, Revised Edition, July, 2017.
- Brundage (ed.), The Crusades, Marquette University Press, 1962.
- Burke, Edmund, III & Ira M. Lapidus, Islam, Politics and Social Movements, University of California Press, 1988.
- Burke, Peter, Popular Culture, Ashgate Publishing Ltd, 2009.

Cohen, Mark, *Under Crescent and Cross The Jews in the Middle Ages*, Princeton University Press, 2008.

Deansley, Margaret, *A History of Early Medieval Europe, 476 to 911*, Methuen, 1956.

Dobb, Maurice Dobb, *Studies in the Development of Capitalism*, Routledge, First Edition, March, 1965.

Goff, Le, *Medieval Civilizations (400-1500)*, Blackwell Publishing, August 1991.

Hitti, Philip K., *History of the Arabs*, Macmillan Education Ltd., First Edition, 1937.

Inalcik, Halil, *The Ottoman Empire*, Phoenix, December 2001.

Lewis, Bernard, *The Arabs in History*, Oxford University Press, 6<sup>th</sup> Edition, May 2002.

Lewis, Bernard, *The Jews of Islam*, 1984.

Man, John, *The Mongol Empire*, Penguin Random House, May 2015.

Pirenne, Heim, *Medieval Cities*, Princeton University Press, 1969.

Smith, Leslie and Leyser, Conrad; *Motherhood, Women and Society in Medieval Europe (400-1400)*, Ashgate Publishing Ltd, 2011.

Stuard, Susan Mosher (Ed.), *Women in Medieval History and Historiography*, University of Pennsylvania Press; New edition, December, 1988.

## **CC-5 : History of India (CE 750 – 1206)**

### **I. Studying Early Medieval India:**

Historical geography sources: texts, epigraphic and numismatic data. Debates on Indian Feudalism, rise of the Rajputs and the nature of the state.

### **II. Political Structures:**

- a) Evolution of political structures: Rashtrakutas, Palas, Pratiharas, Rajputs and Cholas.
- b) Legitimization of kingship; Brahmanas and temples; royal genealogies and rituals
- c) Arab conquest of Sindh : nature and impact of the new set-up; Ismaili Dawah
- d) Cause and consequences of early Turkish invasions : Mamud of Ghazna; Shahab-ud-Din of Ghur.

### **III. Agrarian structure and social change:**

- a) Agricultural expansion; crops
- b) Landlords and peasants
- c) Proliferation of castes: status of untouchables
- d) Tribes as peasants and their place in the Varna order

### **IV. Trade and Commerce**

- a) Inter-regional trade
- b) Maritime trade
- c) Forms of exchange
- d) Process of urbanization
- e) Merchant guilds of South India

### **V. Religious and Cultural developments:**

- a) Bhakti, Tantrism, Puranic traditions; Buddhism and Jainism; Popular religious cults.
- b) Islamic intellectual traditions: Al-Biruni; Al-Hujwiri
- c) Regional languages and literature

d) Art and architecture: Evolution of regional styles.

### **Essential Readings**

Chattopadhyaya, B.D, The Making of Early Medieval India, 1994.  
Karashima, N., South Indian History and Society (Studies from Inscriptions, AD 850 – 1800)  
Kulke, Hermann, ed., The State in India (AD 1000 – AD 1700)  
Sharma, R.S and Shrimali, K.M eds., Comprehensive History of India, Vol. IV (A & B)  
Sharma, R.S. Indian Feudalism (circa 300 – 1200)  
Singh, Vipul Interpreting Medieval India, Volume-I, Early Medieval, Delhi Sultanate and Regions (circa 750 – 1550 ), 2009.

### **Suggested Readings :**

Basham, A.L., (ed.), A Cultural History of India  
Basham, A.L., The Wonder that was India  
Bose Mandakranta (ed.), Faces of Feminine in Ancient Medieval and Modern India, New York, 2000  
Chakravarti Ranabir, Exploring Early India upto Circa AD 1300  
Chakravarti, R(ed.), Trade in Early India, Delhi  
Champalakshmi, R, Trade, Ideology and Urbanisation :South India 300 BC – AD 1300, Delhi, 1966  
Chandra, S, History of Medieval India (800 -1700)  
Chattopadhyay, B.D, Aspects of Rural settlements and Rural Society in Early Medieval India  
Chattopadhyay, B.D, Science and Society in Ancient India, Calcutta, 1977  
Chattopadhyay, B.D, Studying Early India: Archaeology, Texts and Historical Issues , New Delhi, 2003  
Chaudhuri, K.N, Trade and Civilisation in the Indian Ocean : An Economic History from the Rise of Islam to 1750  
Gopal Lalanji, The Economic Life of Northern India ,Varanasi, 1965  
Habib, Irfan, Economic History of Medieval India: A Survey, New Delhi, 2001  
Habib, Irfan, Medieval India: The Study of a Civilisation ,New Delhi, 2008  
Habib, Md. And Nizami KA (eds), A Comprehensive History of India Vol. V  
Habibullah, A.B.M, The Foundation of Muslim Rule in India  
Jackson, Peter, The Delhi Sultanate: A Political & Military History, Cambridge, 1999  
Jha D.N (ed), The Feudal Order, New Delhi, 2000  
Kulke, H., The State in India (1000- 1700)  
Majumdar R.C and Dasgupta K.K.(eds), A Comprehensive History of India Vol.III  
Majumdar R.C. et al (eds), History and Culture of the Indian People Vol. IV and Vol. V  
Meister M.M & Dhaky MA, Indian Temple Architecture, Delhi, 1983  
Mukherjee B.N, Post-Gupta Coinages of Bengal, Calcutta, 1989  
Mukhia, H., The Feudalism Debate  
Rakaswami Vijaya, Walking Naked: Women, Society, Spirituality in South India (Simla, 1997)  
Ray H.C, Dynastic History of Northern India (New Delhi, 1973)  
Ray Nihar Ranjan et al ed., A Source Book of Indian Civilisation (Kolkata, 2000)  
Rizvi, S.A.A, The Wonder that was India, Vol. II  
Roy Kumkum (ed), Women in Early Indian Societies (New Delhi, 1999)  
Sastri , K.A. Nilkanta, A History of South India from Prehistoric Times to the Fall of Vijaynagar,  
Sastri K.A. Nilkantha, The Cholas (Madras, 1975 [reprint])  
Sastri, K.A. Nilkanta (ed), A Comprehensive History of India Vol. II  
Sharma R.S, Early Medieval Indian Society: A Study in Feudalisation, Delhi, 2001.  
Sharma R.S, Indian Feudalism, University of Calcutta, 1965.

Sharma R.S, Perspectives in the Social and Economic History of Early India, New Delhi, 1983.  
 Sharma, R.S, Early Medieval Indian Society: A Study in Feudalisation (Delhi, 2001)  
 Sharma, R.S, Indian Feudalism  
 Singh Upinder ed., Rethinking Early Medieval India : A Reader, 2011  
 Singh Upinder, A History of Ancient and Early Medieval India. Delhi, 2008.  
 Thapar Romila, Early India: From the Origins to AD 1300, London, 2002  
 Thapar, R; Early India  
 Veluthat, K; The Political Structure of Early Medieval South India  
 India and the Expansion of Islam 7-11 century, 1990  
 Yadava, B.N.S, Society & Culture in North India in the 12th century  
 Yazdani, G., (ed), The Early History of the Deccan

বাসাম এ এল, অতীতের উজ্জ্বল ভারত, (The Wonder That Was India), প্রগ্রেসিভ পাবলিশার্স, কলকাতা, ২০০৫  
 মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস (১ম খন্ড) (প্রাচীন ও মধ্যযুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, প্রথম মুদ্রণ নভেম্বর ১৯৯৭  
 ভট্টাচার্য, নরেন্দ্রনাথ, ধর্ম ও সংস্কৃতিক: প্রাচীন ভারতীয় প্রেক্ষাপট  
 চক্রবর্তী রণবীর, প্রাচীন ভারতের অর্থনৈতিক ইতিহাসের সন্ধান, আনন্দ পাবলিশার্স, কলকাতা ২০০২  
 চক্রবর্তী রণবীর, ভারত ইতিহাসের আদি পর্ব, ওরিয়েন্ট লংম্যান, কলকাতা, ২০০৭  
 সেন সমরেন্দ্রনাথ, বিপ্লবের ইতিহাস, শৈব্যা প্রকাশন, ১৯৯৬  
 শর্মা রামশরণ, ভারতের সামন্ততন্ত্র, (Indian Feudalism), কে পি বাগচি এন্ড কোং, কলকাতা  
 শর্মা রামশরণ, আদি মধ্যযুগের ভারতীয় সমাজ: সামন্ত-প্রক্রিয়া বিষয়ে এক সমীক্ষা (Early Medieval Indian Society: A Study in Feudalisation), ওরিয়েন্ট লংম্যান, ২০০৩

## **CC-6 : Rise of the Modern West - I**

- I.** Transition Debate on transition from feudalism to capitalism: problems and theories.
- II**
  - a) The exploration of the new world: motives.
  - b.) Portugese and Spanish voyages.
- III.**
  - a) Renaissance : its social roots
    - b.) Renaissance humanism
    - c.) Rediscovery of classics
    - d.) Italian renaissance and its impact on art, culture, education and political thought.
    - e.) Its spread in Europe
- IV.**
  - a) Reformation movements: Origins & courses
    - b.) Martin Luther & Lutheranism
    - c.) John Calvin & Calvinism
    - d.) Radical reformation: Anabapists and Huguenots
    - e.) English reformation and the role of the state
    - f.) Counter Reformation
- V.**
  - a) Economic developments
    - b.) Shift of economic balance from the Mediterranean to the Atlantic
    - c.) Commercial Revolution
    - d.) Price Revolution
    - e.) Agricultural Revolution and the Enclosure Movement
- VI.**
  - a) Development of national monarchy
    - b.) Emergence of European state system

### **Essential Readings**

- Butterfield H., The Origins of Modern Science. The Macmillan Company. 1959
- Cipolla Carlo M., Fontana Economic History of Europe, Vols. II and III Collins/ Fontana Books; 1978
- Cipolla Carlo M., Before the Industrial Revolution, European Society and Economy, 1000-1700, W. W. Norton & Company; 3rd edition 1994
- Coleman D.C (ed.), Revisions in Mercantilism Methuen & Co, 1969.
- Davis Ralph, The Rise of the Atlantic Economics. Cornell University Press, 1973
- Dobb Maurice, Studies in the Development of Capitalism, International Publishers, 1947
- Parker G., Europe in Crisis, 1598-1648 Ithaca, N.Y. : Cornell University Press. 1980
- Parry, J.H., The Age of Reconnaissance University of California Press, 1981
- Phukan Meenaxi, Rise of the Modern West: Social and Economic History of Early Modern Europe. Laxmi Publications 2013
- Polinsky.V, war and Society in Europe, 1618-48 Cambridge University Press, 2008
- Rabb Theodore K., The Struggle for Stability in Early Modern Europe. Oxford University Press, 1975
- Scammell V., The First Imperial Age: European Overseas expansion, 1400-1715. Routledge, 2003

Vries Jan de, Economy of Europe in an Age of Crisis 1600-1750. New York: Cambridge University Press, 1976

### **Suggested Readings :**

- Anderson M.S, Europe in the Eighteenth Century Holt, Rinehart and Winston, 1961  
Anderson, Perry, The lineages of the Absolutist States. Verso, 1979  
Aston, T.H and Philipin C.H.E (eds.), The Brenner Debate: Agrarian Class Structure and Economic Development in Pre-Industrial Europe, Cambridge University Press, 2005.  
Bernal J.D, Science in History Cambridge: The MIT Press, 1954  
Burke, Peter, The Renaissance . Humanities Press International, 1987  
Camerson, Euan (ed.), Early Modern Europe: An Oxford History, Oxford University Press 2001.  
Dunn Rechard S., The Age of Religious Wars, 1559-1715, W.W.Norton & Company, 2004  
Elton, G.R., Reformation Europe, 1517-1559 Wiley, 1999  
Gilmore, M.P., The World of Humanism, 1453-1517 New York, Harper 1952  
Hall, R., From Galileo to Newton Courier Corporation, 1981  
Hill, Christopher, A century of Revolutions. Psychology Press, 2002  
Hilton, Rodney, Transition from feudalism to Capitalism, Aakar Books, 2006  
Koenigsberger, H.G and Mosse, G.L., Europe in the Sixteenth Century. Longmans, 1961  
  
Lee, Stephen J., Aspects of European History, 1494-1789 Routledge, 1982  
Parker, G. and Smith, L.M., General Crisis of the Seventeenth Century. Boston : Routledge & Kegan Paul, 1978.  
Pennington, D.H., Seventeenth Century Europe. Longman, 1972  
Rabb, Theodore K., The Struggle for Stability in Early Modern Europe. Oxford University Press, 1975  
Rice, Eugene F. and Grafton, Anthony, The Foundations of Early Modern Europe, 1460-1559, W.W.Norton & Company, 2004.  
The Cambridge Economic History of Europe, Vol.I, IV Cambridge University Press 1944  
The New Cambridge Economic History of Europe, Vol.I, VII.

ত্রিপাঠী অমলেশ, ইতালির রেনেসাঁস বাঙালির সংস্কৃতি, আনন্দ পাবলিশার্স, কলকাতা ১৯৯৪  
দাশগুপ্ত অশীন, ভারত মহাসাগরে বাণিজ্য ও রাজনীতি ১৫০০-১৮০০, আনন্দ পাবলিশার্স, কলকাতা, ১৯৯৯  
বার্নাল জে ডি, ইতিহাসে বিজ্ঞান, (Science in History), আনন্দ পাবলিশার্স, কলকাতা, ২০০৫  
সেন সমরেন্দ্র, বিজ্ঞানের ইতিহাস, শৈব্যা প্রকাশন, কলকাতা, ১৯৯৬  
ভট্টাচার্য স্নেহাদ্রি, ইংলন্ডের ইতিহাস (টিউডর যুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা, ১৯৯৫  
চক্রবর্তী ভাস্কর, চক্রবর্তী সুভাষ রঞ্জন এবং চট্টোপাধ্যায় কিংশুক, ইউরোপে যুগান্তর, নবভারতী প্রকাশনী, কলকাতা, ২০০৫  
মুখার্জী রীলা, রূপান্তরিত ইউরোপ (১০০ - ১৮০০), প্রগ্রেসিভ পাবলিশার্স, কলকাতা, ২০০৪



## **CC-7 : HISTORY OF INDIA (c.1206-1526)**

### **I. Interpreting the Delhi Sultanate:**

Survey of sources: Persian tarikh tradition; vernacular histories; epigraphy

### **II. Sultanate Political Structures:**

- a. Foundation, expansion and consolidation of the Sultanate of Delhi; the Khaljis and the Tughluqs; Mongol threat and Timur's invasion; Rise and fall of Syed dynasty; The Lodis; Conquest of Bahlul and Sikandar; Ibrahim Lodi and the battle of Panipat;
- b. Theories of Kingship; Ruling elites; Sufis, Ulama and the political authority; imperial monuments and coinage
- c. Emergence of provincial dynasties: Bahamanis, Vijayanagar, Gujarat, Malwa, Jaunpur and Bengal
- d. Consolidation of regional identities: regional art, architecture and literature

### **III. Society and Economy:**

- a. Iqta and the revenue-free grants
- b. Agriculture production; technology
- c. Changes in rural society; revenue systems
- d. Monetization; market regulations; growth of urban centres; trade and commerce; Indian Ocean trade

### **IV. Religion and Culture:**

- a. Sufi silsilas: Chishtis and Suhrawardis; doctrines and practices; social roles.
- b. Bhakti movements and monotheistic traditions in South and North India; Women Bhaktas; Nathpanthis; Kabir, Nanak and the Sant tradition
- c. Sufi literature; Malfuzat; Premakhayans
- d. Architecture of the Delhi Sultanate

### **ESSENTIAL READINGS:**

Asher, Catherine and Talbot Cynthia, India before Europe, Cambridge University Press, March 2006.

Chandra Satish, Medieval India I, Har Anand Publication, New Delhi, July 2007.

Habib Mohammad and Nizami K.A., eds, Comprehensive History of India, Vol. V, The Delhi Sultanate, People's Publishing House, 2<sup>nd</sup> Edition, 1992.

Hasan Mohibul, Historians of Medieval India, Meenakshi Prakashan, 1968.

Jackson Peter, The Delhi Sultanate, Cambridge University Press, Revised Edition, 2003.

Schomer, Karine, and McLeod W.H., (Eds), The Sants Studies in A Devotional Tradition of India, Motilal Banarsidas, Delhi, 1987.

Nizami K.A., Some Aspects of Religion and Politics in India During the 13<sup>th</sup> Century, Aligarh, 1961.

Raychaudhuri Tapan and Habib Irfan, (Eds), Cambridge Economic History of India, Vol. I: c. 1200 – c. 1750, Cambridge University Press, Cambridge, 1982, 1987 (reprint).

Rizvi S.A.A., A History of Sufism in India, Vol. I, Munshiram Manoharlal, New Delhi, 1978.

### **Suggested Readings**

Ashraf K.M, Life and Conditions of the People of Hindusthan (1250 – 1550), Gyan Publishing House, 2000.

Eaton, R.M, The Rise of Islam and the Bengal Frontier (1204- 1760), University of California Press, July 1996.

Habib, Irfan, Medieval India: The Study of a Civilization, National Book Trust, July 2008.

Karashima, Noboru, South Indian History and Society: studies from inscriptions, A.D. 850 - 1800, Oxford, 1984.

Karashima, Noboru, Towards a New Formation: South Indian Society under Vijayanagara, Oxford University Press, 1992.

Kumar Sunil, The Emergence of the Sultanate of Delhi, Permanent Black, Delhi, First edition, 2010.

Stein, Burton, Peasant State and Society in Medieval South India, Oxford University Press, Oxford, February 1995.

Sherwani, H.K., Joshi, P.M. (eds), The History of Medieval Deccan (1295 - 1724), Government of Andhra Pradesh, Hyderabad, 1973-74.

Singh, Vipul, Interpreting Medieval India, Volume-I, Early Medieval, Delhi Sultanate and Regions (circa 750 – 1550 ), Macmillan Publishers India Ltd, 2009.

Tripathi, R.P; Some Aspects of Muslim Administration, The Indian Press Ltd., 1936.

Wink, Andre, Al Hind; The Making of the Indo Islamic World, Volume I – Early Medieval, Brill Academic Publishers, 2<sup>nd</sup> Edition, 1991.

রায় মিহিরকুমার, ভারতের ইতিহাস (তুরক-আফগান যুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, দ্বিতীয় মুদ্রণ, ফেব্রুয়ারী ১৯৯২

হাবিব ইরফান, মধ্যযুগের ভারতের অর্থনৈতিক ইতিহাস, (Economic History of Medieval India: A Survey), প্রগ্রেসিভ পাবলিশার্স

হাবিব ইরফান, মধ্যকালীন ভারত ১-৪ খন্ড (Medieval India)কে পি বাগচি এন্ড কোং, কলকাতা

হাবিবুল্লাহ এ বি এম, ভারতে মুসলিম শাসনের প্রতিষ্ঠা ১২০৬-১২৯০, (The Foundation of Muslim Rule in India), প্রগ্রেসিভ পাবলিশার্স, কলকাতা

রায় অনিরুদ্ধ ও চট্টোপাধ্যায় রত্নাবলী, মধ্যযুগে বাংলার সমাজ ও সংস্কৃতি, কে পি বাগচি এন্ড কোং, কলকাতা ১৯৯২

রায় অনিরুদ্ধ, মধ্যযুগের ভারতের ইতিহাস: সুলতানি আমল, ওরিয়েন্ট লংম্যান, কলকাতা

করিম আব্দুল, বাংলার ইতিহাস: সুলতানি আমল, ঢাকা

## **CC-8 : Rise of the Modern West - II**

- I.** a) Printing Revolution.  
b) Revolution in war techniques
- II.** a.) Crisis in Europe in the 17<sup>th</sup> century  
b.) Its economic, social and political dimensions
- III.** a.) The English Revolution : major issues  
b.) Political and intellectual issues
- IV.** a.) Scientific Revolution  
b.) Emergence of scientific academies  
c.) Origins of Enlightenment
- Va.)** Mercantilism and European economics  
b.) Preludes to the Industrial Revolution
- VI. a.)** European Politics in the 17<sup>th</sup> & 18<sup>th</sup> Century  
b.) Parliamentary monarchy  
c.) patterns of Absolutism in Europe

### **Essential Readings**

Butterfield H., The Origins of Modern Science. The Macmillan Company. 1959  
Cipolla Carlo M., Fontana Economic History of Europe, Vols. II and III Collins/ Fontana Books; 1978  
Cipolla Carlo M., Before the Industrial Revolution, European Society and Economy, 1000-1700, W. W. Norton & Company; 3rd edition 1994  
Coleman D.C (ed.), Revisions in Mercantilism Methuen & Co, 1969.  
Davis Ralph, The Rise of the Atlantic Economics. Cornell University Press, 1973  
Dobb Maurice, Studies in the Development of Capitalism, International Publishers, 1947  
Parker G., Europe in Crisis, 1598-1648 Ithaca, N.Y. : Cornell University Press. 1980  
Parry, J.H., The Age of Reconnaissance University of California Press, 1981  
Phukan Meenaxi, Rise of the Modern West: Social and Economic History of Early Modern Europe. Laxmi Publications 2013  
Poliensky.V, war and Society in Europe, 1618-48 Cambridge University Press, 2008  
Rabb Theodore K., The Struggle for Stability in Early Modern Europe. Oxford University Press, 1975  
Scammell V., The First Imperial Age: European Overseas expansion, 1400-1715. Routledge, 2003  
Vries Jan de, Economy of Europe in an Age of Crisis 1600-1750. New York: Cambridge University Press, 1976

### **Suggested Readings :**

Anderson M.S, Europe in the Eighteenth Century Holt, Rinehart and Winston, 1961  
Anderson, Perry, The lineages of the Absolutist States. Verso, 1979  
Aston, T.H and Philipin C.H.E (eds.), The Brenner Debate: Agrarian Class Structure and Economic Development in Pre-Industrial Europe, Cambridge University Press, 2005.

Bernal J.D, Science in History Cambridge: The MIT Press, 1954  
 Burke, Peter, The Renaissance . Humanities Press International, 1987  
 Camerson, Euan (ed.), Early Modern Europe: An Oxford History, Oxford University Press 2001.  
 Dunn Rechard S., The Age of Religious Wars, 1559-1715, W.W.Norton & Company, 2004  
 Elton, G.R., Reformation Europe, 1517-1559 Wiley, 1999  
 Gilmore, M.P., The World of Humanism, 1453-1517 New York, Harper 1952  
 Hall, R., From Galileo to Newton Courier Corporation, 1981  
 Hill, Christopher, A century of Revolutions. Psychology Press, 2002  
 Hilton, Rodney, Transition from feudalism to Capitalism, Aakar Books, 2006  
 Koenigsberger, H.G and Mosse, G.L., Europe in the Sixteenth Century. Longmans, 1961

Lee, Stephen J., Aspects of European History, 1494-1789 Routledge, 1982  
 Parker, G. and Smith, L.M., General Crisis of the Seventeenth Century. Boston : Routledge & Kegan Paul, 1978.  
 Pennington, D.H., Seventeenth Century Europe. Longman, 1972  
 Rabb, Theodore K., The Struggle for Stability in Early Modern Europe. Oxford University Press, 1975  
 Rice, Eugene F. and Grafton, Anthony, The Foundations of Early Modern Europe, 1460-1559, W.W.Norton & Company, 2004.  
 The Cambridge Economic History of Europe, Vol.I, IV Cambridge University Press 1944  
 The New Cambridge Economic History of Europe, Vol.I, VII.

ত্রিপাঠী অমলেশ, ইতালির রেনেসাঁস বাঙালির সংস্কৃতি, আনন্দ পাবলিশার্স, কলকাতা ১৯৯৪  
 দাশগুপ্ত অশীন, ভারত মহাসাগরে বাণিজ্য ও রাজনীতি ১৫০০-১৮০০, আনন্দ পাবলিশার্স, কলকাতা, ১৯৯৯  
 বার্নাল জে ডি, ইতিহাসে বিজ্ঞান, (Science in History), আনন্দ পাবলিশার্স, কলকাতা, ২০০৫  
 সেন সমরেন্দ্র, বিজ্ঞানের ইতিহাস, শৈব্যা প্রকাশন, কলকাতা, ১৯৯৬  
 ভট্টাচার্য স্নেহাদ্রি, ইংলন্ডের ইতিহাস (টিউডর যুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা, ১৯৯৫  
 চক্রবর্তী ভাস্কর, চক্রবর্তী সুভাষ রঞ্জন এবং চট্টোপাধ্যায় কিংশুক, ইউরোপে যুগান্তর, নবভারতী প্রকাশনী, কলকাতা, ২০০৫  
 মুখার্জী রীলা, রূপান্তরিত ইউরোপ(১০০ - ১৮০০), প্রগ্রেসিভ পাবলিশার্স, কলকাতা, ২০০৪

## **CC-9 : History of India (c 1526 – 1605)**

### **I. Sources and Historiography:**

- a) Persian literary culture; translations; Vernacular literary traditions.
- b) Modern Interpretations

### **II. Establishment of Mughal rule:**

- a) India on the eve of Babur's Invasion
- b) Fire arms, military technology and warfare
- c) Humayun's struggle for empire
- d) Sher Shah and his administrative and revenue reforms

### **III. Consolidation of Mughal rule under Akbar:**

- a) Campaigns and conquests: tactics and technology
- b) Evolution of administrative institutions : Zabt, Masnab, Jagir, Madad-I-Maash
- c) Revolts and resistance

### **IV. Expansion and Integration:**

- a) Incorporation of Rajputs and other indigenous groups in Mughal nobility.
- b) North-West frontier, Gujarat and the Deccan
- c) Conquest of Bengal

### **V. Rural Society and Economy:**

- a) Land rights and revenue system; Zamindars and Peasants; rural tensions
- b) Extension of agriculture; agricultural production; crop patterns
- c) Trade routes and patterns of internal commerce; overseas trade; rise of Surat

### **VI. Political and religious ideals:**

- a) Inclusive political ideas: theory and practice
- b) Religious tolerance and Sulh-i-kul; Sufi mystical and intellectual interventions
- c) Pressure from the Ulama

### **Readings**

For readings – see the listing given in Paper -10

## **CC-10: History of India (c 1605 – 1750s)**

### **I. Sources: Persian and vernacular literary cultures, histories, memoirs and travelogues**

### **II. Political Culture under Jahangir and Shah Jahan**

- a) Extension of Mughal rule; changes in Mansab and Jagir systems; imperial culture
- b) Orthodoxy and syncretism – Naqshbandi Sufis, Miyan Mir, Dara Shukoh, Samrad

### **III. Mughal Empire under Aurangzeb**

- a) State and religion under Aurangzeb; issues in the war of succession; policies regarding religious groups and institutions
- b) Conquests and limits of expansion
- c) Beginning of the crisis: contemporary perceptions; agrarian and Jagir crises; revolts.

### **IV. Visual Culture: Paintings and Architecture**

### **V. Patterns of Regional Politics:**

- a) Rajput political culture and state formation
- b) Deccan kingdoms; emergence of the Marathas; Shiva; expansion under the Peshwas
- c) Mughal decline; emergence of successor states
- d) Interpreting eighteenth century India: recent debates

### **V. Trade and Commerce**

- a) Crafts and technologies; Monetary system
- b) Markets, transportation, urban centres
- c) Indian Ocean trade network

### **Essential Readings**

Alam Muzaffar and Subramaniam Sanjay , eds., The Mughal state, 1526-1750  
Ali Athar M., The Mughal Nobility under Aurangzeb  
Chandra Satish, Essays on Medieval Indian History  
Dasgupta Ashin, Indian Merchants and the Decline of Surat, 1700 – 1750  
Gordon Stewart, The Marathas 1600 – 1818  
Habib Irfan, Agrarian System of Mughal India, 1526 – 1701  
Koch Ebba, Mughal Art and Imperial Ideology  
Qanungo, K.R, Dara Shukoh  
Richards, J.F, The Mughal Empire  
Rizvi, S.A.A, Muslim Revivalist Movements in Northern India.

### **Suggested Readings**

Alam, Muzaffar-The Crisis of Empire in Mughal North India: Awadh and Punjab-1707-1748.  
Alavi, Seema (ed.), The Eighteenth Century in India  
Ali, M. Athar, Mughal India: Studies in Polity, Ideas, society and Culture.  
Arasaratnam S., Maritime India in the Seventeenth Century  
Asher Catherine, Architecture of Mughal India  
Bandyopadhyaya S, From Plassey to Partition  
Barnett, R.B, North India between Empires: Awadh, the Mughals and the British.  
Bashir, Ahmed, Akbar, the Mughal Emperor.  
Bayly, Susan, Caste, Society and Politics in India from the 18th century to the modern age.  
Bayly, C.A., Indian Society and the Making of the British Empire;  
Beach Milo, Mughal and Rajpur Paintings

Bernier, F, Travels in Mughal India.  
 Chandra Satish, Parties and Politics at the Mughal Court  
 Chandra, Satish, A History of Medieval India (Part II)  
 Chandra, Satish, Historiography, Religion and State in Medieval India  
 Chandra, Satish, Mughal Religious Policies, the Rajputs and the Deccan.  
 Chandra, Satish, The 18th century in India: Its economy and the Role of the Marathas, the jats and the Sikhs and the Afghans and Supplement (K.P.Bagchi)  
 Chaudhuri, K.N., Trade & Civilization: An Economic History from the Rise of Islam to 1750.  
 Eaton, R.M., The Rise of Islam and the Bengal Frontier 1204-1760;  
 Eaton, R.M., The Sufis of Bijapur  
 Fukuzawa, H., The Medieval Deccan: Peasants, Social systems and States 16th to 18th centuries.  
 Gordon S., The Marathas 1600-1818  
 Grewal J.S., The Sikhs of the Punjab  
 Habib Irfan (ed.), Medieval India  
 Habib Irfan (ed), Resistance and Modernization under Haider Ali and Tipu Sultan  
 Hasan S., Nurul, Thoughts on Agrarian Relations in Mughal India  
 Hasan S. Nurul, Religion, State, and Society in Medieval India  
 Husain Iqbal, Ruhela Chieftancies in 18th Century India  
 Kulke, H. (ed.), The State in India 1000-1700.  
 Malik, Z.U, The Reign of Muhammad Shah  
 Marshall P J., (Edited) , The Eighteenth century in Indian history: Evolution or revolution  
 Marshall P J., East Indian Fortunes: the British in Bengal in the 18th Cent,  
 Mukhia Harbans, The Mughals of India  
 Nizami K.A., (ed.) Politics and society during the early Medieval Period : The collected Works of Prof. Md. Habib (2 vols.)  
 Raychoudhuri T.K. & Habib I. (eds.)-The Cambridge Economic History of India Vol.1  
 Richards J.F., The Mughal Empire  
 Richards, J.F, Mughal Administration in Golconda  
 Rizvi S.A.A., A History of Sufism in India  
 Rizvi S.A.A., The Wonder that was India (vol.2);  
 Sarkar, Sir J.N., History of Aurangzeb 5 vols.  
 Sarkar, Sir J.N., The Fall of the Mughal Empire, 4 vols.  
 Siddiqi. N.A., Land Revenue Administration Under the Mughals (1700- 1750)  
 Stein, Burton, Eighteenth Century in India: Another view (Studies in History, No.I, 1989)  
 Stein, Burton, Peasant, State and Society in Medieval South India (Oxford University Press)  
 Streusand D.F., The Formation of the Mughal Empire  
 Tripathi R.P., Some Aspects of Muslim Administration  
 Tripathi R.P., The Rise & Fall of the Mughal Empire  
 Wink, Andre, Land and Sovereignty in India: Agrarian society and politics under the eighteenth century Maratha Swarajya.

আলি এম আখার, আওরঙ্গজেবের সময়ে মুঘল অভিজাত শ্রেণী (The Mughal Nobility under Aurangzeb) কে পি বাগচি এন্ড কোং, কলকাতা  
 বন্দ্যোপাধ্যায় শেখর, অষ্টাদশ শতকের মুঘল সংকট ও আধুনিক ইতিহাস চিন্তা, কলকাতা, ১৯৮৩  
 ভদ্র গৌতম, মুঘল যুগে কৃষি অর্থনীতি ও কৃষক বিদ্রোহ, সুবর্ণরেখা, কলকাতা, ১৯৮৩  
 চন্দ্র সতীশ, মুঘল দরবারে দল ও রাজনীতি, (Parties and politics at the Mughal Court 1707-1740) কে পি বাগচি এন্ড কোং, কলকাতা

চৌধুরী বিনয় ভূষণ ও অন্যান্যরা, বাংলার কৃষি সমাজের গঠন, কে পি বাগচি এন্ড কোং, কলকাতা

হাবিব ইরফান, মধ্যকালীন ভারত, খন্ড ১-৪, কে পি বাগচি এন্ড কোং, কলকাতা

হাবিব ইরফান, মুঘল সাম্রাজ্য ও তার পতন- একটি সমীক্ষা, পশ্চিমবঙ্গ ইতিহাস সংসদ, ২০০০

হাবিব ইরফান, মুঘল ভারতের কৃষি ব্যবস্থা, (The Agrarian System of Mughal India (1556-1707)), কে পি বাগচি এন্ড কোং, কলকাতা

হাবিব ইরফান, মধ্যযুগের ভারতের অর্থনৈতিক ইতিহাস, (Economic History of Medieval India: A Survey), প্রগ্রেসিভ পাবলিশার্স, কলকাতা, ২০০৯

হাবিব ইরফান, ভারতের ইতিহাস প্রসঙ্গ: মার্কসীয় চেতনার আলোকে (Essays in Indian History: Towards a Marxist Perception), ন্যাশনাল বুক এজেন্সি, কলকাতা, ১৯৯৯

রায় অনিরুদ্ধ, মধ্যযুগের ভারতের অর্থনৈতিক ইতিহাস, ১২০০-১৭৫৭, প্রগ্রেসিভ পাবলিশার্স, কলকাতা

রায় অনিরুদ্ধ, মুঘল যুগের অর্থনৈতিক ইতিহাস, কে পি বাগচি এন্ড কোং, কলকাতা

সরকার জগদীশ নারায়ণ, মুঘল অর্থনীতি: সংগঠন এবং কার্যক্রম, (Mughal Economy : Organisation and Working) পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা ১৯৯১

সিদ্দিকী নোমান আহমেদ, মোঘল রাজত্বে ভূমিরাজস্ব পরিচালন ব্যবস্থা (১৭০০ - ১৭৫০) (Land Administration Under the Mughals (1700 -1750) পার্ল পাবলিশার্স, কলকাতা, ১৯৮০

মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস (২য় খন্ড)

(মুঘল ও ব্রিটিশ ভারত, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা ১৯৯৮

চট্টোপাধ্যায় রত্নাবলী, মুঘল যুগের দরবারি চিত্রকলা, থীমা, কলকাতা



## **CC-11: History of Modern Europe (c.1780 – 1939)**

### **I. The French Revolution and its European repercussions:**

- a) Crisis of *ancien regime*
- b) Intellectual currents
- c) Social classes and emerging gender relations.
- d) Phases of the French Revolution
- e) Art and Culture of French Revolution
- f) Napoleonic consolidation – reform and empire.

### **II. Restoration and Revolution: c.1815 - 1848**

- a) Forces of conservatism and restoration of old hierarchies.
- b) Social, Political and intellectual currents.
- c) Revolutionary and Radical movements, 1830 -1848

### **III. Capitalist Industrialization and Social and Economic Transformation (Late 18<sup>th</sup> century to AD 1914)**

- a) Process of capitalist development in industry and agriculture: case studies of Britain, France, the German States and Russia.
- b) Evolution and Differentiation of social classes : Bourgeoisie, proletariat, Land Owning classes and peasantry.
- c) Changing trends in demography and urban patterns
- d) Family, gender and process of industrialization.

### **IV. Varieties of Nationalism and the Remaking of States in the 19<sup>th</sup> and 20<sup>th</sup> centuries.**

- a) Intellectual currents, popular movements and the formation of National identities in Germany, Italy, Ireland and the Balkans.
- b) Specifications of economic development, political and administrative Reorganization – Italy; Germany.
- c) Revolutions of 1905; the Bolshevik Revolution of 1917
- d) Programme of Socialist Construction and the Soviet Union during the inter-war period 1918-39.

### **V. Imperialism, War and Crisis: c.1880 - 1918**

- a) Theories and mechanisms of imperialism;
- b) Growth of Militarism;
- c) Power blocks and alliances;
- d) Expansion of European empires
- e) War of 1914 - 1918

### **VI. Europe between Two World Wars:**

- a) Post War Europe: A Diplomatic History
- b) The Great Depression
- c) Rise of Fascism in Italy and Nazism in Germany
- d) The Spanish Civil War
- e) Policy of Appeasement and Russo German Non-Aggression Pact
- f) Origins and Course of the Second World War

## **Essential Readings**

Brennan Gerald, The Spanish Labyrinth: An Account of the Social and Political Background of the Civil War.  
Cipolla C.M, Fontana Economic History of Europe, Volume III: The Industrial Revolution  
Davies Norman, Europe  
Evans J., The Foundations of a Modern State in 19<sup>th</sup> Century Europe  
Hamerow T.S, Restoration, Revolution and Reaction : Economics and Politics in Germany [1815 – 1871]  
Hobsbawm, E.J, The Age of Revolution  
Hunt Lynn, Politics, Culture and Class in the French Revolution  
Joll James, Europe Since 1870  
Landes David; Prometheus Unbound  
Lefebvre George, Coming of the French Revolution  
Lichteim, A Short History of Socialism  
Mathias Peter, First Industrial Revolution  
Nove, Alec; An Economic History of the USSR  
Porter Andrew, European Imperialism, 1876 – 1914  
Wood Anthony, History of Europe, 1815 – 1960  
Woolf Stuart, History of Italy, 1700 to 1860

## **Suggested Readings**

Barracclough G., An Introduction to Contemporary History  
Blanning, T.C.W, The French Revolution: Class War or Culture Clash  
Braudel Fernand, History and the Social Science in M. Aymard and Mukhia H. ed., French Studies in History, Vol.I (1989)  
Briggs Asa and Clavin Patricia, Modern Europe: 1789 – Present  
Calleo D, German Problem Reconsidered  
Carr E.H, International Relations between the Two World Wars  
Carr E.H, The Bolshevik Revolution (Vol. I, II, III)  
Cobban, Alfred, History of Modern France, Volume I – III  
Dobb Maurice, Soviet Economic Development since 1917  
Doyle, William, Origins of the French Revolution  
Droz. Jacques, Europe Between Revolutions  
Ellis G., The Napoleonic Empire  
Evans, J., The Foundations of a Modern State in 19<sup>th</sup> Century Europe  
Hamerow, T.S, Restoration, Revolution and Reaction : Economics and Politics in Germany (1815 – 1871)  
Hanham H.J, Nineteenth Century Constitution, 1815-1914  
Hobsbawm, E.J, Age of Capital  
Hobsbawm, E.J, Age of Empire  
Hobsbawm, E.J, Age of Revolution  
Hobsbawm, E.J, Nation and Nationalism  
Hufton, Olwen, Europe: Privilege and Protest  
Jelavich Charles and Jelavich Barbara, Establishment of the Balkan National States, 1840 – 1920  
Joll James, Europe Since 1870  
Joll James, Origins of the First World War, 1989  
Landes Jaon B., Women and the Public Sphere in the Age of the French Revolution  
Lee Stephen J., Aspects of European History 1789 – 1980  
Licas Colin, The French Revolution and the Making of Modern Political Culture

Lowenthal David, The Past is a Foreign Country  
 Lyon Martin, Napoleon Bonaparte & the Legacy of the French Revolution  
 Mansergh Nicholas, The Irish Question, 1840 – 1921  
 Morgan K.O, Oxford Illustrated History of Britain, Volume 3 (1789-1983)  
 Morgan R.P, German Social Democracy and the First International  
 Perrot M. and Duby G. [eds.], A History of Women in the West, Volumes 4 and 5  
 Renton Dave, Fascism: Theory and Practice  
 Riasanovsky N.V, A History of Russia  
 Robert J.M, Europe 1880 to 1985  
 Roth J.J (ed), World War I: A Turning Point in Modern History  
 Rude, George, Revolutionary Europe  
 Schamma Simon , Citizens: A chronicle of the French Revolution  
 Soboul Albert, History of the French Revolution (in two Volumes)  
 Stone Lawrence, History and the Social Sciences in the twentieth Century, The Past and the Present, 1981  
 Taylor A.J.P, Europe: Grandeur and Decline  
 Taylor A.J.P, The Course of German History  
 Taylor A.J.P, The Origin of the Second World War  
 Taylor, A.J.P, The Struggle for Mastery in Europe  
 Thompson Dorothy; Chartists: Popular Politics in the Industrial Revolution  
 Thompson, E.P, Making of the English Working Class  
 Thomson, David, Europe Since Napoleon  
 Vovelle Michael, Fall of the French Monarchy, 1984.  
 Watson H. Seton, The Russian Empire  
 Watson, Seton, The Russian Empire  
 Williams Raymond, Culture and Society

গৌতম চট্টোপাধ্যায় সম্পাদিত: দু'শো বছরের আলোকে, পশ্চিমবঙ্গ ইতিহাস সংসদ, ১৯৮৯  
 চক্রবর্তী সুভাষ রঞ্জন, ফরাসী বিপ্লব, পশ্চিমবঙ্গ পুস্তক পর্ষদ, কলকাতা  
 চক্রবর্তী সুভাষ রঞ্জন, ইউরোপের ইতিহাস, পশ্চিমবঙ্গ পুস্তক পর্ষদ, কলকাতা, ১৯৮৬  
 জ্যাকসন টি এ, ফরাসী বিপ্লব - দশ দিগন্ত, কে পি বাগচি এন্ড কোং, কলকাতা ২০০৪  
 টমসন ডেভিড, বিশ্ব ইতিহাসের প্রেক্ষাপটে ইউরোপ, ১ম খন্ড (১৭৮৯-১৮৫০), ২য় খন্ড (১৮৫১-১৯১৪) প্রগ্রেসিভ পাবলিশার্স, কলকাতা ২০০২ ও ২০০৩  
 রায় সিদ্ধার্থ গুহ, আধুনিক ইউরোপ: ফরাসী বিপ্লব থেকে দ্বিতীয় বিশ্বযুদ্ধ, প্রগতিশীল প্রকাশক, কলকাতা, ২০১৩

## **CC-12: History of India (c 1750s – 1857)**

### **I. India in the mid 18<sup>th</sup> Century; Society, Economy, Polity**

### **II. Expansion and Consolidation of Colonial Power :**

- a) Mercantilism, foreign trade and early forms of exactions from Bengal
- b) Dynamics of expansion, with special reference to Bengal, Mysore, Western India, Awadh, Punjab and Sindh.

### **III. Colonial State and Ideology:**

- a) Arms of the colonial state : army, police, law
- b) Ideologies of the Raj and racial attitudes.
- c) Education : indigenous and modern.

### **IV. Rural Economy and Society:**

- a) Land revenue systems and forest policy
- b) Commercialization and indebtedness
- c) Rural society : change and continuity.
- d) Famines
- e) Pastoral economy and shifting cultivation.

### **V. Trade and Industry**

- a) De industrialization
- b) Trade and fiscal policy
- c) Drain of Wealth
- d) Growth of modern industry

### **VI. Popular Resistance:**

- a) Santhal uprising (1857); Indigo rebellion (1860); Pabna Agrarian Leagues (1873); Deccan riots (1875)
- b) Uprising of 1857

### **Essential Readings**

Bayly C.A, Indian Society and the Making of the British Empire, New Cambridge History of India.

Bhattacharya, Sabyasachi.ed., Rethinking 1857, Delhi, Orient Longman, 2007

Chakravarty Suhash, The Raj Syndrome: A study in Imperial Perceptions, 1989

Chandra Bipan, Rise and Growth of Economic Nationalism in India

Choudhury, Sushil, Prelude to Empire Plassey Revolution of 1757, Delhi: Manohar, 2000

Cohn, B., Colonialism and its Forms of Knowledge, Princeton, New Jersey, Princeton University Press, 2001

Dirks, Nicholas B., Castes of Mind, Princeton, New Jersey, Princeton University Press, 1996

Ghosh Suresh Chandra, The History of Education in Modern India 1757-2012, Delhi, Orient Blackswan, 4<sup>th</sup> Edition, 2013

Grewal, J.S, The Sikhs of the Punjab, New Cambridge History of India

Guha Ranajit, ed., A Subaltern Studies Reader

Guha, Ranajit, Elementary Aspects of Peasant Insurgency in Colonial India, New Delhi, Oxford University Press, 1983

Kumar Dharma and Raychaudhuri Tapan, eds., The Cambridge Economic History of India, Vol.II

Majumdar, R.C,ed., History and Culture of Indian People, Vols. IX and X, British Paramountcy and Indian Renaissance.  
Marshall, P.J, Bengal: The British Bridgehead, New Cambridge History of India  
Metcalf, Thomas, Ideologies of the Raj, Cambridge, Cambridge University Press, 1995  
Ray, Rajat K., ed., Entrepreneurship and Industry in India, 1800-1947, Oxford In India Readings.  
Sinha, N.K.ed, The history of Bengal 1757-1905, Calcutta, Calcutta University Press, 1967  
Stokes, Eric, English Utilitarians and India  
Stokes, Eric, The Peasant Armed: The Indian Rebellion of 1857, ed. Bayly, C.A, New Delhi, Oxford University Press, 1986

### **Suggested Readings**

Arnold David and Guha Ramchandra , eds., Nature, Culture and Imperialism  
Bagchi, Amiya, Private Investment in India  
Chandra Bipan, Panikkar, K.K, Mukherjee Mridula, Mahajan Sucheta and Mukherjee Aditya, India's Struggles for Independence.  
Dadabhai Naroji, Poverty and Un-British Rule in India.  
Desai, A.R, Peasant Struggles in India  
Dutt, R.P, India today  
Fisher, M.J, ed., Politics of Annexation (Oxford in India Readings).  
Guha Ranajit, Elementary Aspects of Peasant Insurgency in Colonial India(1983)  
Krishnamurti, J., Women in Colonial India.

বন্দ্যোপাধ্যায় শেখর, অষ্টাদশ শতকের মুঘল সংকট ও আধুনিক ইতিহাস চিন্তা, কলকাতা, ১৯৮৩  
বন্দ্যোপাধ্যায় শেখর, পলাশী থেকে পার্টিশন: আধুনিক ভারতের ইতিহাস, ওরিয়েন্ট লংম্যান, ২০০৪  
ভট্টাচার্য্য সব্যসাচী, ঔপনিবেশিক ভারতের অর্থনীতি, কলকাতা, ২০০০  
সুনীল সেন, ভারতে কৃষিকার্য ১৭৯৩-১৯৪৭, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৫  
চৌধুরী বিনয় ভূষণ, ঔপনিবেশিক আমলে বাংলার কৃষি ইতিহাস, কে পি বাগচি এন্ড কোং, কলকাতা  
ইসলাম, সিরাজুল, বাংলার ইতিহাস ঔপনিবেশিক শাসনকার্যামো, চয়নিকা, ঢাকা, ২০০২  
চক্রবর্তী মৃণাল, সিরাজ-উদ্-দৌলা, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা, ১৯৮১  
রায় রজতকান্ত, পলাশীর ষড়যন্ত্র ও সেকালের সমাজ, আনন্দ পাবলিশার্স, কলকাতা  
চৌধুরী সুশীল, পলাশীর অজানা কাহিনী, আনন্দ পাবলিশার্স, কলকাতা

## **CC-13 : History of India (c. 1857 – 1964)**

### **I. Cultural changes and Social and Religious Reform Movements:**

- a) Growth of a new intelligentsia – the Press and Public Opinion
- b) Reform and Revival : Brahmo Samaj, Prarthna Samaj, and Ramakrishna and Vivekananda, Arya Samaj, Wahabi, Deoband, Aligarh and Singh Sabha Movements.
- c) Debates around gender
- d) Making of religious and linguistic identities
- e) Caste : Sanskritising and anti Brahminical trends

### **II. Nationalism : Trends up to 1919**

- a) Formation of early political organizations
- b) Moderates and extremists
- c) Swadeshi movement
- d) Revolutionaries

### **III. Gandhian nationalism after 1919 : Ideas and Movements:**

- a) Mahatma Gandhi : his Perspectives and Methods
- b) i) Impact of the First World War
- ii) Rowlatt Satyagraha and Jalianwala Bagh
- iii) Non-Cooperative and Civil Disobedience
- iv) Provincial Autonomy, Quit India and INA
- c) Left wing movements
- d) Princely India : States people movements

### **IV. Nationalism and Social Groups : Interfaces:**

- a) Landlords, Professionals and Middle Classes
- b) Peasants
- c) Tribals
- d) Labours
- e) Dalits
- f) Women
- g) Business groups

### **V. Communalism : Ideologies and practices, RSS , Hindu Maha Sabha, Muslim League**

### **VI. Independence and Partition**

- a) Negotiations for independence and partition
- b) Popular movements
- c) Partition riots

### **VII. Emergence of a New State:**

- a) Making of the Constitution
- b) Integration of princely states
- c) Land reform and beginnings of planning
- d) The Nehru years.

## Essential Readings

Bandyopadhyay Sekhar, From Plassey to Partition and After  
Brass Paul, The Politics of India since Independence, OUP, 1990  
Brown Judith, Gandhi's rise to power, 1915-22  
Brown Judith, Gandhi and Civil Disobedience  
Brown Judith, Nehru : A political Life. New Delhi: Oxford University Press 2003  
Chandra Bipan, et Al., India's Struggle for Independence  
Chandra Bipan, et Al. India after Independence  
Chandra Bipan, Communalism in Modern India (2<sup>nd</sup> Ed., 1987)  
Chandra Bipan, Nationalism and Colonialism in Modern India ( 1979)  
Chandra Bipan, Rise and Growth of Economic Nationalism in India  
Chatterjee Joya, Bengal Divided : Hindu Communalism and Partition 1932 – 1947, O.U.P, 1994  
Desai, A.R, Social Background to Indian Nationalism  
Desai, A.R Peasant Struggles in India  
Dutta, R.P, India Today  
Gallagher J., Johnson, G. Seal, A Locality, Province and Nation  
Hardy Peter, Muslims of British India  
Heimsath Charles, Indian Nationalism and Hindu Social Reform  
Hassan Mushirul ed., India's Partition, Oxford in India Readings  
Hutchins F., Illusion of Permanence  
Kumar Ravinder, Social History of Modern India  
Krishnamurty J., Women in Colonial India  
Low D.A (ed.) Congress and the Raj  
McLane J.R, Indian Nationalism and Early Congress  
Pandey Gyanendra, The Construction of Communalism in Colonial North India  
Sarkar Sumit , Swadeshi Movement in Bengal  
Sarkar Sumit, Modern India, 1885-1947  
Sarkar Susobhan, Notes on Bengal Renaissance  
Seal Anil, Emergence of Indian Nationalism  
Sen S.N, An Advanced History of Modern India, Kolkata, 2010  
Stokes Eric, Peasants and the Raj : Studies in Agrarian Society and Peasant Rebellion in Colonial India  
Tripathi Amal, The Extremist Challenge  
Zelliot Eleanor, From Untouchables to Dalit : Essays on the Ambedkar Movement

বন্দ্যোপাধ্যায় শেখর, পলাশি থেকে পার্টিশান ও তারপর (From Plassey to Partition and after),  
ওরিয়েন্ট লংম্যান  
চন্দ্র বিপান এবং অন্যান্য, ভারতের স্বাধীনতা সংগ্রাম, (India's Struggle for Independence) কে পি  
বাগচি এন্ড কোং, কলকাতা  
চন্দ্র বিপান এবং অন্যান্য, ভারতবর্ষ - স্বাধীনতার পরে, (India after Independence), আনন্দ  
পাবলিশার্স, কলকাতা  
দেশাই এ আর, ভারতীয় জাতীয়তাবাদের সামাজিক পটভূমি, (Social Background to Indian  
Nationalism) কে পি বাগচি এন্ড কোং, কলকাতা  
জয়া চ্যাটার্জী, বাংলা ভাগ হল: হিন্দু সাম্প্রদায়িকতা ও দেশ-বিভাগ, ১৯৩২-১৯৪৭  
(Bengal Divided : Hindu Communalism and Partition 1932 – 1947) এল আলমা পাবলিকেশনস,  
কলকাতা, ২০০৩

দত্ত রজনী পাম, আজিকার ভারত (India Today)

সরকার সুশোভন, বাংলার রেনেসাঁস, (Notes on Bengal Renaissance), দীপায়ন, কলকাতা  
ত্রিপাঠী অমলেশ, ভারতের মুক্তিসংগ্রামে চরমপন্থী পর্ব, (The Extremist Challenge) আনন্দ  
পাবলিশার্স, কলকাতা

মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস (২য় খন্ড) (মুঘল ও ব্রিটিশ ভারত) পশ্চিমবঙ্গ রাজ্য  
পুস্তক পর্ষদ, ৪র্থ মুদ্রণ, ১৯৯৮

সুর নিখিল, ভারতীয় জাতীয়তাবাদী আন্দোলনের পটভূমি, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৯  
চট্টোপাধ্যায় প্রণবকুমার, আধুনিক ভারত (১৮৫৮-১৯২০) (১ম খন্ড) পশ্চিমবঙ্গ রাজ্য পুস্তক  
পর্ষদ, ১৯৯৮

চট্টোপাধ্যায় প্রণবকুমার, আধুনিক ভারত (১৯২০-১৯৪৭) (২য় খন্ড) পশ্চিমবঙ্গ রাজ্য পুস্তক  
পর্ষদ, ১৯৯৯

সেন সুনীল, ভারতে কৃষিসম্পর্ক (১৭৯৩-১৯৪৭) (Agrarian Relations in India (1793-1847)  
পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৫

ত্রিপাঠী অমলেশ, স্বাধীনতা সংগ্রামে ভারতের জাতীয় কংগ্রেস, আনন্দ পাবলিশার্স, কলকাতা  
চন্দ্র বিপান, আধুনিক ভারতঃ ঔপনিবেশিকতাবাদ ও জাতীয়তাবাদ (Nationalism and Colonialism),  
কে পি বাগচি এন্ড কোং, কলকাতা



## **CC-14 : History of World Politics: 1945-1994**

- I. The Cold War: Weakening of European balance of power: Origins of The Cold War: Yalta and Potsdam Conferences; End of wartime alliance.
- II. The USA in World Politics: Truman Doctrine, Marshall Plan, NATO.
- III. The USSR in World Politics: Molotov Plan, COMECON and Cominform; Sovietisation of Eastern Europe; Berlin Blockade; Warsaw Pact.
- IV. Manifestation of Cold War: The Korean Crisis- End of French Colonial rule in Indo-China and the Vietnam War – Cuban Crisis.
- V. De-Stalinisation; Thaw in Cold War; Détente and road to the ending of Cold War.
- VI. Disintegration and Decline of the Soviet Union – Glasnost and Perestroika – Crisis of Socialist regimes in other East European Countries: Poland, Germany, Czechoslovakia, Hungary – Response of the USA; Rise of a Unipolar World system, Globalization.
- VII. Emergence of the People's Republic of China – China and the USA – Sino-Soviet rift.
- VIII. West Asian Crisis – Palestine and Western Powers – Birth of Israel – Arab-Israel Conflict –The Suez Crisis (1956); Origin and Formation of PLO; Yom Kippur War(1973) ; Camp David Accord(1979); Oslo Peace Accord(1993).
- IX. Decolonization: The African Case Study: Ghana, Algeria, Congo, Kenya.
- X. Protest Politics: Civil Rights Movement, Anti-Apartheid Movement and the end of Apartheid (1994), Second Wave Feminist Movement.

### **Selected Readings**

Asa Briggs and Patricia Clavin, *Modern Europe 1789 – Present*, Delhi, 2009.

Peter Calvocoressi, *World Politics 1945 – 2000*, New Delhi, 2006.

Edward Crankshaw, *The New Cold War : Moscow vs. Peking*, Penguin Books, 1963.

Issac Dentscher, *Russia, China, and the West*, Penguin Books, 1949.

Eric Hobsbawm, *The Age of Extremes : The Short Twentieth Century*, London, 1994.

Eric Hobsbawm, *Globalisation, Democracy and Terrorism*, London, 2007.

Henry Heller, *The Cold War and the New Imperialism*, New York, 2007.

Wayne C. Mcwilliam and Harry Piotrowsky, *The World since 1945: A History of International Relations*, New Delhi, 2018.

Andreas Wenger and Doron Zimmermann, *International Relations From the Cold War to the Globalized World*, New Delhi, 2010.

John Merriman, *A History of Modern Europe From Renaissance to the Present*, London, 1996.

Norman Lowe, Mastering Modern World History, Hampshire, Palgrave Macmillan 2013.

Kathleen A. Laughlin and Jacqueline L. Castledine, Breaking the wave : women, their organizations, and feminism, 1945-1985 New York : Routledge, 2011.

Wini Breines, Trouble Between Us: an Uneasy History of White and Black Women in the Feminist Movement New York : Oxford University Press, 2006.

Gail Collins, When Everything Changed: the Amazing Journey of American Women from 1960 to the Present, New York : Little, Brown and Co., 2009.

P. Eric Louw , The Rise, Fall, and Legacy of Apartheid, Praeger, 2004

Ryan M. Irwin Gordian Knot: Apartheid and the Unmaking of the Liberal World Order, Oxford University Press, 2012

Mark Newman , The Civil Rights Movement , Edinburgh University Press, 2004

চক্রবর্তী রাধারমণ ও চক্রবর্তী সুকল্পা, সমসাময়িক আন্তর্জাতিক সম্পর্ক , প্রগ্রেসিভ পাবলিশার্স, কলিকাতা।

চট্টোপাধ্যায় প্রণবকুমার, আন্তর্জাতিক সম্পর্কের ইতিহাস, কলিকাতা ১৯৯৪।

# Discipline Specific Elective: DSE TH&TU

## Paper 1 DSE-A-1 SEM -5: History of Bengal (c.1757-1905)

- I. Political history of Bengal under the Nawabs: Rise of British power in Bengal from the battle of Plassey to Buxar.
- II. Administrative history: 1765--1833
- III. Colonial economy: - Agriculture, trade and industry.
- IV. Cultural changes and Social and Religious Reform Movements: Christian missionaries- The advent of printing and its implications, education: Indigenous and western - Hindu and Muslim religious revivalist movements.
- V. Social Reforms and the women's question.
- VI. Protest movements and insurgencies against the Raj: The Fakir and Sannyasi revolts, Indigo Revolt (1859-1860), Pabna Peasant Uprisings (1873-76)
- VII. Partition of Bengal 1905: Curzon and the administrative blueprint.

### Select Readings:

Bandyopadhyay, Sekhar. From Plassey to Partition: A History of Modern India. New Delhi: Orient Blackswan , 2004

Banerjee Dube, Ishita. A History of Modern India. Cambridge University Press, 2015

Bayly C.A., Indian Society and the Making of the British Empire Cambridge University Press, 1995

Choudhary Sushil, Prelude to Empire: Plassey Revolution of 1757. Delhi: Manohar, 2000.

Ghosh, Suresh Chandra. The History of Education in Modern India, 1757 - 2012 Delhi: Orient Blackswan , Edition4, 2013

Guha, Ranajit . Elementary Aspects of Peasant Insurgency in Colonial India. New Delhi: Oxford University Press, 1983.

Islam, Sirajul ed. History of Bangladesh 1704-1971 (Vols. I,II & III) Dhaka: Asiatic Society of Bangladesh, 1997

Khan Abdul Majed, Muhammad Reza Khan and the Transition in Bengal . Cambridge University Press, 1969

Kopf David, British Orientalism and the Bengal Renaissance: The Dynamics of Indian Modernization, 1773-1835 University of California Press, 1969

Kopf David, The Brahmo Samaj and the Shaping of the Modern Indian Mind. Atlantic Publishers 1979.

Marshall P.J, Bengal the British Bridgehead Bengal: The British Bridgehead: Eastern India 1740-1828. Cambridge University Press. 1987

Metcalfe, Thomas, Ideologies of the Raj. Cambridge: Cambridge University Press, 1995.

Sinha, N.K. ed. The history of Bengal 1757- 1905 Calcutta: Calcutta University Press, 1967

বন্দ্যোপাধ্যায় শেখর, পলাশি থেকে পার্টিশান, ওরিয়েন্ট লংম্যান  
চন্দ্র বিপান এবং অন্যান্য, ভারতের স্বাধীনতা সংগ্রাম, কে পি বাগচি এন্ড কোং, কলকাতা  
চন্দ্র বিপান এবং অন্যান্য, ভারতবর্ষ – স্বাধীনতার পরে, , আনন্দ পাবলিশার্স, কলকাতা  
চন্দ্র বিপান, আধুনিক ভারত: ঔপনিবেশিকতাবাদ ও জাতীয়তাবাদ, কে পি বাগচি এন্ড কোং,  
কলকাতা

চ্যাটার্জী জয়া, বাংলা ভাগ হোল: হিন্দু সাম্প্রদায়িকতা ও দেশ-বিভাগ, ১৯৩২-১৯৪৭। এল আলমা  
পাবলিকেশনস, কলকাতা, ২০০৩

দেশাই এ আর, ভারতীয় জাতীয়তাবাদের সামাজিক পটভূমি, কে পি বাগচি এন্ড কোং, কলকাতা

দত্ত রজনী পাম, আজিকার ভারত সরকার সুশোভন, বাংলার রেনেসাঁস, দীপায়ন, কলকাতা  
ত্রিপাঠী অমলেশ, স্বাধীনতা সংগ্রামে ভারতের জাতীয় কংগ্রেস ১৮৮৫-১৯৪৭। কলকাতা আনন্দ  
পাবলিশার্স, ২০১২।

ত্রিপাঠী অমলেশ, ভারতের মুক্তিসংগ্রামে চরমপন্থী পর্ব, আনন্দ পাবলিশার্স, কলকাতা  
মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস(২য় খন্ড) (মুঘল ও ব্রিটিশ ভারত) পশ্চিমবঙ্গ রাজ্য  
পুস্তক পর্ষদ, ৪র্থ মুদ্রণ, ১৯৯৮

সুর নিখিল, ভারতীয় জাতীয়তাবাদী আন্দোলনের পটভূমি, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৯  
চট্টোপাধ্যায় প্রণবকুমার, আধুনিক ভারত (১৮৫৮-১৯২০) (১ম খন্ড) পশ্চিমবঙ্গ রাজ্য পুস্তক  
পর্ষদ, ১৯৯৮

চট্টোপাধ্যায় প্রণবকুমার, আধুনিক ভারত (১৯২০-১৯৪৭) (২য় খন্ড) পশ্চিমবঙ্গ রাজ্য পুস্তক  
পর্ষদ, ১৯৯৯

সেন সুনীল, ভারতে কৃষিসম্পর্ক(১৭৯৩-১৯৪৭) পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৫

ত্রিপাঠী অমলেশ, স্বাধীনতা সংগ্রামে ভারতের জাতীয় কংগ্রেস, আনন্দ পাবলিশার্স, কলকাতা

## Paper 2 DSE-A-3 SEM -6: History of Bengal (c.1905-1947)

- I. Partition of Bengal and Swadeshi Movement (1905-08) Political ideology and organizations, rise of Extremism in Bengal, Swadeshi movement, Revolutionary terrorism.
- II. Communal Politics: 1906- 30 Birth of Muslim League, and the Hindu response.
- III. Gandhian nationalism after 1919, Non- Cooperation and Khilafat movement, Swaraj party, Civil Disobedience movement, Revolutionary Nationalists and the beginnings of Left politics in the 1920s, Rise of Krishak Praja Party, Muslim League in Bengal politics.
- IV. Government of India Act 1935 and its aftermath:
- V. Peasant Movements in Bengal 1920-1946, Labour Movement in Bengal 1920-1946, Caste Movement in Bengal 1920-1946, Women's Movements in Bengal 1920-1946.
- VI. Subhash Chandra Bose and the Congress, Quit India Movement in Bengal, Post war upsurges in Bengal- Left wing movements.
- VIII. Independence and Partition: Communal Riots, the great Calcutta killing and Noakhali riots, Hindu Mahasabha, Muslim League, freedom and Partition, Birth of West Bengal and East Pakistan.

### Select Readings:

Bhattacharya Sabyasachi , The Defining Moments in Bengal 1920–1947 New Delhi: Oxford University Press, 2014.

Brown Judith, Gandhi's rise to Power, 1915-22. Cambridge University Press, 1974

Brown Judith, Gandhi: A Prisoner of Hope. Yale University Press, 1991

Chandra Bipan, Panikkar K.N., Mukherjee Mridula, Mahajan Sucheta and Mukherjee Aditya, India's, Struggles for Independence.

Hiren Chakrabarty, Political Protest In Bengal : Boycott and Terrorism 1905-1918 Papyrus, Calcutta

Das Suranjan, Communal Riots in Bengal 1905-47, Oxford University Press, OUP 1991, 1993

Sarkar Sumit, Modern India, 1885-1947. Macmillan Publishers India Publication, 2000.

Sarkar Sumit , The Swadeshi Movement in Bengal 1903-1908 New Delhi: People's Publishing House, 1973

Tripathi Amallesh, The Extremist Challenge: India between 1890 and 1910 Orient Longmans, 1967.

বন্দ্যোপাধ্যায় শেখর, পলাশি থেকে পার্টিশান, ওরিয়েন্ট লংম্যান

চন্দ্র বিপান এবং অন্যান্য, ভারতের স্বাধীনতা সংগ্রাম, কে পি বাগচি এন্ড কোং, কলকাতা

চন্দ্র বিপান এবং অন্যান্য, ভারতবর্ষ – স্বাধীনতার পরে, , আনন্দ পাবলিশার্স, কলকাতা

চন্দ্র বিপান, আধুনিক ভারতঃ ঔপনিবেশিকতাবাদ ও জাতীয়তাবাদ, কে পি বাগচি এন্ড কোং, কলকাতা

চ্যাটার্জী জয়া, বাংলা ভাগ হোল: হিন্দু সাম্প্রদায়িকতা ও দেশ-বিভাগ, ১৯৩২-১৯৪৭। এল আলমা পাবলিকেশনস, কলকাতা, ২০০৩

দেশাই এ আর, ভারতীয় জাতীয়তাবাদের সামাজিক পটভূমি, কে পি বাগচি এন্ড কোং, কলকাতা

দত্ত রজনী পাম, আজিকার ভারত সরকার সুশোভন, বাংলার রেনেসাঁস, দীপায়ন, কলকাতা  
ত্রিপাঠী অমলেশ, স্বাধীনতা সংগ্রামে ভারতের জাতীয় কংগ্রেস ১৮৮৫-১৯৪৭। কলকাতা আনন্দ  
পাবলিশার্স, ২০১২।

ত্রিপাঠী অমলেশ, ভারতের মুক্তিসংগ্রামে চরমপন্থী পর্ব, আনন্দ পাবলিশার্স, কলকাতা  
ভট্টাচার্য্য সব্যসাচী, বাংলায় সন্ধিক্ষণ: ইতিহাসের ধারা ১৯২০-৪৭। অক্সফোর্ড ইউনিভার্সিটি প্রেস:  
২০১৮।

মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস(২য় খন্ড) (মুঘল ও ব্রিটিশ ভারত) পশ্চিমবঙ্গ রাজ্য  
পুস্তক পর্ষদ, ৪র্থ মুদ্রণ, ১৯৯৮

সুর নিখিল, ভারতীয় জাতীয়তাবাদী আন্দোলনের পটভূমি, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৯  
চট্টোপাধ্যায় প্রণবকুমার, আধুনিক ভারত (১৮৫৮-১৯২০) (১ম খন্ড) পশ্চিমবঙ্গ রাজ্য পুস্তক  
পর্ষদ, ১৯৯৮

চট্টোপাধ্যায় প্রণবকুমার, আধুনিক ভারত (১৯২০-১৯৪৭) (২য় খন্ড) পশ্চিমবঙ্গ রাজ্য পুস্তক  
পর্ষদ, ১৯৯৯

সেন সুনীল, ভারতে কৃষিসম্পর্ক(১৭৯৩-১৯৪৭) পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৫

ত্রিপাঠী অমলেশ, স্বাধীনতা সংগ্রামে ভারতের জাতীয় কংগ্রেস, আনন্দ পাবলিশার্স, কলকাতা

## **Paper 3 DSE-B-2 SEM -5: History of Southeast Asia – The 19<sup>th</sup> Century**

### **I. Pre-Colonial Structures of Power and Authority c.1800**

### **II. Economy and Society in early 19<sup>th</sup> c.**

a) Patterns of production in agriculture and the crafts

- b) Organisation of trade and banking
- c) Cultural expressions : Folk and Classical
- d) Islam and popular culture

### **III. Colonisation and Colonial Transformations:**

- a) Processes of colonial controls and the Informal Empire in Thailand
- b) Peasant society and agrarian transformations, plantations, forests, mining.
- c) Urbanisation : Colonial cities in Plural Societies
- d) Culture : i) Colonial Discourses and the Creation of National Culture
- ii) Oral traditions, literacy and the case of Malay Hikayats.
- iii) Creation of Perfect Natives
- iv) Education

### **Essential Readings**

Anderson B., *Imagined Communities: Reflections on the Origin and Spread of Nationalism* Verso 1983

Benda H., *The Crescent and the Rising Sun*. The Hague, W. van Hoeve , 1958.

Furnivall, *Colonisation and the Plural Society* Oxford University. Press, 1980

Hart G., ed., *Agrarian Transformations: Local Processes and the state in South-East Asia*. Berkeley : University of California Press, 1989

Kemp J., ed., *Peasants and Cities, Cities and Peasants : Rethinking Southeast Asian Models*.

Osborne Milton, *South East Asia : An Introductory History* Allen & Unwin, 2016.

Tarling Nicholas, ed., *Cambridge History of South-East Asia*, 2 vols. Cambridge University Press . 1993

দাসগুপ্ত অরুণ, দক্ষিণ পূর্ব এশিয়ার ইতিহাস

সেন জহর, দক্ষিণ পূর্ব এশিয়ার ইতিহাস

### **Suggested Readings**

Anderson B., *Mythology and the Tolerance of the Javanese* Southeast Asia Program Cornell University monograph series, Modern Indonesia Project (1985)

Dijk Van C., *Trousers, Sarongs and Jubbahs*

Dobblin C., *Islamic Revivalism in a Changed Peasant Economy (1784 – 1847)* London: Curzon Press, 1983

Keys, Charles F., *The Golden Peninsula* Honolulu : University of Hawaii Press, 1995.

Lev Daniel S., and McVey T., eds, *Making Indonesia – Essays on Modern Indonesia*. Ithaca: Cornell Southeast Asia Program, 1996

Purcell Victor, *The Chinese in South-East Asia* London and New York: Oxford University Press, 1951

Winichakul Tongchai, *Siam Mapped : A History of the Geo-Body of a Nation* University of Hawaii Press, 1994

Wyatt, David K, *Thailand: Studies in Thai History*, 1999

## **Paper 4 DSE-B-4 SEM -6: History of Southeast Asia – The 20<sup>th</sup> Century**

### **I. Migration : Indian and Chinese Labour and Capital**

### **II. Movements of Resistance and the making of new identities**

- a) Peasant resistance
- b) Radicalism and the Origins of the Vietnamese Revolution, 1920-1946
- c) Indonesian Revolution, 1945-1949

### **III. Emergence of Modern Nations and States**

- a) The Union of Burma (Mynamar), 1948-1962
- b) Indonesia, the Sukarno Era, 1949-1965
- c) Two Vietnams : 1946 - 1976

### **Essential Readings**

Amin Mohammad and Malcolm Coldwell, ed, Malay: The Making of a Neo Colony, 1977  
Anderson B., Imagined Communities Reflections on the Origin and Spread of Nationalism Verso 1983  
Bandyopadhyay Sekhar, Burma Today, 1987  
Benda H., The Crescent and the Rising Sun The Hague, W. van Hoeve, 1958.

Furnivall, Colonization and the Plural Society Oxford University. Press, 1980  
Hart G., ed., Agrarian Transformations: Local Processes and the state in South-East Asia Berkeley : University of California Press, 1989  
Kemp J., ed., Peasants and Cities, Cities and Peasants : Rethinking Southeast Asian Models. Legge John D, Indonesia (1964)  
Osborne Milton, South East Asia: An Introductory History Osborne Milton, Allen & Unwin, 2016.  
Ryan N. J, A History of Malaysia and Singapore, 1976  
Sardesai D.R, Vietnam : Trials and tribulations of a Nation (1988)  
Tarling Nicholas, ed., Cambridge History of South-East Asia, 2 vols. Cambridge University Press . 1993

সেন জহর, দক্ষিণ পূর্ব এশিয়ার ইতিহাস, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ,  
মুখোপাধ্যায় সুবোধ, দক্ষিণ পূর্ব এশিয়া ,

### **Suggested Readings**

Anderson B., Mythology and the Tolerance of the Javanese Southeast Asia Program Cornell University monograph series, Modern Indonesia Project (1985)  
Dijk Van C., Trousers, Sarongs and Jubbahs  
Dobblin C., Islamic Revivalism in a Changed Peasant Economy (1784 – 1847) ) London: Curzon Press, 1983  
Keys, Charles F., The Golden Peninsula Honolulu :University of Hawaii Press, 1995.  
Lev Daniel S., and McVey T., eds, Making Indonesia – Essays on Modern Indonesia. Ithaca: Cornell Southeast Asia Program, 1996  
Purcell Victor, The Chinese in South-East Asia London and New York: Oxford University Press, 1951

Winichakul Tongchai, Siam Mapped : A History of the Geo-Body of a Nation University of Hawaii Press, 1994

Wyatt, David K, Thailand: Studies in Thai History, 1999



## **Paper 5 DSE-B-1 SEM -5: History of Modern East Asia – I China (c.1840 – 1949)**

### **I. Imperialism and China during the 19<sup>th</sup> and early 20<sup>th</sup> century**

- a) Chinese feudalism : Gentry, Bureaucracy and peasantry; the Confucian value system; Sinocentrism; the canton commercial system
- b) The transformation of China into an informal colony; the Opium Wars; the Unequal Treaties; the scramble for concessions; Finance Imperialism; the Open Door policy.
- c) Agrarian and Popular Movements : Taiping and Yi Ho Tuan
- d) Attempts at Self-Strengthening (Tzu-Chiang): Reforms of 1860-95; 1898; and 1901-08.
- ii) The Emergence of Nationalism in China
  - a) The Revolution of 1911: Causes , nature and significance; the social composition of the Revolution; Sun Yat-sen and his contribution; the formation of the Republic; Yuan Shih Kai; War Lordism.
  - b) May Fourth Movement of 1919: Nature and Significance

### **II. History of China (cc.1919 – 1949)**

- i) Nationalism and Communism in China (1921 – 1937)
  - a) Formation of CCP; and the
  - b) The First United Front
- i) The Communist Movement (1938-1949)
- ii) The Jiangxi Period and the rise of Mao Tse Tung

### **Essential Readings**

- Beckmann George M., Modernization of China and Japan Harper & Row, 1962
- Bianco Lucien, Origins of the Chinese Revolution, 1915 -1949 Stanford University Press, 1973
- Chesneaux Jean, et al, China from Opium War to 1911 Revolution to Liberation. Hassocks, Sussex : The Harvester Press, cop.1976
- Chesneaux Jean, Peasant Revolts in China, 1840 – 1949 W. W. Norton ,1973
- Chung Tan, China and the Brave New World : A Study of the Origins of the Opium War, 1840 - 42
- Chung Tan, Triton and Dragon : Studies on the Nineteenth Century China and Imperialisms Gian Publishing House, 1986
- Fairbank J.K (ed), The Cambridge History of China, Vol. X Cambridge University Press, 1978
- Fairbank John K., et al, and East Asia: Modern Transformation London : Allen & Unwin,1965
- Franke Wolfgang, A Century of Chinese Revolution University of South Carolina Press, 1980
- Hsu Y.Immanuel, The Rise of Modern China OUP 1995
- Jansen M.B., Japan and China: From War to Peace, 1894 – 1972 Chicago : Rand McNally College Pub. Co., [1975
- Johnson Chalmers A, Peasant Nationalism and Communist Power: The Emergence of Red China, 1937 -1945 Stanford, 1962
- Michael Franz, The Taiping Rebellion Seattle and London: University of Washington Press, 1971
- Peffer Nathaniel, The Far East: A Modern History. University of Michigan Press, 1958
- Purcell Victor, The Boxer Uprising: A Background Study. Cambridge University Press, 2010
- Schiffrin Harold Z, Sun Yat-Sen and the Origin of the Chinese Revolution. University of California Press, 1968

Schuramann Franz and Schell Orville (eds.), China Readings, 2 Volumes, (Imperial China, and Republican China) Penguin; First edition 1967  
Schwartz Benjamin I., Mao and the Rise of Chinese Communism. Stanford, Stanford University Press,. 1951.  
Sheng Hu, Imperialism and Chinese Politics. Foreign Languages Press, 1981  
The Yi Ho Tuan Movement, The Revolution of 1911, Foreign Language Press, Beijing.  
Tse Tung Chow, The May Fourth Movement: Intellectual Revolution in Modern China. Stanford University Press: Stanford, 1967  
Wright Mary C., China in Revolution : The First Phase, 1900 – 1913. New Haven: Yale University Press, 1968  
Yu-teng Ssu and K. Fairbank John , China's Response to the West. Cambridge: Harvard University Press, 1954

চৌধুরী দেবপ্রসাদ-আধুনিক যুগে পূর্ব এশিয়ার সংক্ষিপ্ত ইতিহাস, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ,, কলকাতা, ১৯৮৬  
ভট্টাচার্য্য অমিত- চীনের রূপান্তরের ইতিহাস, ১৮৪০-১৯৮৯, কলকাতা, ২০০৪  
চট্টোপাধ্যায় হরপ্রসাদ, চীনের ইতিহাস, কলকাতা, ১৯৮৮  
সেন জহর, এ যুগের চীনকথা, কলকাতা, ২০০৭

## **Paper 6 DSE-B-3 SEM -6: History of Modern East Asia – II Japan (c.1868 – 1945)**

### **I) Transition from feudalism to capitalism:**

- a) Crisis of Tokugawa Bakuhau system
- b) Meiji Restoration : Its nature and Significance
- c) Political Reorganization
- d) Military Reforms

- e) Social, cultural and educational reforms (Bunmeikaika)
- f) Financial reforms and educational development in the 'Meiji' era
- g) Meiji Constitution

## **II) Japanese Imperialism**

- a) China
- b) Manchuria
- c) Korea

## **3) Democracy and Militarism / Fascism**

- a) Popular/ People's Rights Movement
- b) Nature of political parties
- c) Rise of Militarism-Nature and significance
- d) Second World War; American occupation
- e) Post-War Changes

## **Essential Readings**

Allen George, A Short Economic History of Modern Japan. Psychology Press, 2003  
 Beasley G., The Modern History of Japan. Weidenfeld & Nicolson, 1963  
 Beckman George M, Modernization of China and Japan. Joanna Cotler Books , 1962  
 Beckman George M, The Making of the Meiji Constitution . Praeger; New edition 1975  
 Fairbank John K., et al, East Asia: Modern Transformation. London : Allen & Unwin,1965  
 Jansen M B (ed), The Cambridge History of Japan Vols. I and II  
 Livingstone Jon, et al., The Japan Reader (Imperial Japan : 1800 – 1945), Vol.I Pantheon, 1974  
 Mikiso Hane, Modern Japan: A Historical Survey. Westview Press, 4th edition 2008  
 Norman E.H, Japan's Emergence as a Modern State. Greenwood Press, 1973  
 Peffer Nathaniel, The Far East: A Modern History. University of Michigan Press, 1968 -  
 Pyle Kenneth B., The Making of Modern Japan. D.C. Heath, 1996  
 Storry Richard, A History of Modern Japan Penguin Books, 1991  
 Vinacke H, A History of the Far East in Modern Times 1928

চৌধুরী দেবপ্রসাদ-আধুনিক যুগে পূর্ব এশিয়ার সংক্ষিপ্ত ইতিহাস, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা, ১৯৮৬

ভট্টাচার্য্য অমিত- জাপানের রূপান্তরের ইতিহাস, ১৬০০-১৯৪৫, কলকাতা, ২০০৫

চট্টোপাধ্যায় হরপ্রসাদ, জাপানের ইতিহাস, কলকাতা, ১৯৮৬

গুহরায় সিদ্ধার্থ, - আধুনিক পূর্ব এশিয়ার ইতিহাস: চীন ও জাপানের ইতিহাস, কলকাতা, ১৯৯৬

## **Paper 7 DSE-A-2 SEM -5: History of United States of America – I (c.1776 – 1945)**

### **I. The Background:**

The land and indigenous people: settlement and colonization by Europeans; early colonial society and politics; indentured labour- White and Black.

### **II. Making of the Republic:**

a) Revolution : Sources of conflict : Revolutionary groups, Ideology: The War of Independence and its historical interpretations

b) Processes and Features of Construction making : Debates, Historical interpretations.

### **III. Evolution of American Democracy:**

- a)Federalists: Jeffersonianism: Jacksonianism, Rise of political parties- 1840 – 1960; judiciary- role of the Supreme Court
- b) Expansion of Frontier: Turner's Thesis; Marginalization, displacement and decimation of native Americans; Case histories of Tecumseh , Shawnee Prophet.
- c)Limits of Democracy: Blacks and Women

### **IV. Early Capitalism**

- a) Beginnings of Industrialization
- b) Immigrants and changing composition of Labour; Early Labour Movements.

### **V. The Agrarian South :**

- a)Plantation economy
- b)Slave Society and Culture: Slave resistance.

### **VI. Ante Bellum Foreign Policy:**

War of 1812: Monroe Doctrine: Manifest Destiny

### **VII. Civil War:**

- a)Abolitionism and Sectionalism
- b)Issues and interpretations
- c)Rise of Republicanism, Emancipation and Lincoln

### **Essential Readings**

Bailyn Bernard, The Great Republic 1985.

Bailyn Bernard, The Ideological Origins of the American Revolution. Harvard University Press 1967

Beard Charles, An Economic Interpretation of the American Constitution. Macmillan, 1921

Brown Dee, Bury My Heart at Wounded Knee, An Indian History of the American West. Grover Gardner 1970

Carroll Peter and Noble David, Free and Unfree: A New History of the United States. Penguin Books, 1977.

Davis David B., The Problem of Slavery in the Age of Revolution 1770-1823. New York: Oxford University Press, 1999.

Faulkner U., American Economic History . New York, Harper, 1960

Fogel Robert, Railroads and American Economic Growth Baltimore: Johns Hopkins Press, 1964.

Foner Eric, America's Black Past. Harper collins, 1970

Franklin, John Hope, From Slavery to Freedom. New York: Alfred A Knopf, 1947

Grobb Gerald N., and Billias George A., Interpretations of American History: Patterns and Perspectives, 2 Vols. New York, Free Press 1972.

Hofstadter Richard, The Age of Reform, From Bryan to FDR. Vintage Books, 1955

Kerber Linda, Women's America: Refocussing the Past. Oxford University Press, 1991

Potter David M., The Impending Crisis HarperCollins, 1977

Pratt W., A History of the United States Foreign Policy. Prentice-Hall, 1965

Randail James, The Civil War and Reconstruction. W. W. Norton & Company ,1937

Randall J.G and Donald David, The Civil War and Reconstruction. Pickle Partners Publishing, 2016

Stampf Kenneth, *The Peculiar Institution, Slavery in the Antebellum South*. (New York: Alfred A. Knopf, 1956)

Jackson Frederick Turner, *The Frontier in American History*. Henry Holt, 1921

Wiebe Robert, *The Search for Order*. Farrar, Straus and Giroux, 1967

### **Suggested Readings**

Benson Lee, *The Concept of Jackson Democracy: New York as a Test Case* Princeton Legacy Library 1961

Billington Ray A., *Westward Expansion*. UNM Press, 2001

Boyer Paul, Sitkoff Harvard, Woloch Nancy, *The Enduring Vision : A History of the American People*, Vols. 1 and 2. Houghton Mifflin; 5th Revised edition 2003

Cochran Thomas, *The Inner Revolution* Harper Torchbooks, The Academy Library), 1964.

Craven A.O., *The Growth of Southern Nationalism, 1848 – 1861*. Louisiana State University Press, 1953

Davis lance E.,(ed.), *American Economic Growth*. Harper & Row; First edition 1972

Degler Carl N., *At Odds: Women and Family in America from the Revolution to the Present*. Oxford University Press, 1980

Fogel and Engerman, *Time on the Cross*. Brown and Company, 1974.

Gould Lewis L., (ed.), *The Progressive Era*. Longman, 2001

Hicks, John D., *The Federal Union : A History of USA since 1865*. Houghton Mifflin, 1964

Kaushik R.P., *Significant Themes in American History*. Ajanta Publications, 1983

Kennedy, David M., Bailey Thomas and Piehl Mel, *The Brief American Pageant*. Cengage Learning, 1999.

Kristol Irving, Wood Gordon and others, *America's Continuing Revolution*.

Washington : American Enterprise Institute for Public Policy Research, 1975]

Leopard Richard W., *The Growth of American Foreign Policy*. Alfred A. Knopf 1967

Miller Perry, *From Colony to Province*. Harvard University Press, 1953

Nash Gary (ed.), *Retracing the Past*. Longman, 2000

Pelling Henry, *American Labor*. University of Chicago 1960

Pessen Edward, *Jacksonian Panorama*. Bobbs-Merrill, 1976

Sellers Charles, May Henry and McMillen Neil, *A Synopsis of American History*; 2 volumes. Rand McNally College Pub. Co., 1976

Tripathi Dwijendra and Tiwari S.C., *Themes and Perspectives in American History* American Studies Research Centre, 1978.

Weinstein James, *The Corporate Ideal in the Liberal state. 1900-1918* Beacon Press, 1985

## **Paper 8 DSE-A-4 SEM -6: History of United States of America – II (c.1776-1945)**

### **I. Reconstructions: Political changes and agrarian transformation:**

a) Conservative and Radical phases.

b) The New South : Participants and Reactions, Carpetbaggers; Scalawags, Blacks, Ku Klux Klan.

### **II. Industrial America:**

- a) Growth of Capitalism and Big Business.
- b) Business cycles; Depression..

### **III. Resistance and Reform:**

- a) Labour movements and Unionization.
- b) Agrarian crisis and populism. Urban corruption and progressivism.
- c) New Deal.

### **IV. U.S Imperialism**

- a) Spanish-American War
- b) Expansion in the Far east and Latin America
- c) World War I and Fourteen Points
- d) Isolation
- e) Americans in World War II: Bombing of Hiroshima and Nagasaki

### **V. Afro-American Movements:**

Black Movements: Booker T. Washington, W.E.B Dubois, NAACP and Marcus Garvey.

### **VI. Women's Movements:**

- a) Rise of the Lowell Factory System
- b) Abolitionists and Women's rights movement
- c) Suffrage
- d) Afro-American Women

### **VII. Religious, Cultural and Intellectual Trends:**

- a) Religious movements; Early Revivalism; Puritans, Quakers; Mormons; Temperance
- b) Mass Culture (circa 1900 – 1945)
- c) Major Literary trends (circa 1900 – 1945)

### **Essential Readings**

Bailyn Bernard, *The Great Republic* 1985.

Bailyn Bernard, *The Ideological Origins of the American Revolution*. Harvard University Press 1967

Beard Charles, *An Economic Interpretation of the American Constitution*. Macmillan, 1921

Brown Dee, *Bury My Heart at Wounded Knee, An Indian History of the American West*. Grover Gardner 1970

Carroll Peter and Noble David, *Free and Unfree: A New History of the United States*. Penguin Books, 1977.

Davis David B., *The Problem of Slavery in the Age of Revolution 1770-1823*. New York: Oxford University Press, 1999.

Faulkner U., *American Economic History*. New York, Harper, 1960

Fogel Robert, *Railroads and American Economic Growth* Baltimore: Johns Hopkins Press, 1964.

Foner Eric, *America's Black Past*. Harper collins, 1970

Franklin, John Hope, *From Slavery to Freedom*. New York: Alfred A Knopf, 1947

Grobb Gerald N., and Billias George A., *Interpretations of American History: Patterns and Perspectives*, 2 Vols. New York, Free Press 1972.

Hofstadter Richard, *The Age of Reform, From Bryan to FDR*. Vintage Books, 1955

Kerber Linda, *Women's America: Refocussing the Past*. Oxford University Press, 1991

Potter David M., *The Impending Crisis* HarperCollins, 1977

Pratt W., *A History of the United States Foreign Policy*. Prentice-Hall, 1965

Randail James, *The Civil War and Reconstruction*. W. W. Norton & Company ,1937  
 Randall J.G and Donald David, *The Civil War and Reconstruction*. Pickle Partners Publishing, 2016  
 Stamp Kenneth, *The Peculiar Institution, Slavery in the Antebellum South*. (New York: Alfred A. Knopf, 1956  
 Jackson Frederick Turner, *The Frontier in American History*. Henry Holt, 1921  
 Wiebe Robert, *The Search for Order*. Farrar, Straus and Giroux, 1967

### **Suggested Readings**

Benson Lee, *The Concept of Jackson Democracy: New York as a Test Case* Princeton Legacy Library 1961

Billington Ray A., *Westward Expansion*. UNM Press, 2001  
 Boyer Paul, Sitkoff Harvard, Woloch Nancy, *The Enduring Vision : A History of the American People*, Vols. 1 and 2. Houghton Mifflin; 5th Revised edition 2003  
 Cochran Thomas, *The Inner Revolution* Harper Torchbooks, The Academy Library), 1964.  
 Craven A.O., *The Growth of Southern Nationalism, 1848 – 1861*. Louisiana State University Press, 1953  
 Davis lance E.,(ed.), *American Economic Growth*. Harper & Row; First edition 1972  
 Degler Carl N., *At Odds: Women and Family in America from the Revolution to the Present*. Oxford University Press, 1980  
 Fogel and Engerman, *Time on the Cross*. Brown and Company, 1974.  
 Gould Lewis L., (ed.), *The Progressive Era*. Longman, 2001  
 Hicks, John D., *The Federal Union : A History of USA since 1865*. Houghton Mifflin, 1964  
 Kaushik R.P., *Significant Themes in American History*. Ajanta Publications, 1983  
 Kennedy, David M., Bailey Thomas and Piehl Mel, *The Brief American Pageant*. Cengage Learning, 1999.  
 Kristol Irving, Wood Gordon and others, *America's Continuing Revolution*. Washington : American Enterprise Institute for Public Policy Research, 1975]  
 Leopard Richard W., *The Growth of American Foreign Policy*. Alfred A. Knopf 1967  
 Miller Perry, *From Colony to Province*. Harvard University Press, 1953  
 Nash Gary (ed.), *Retracing the Past*. Longman, 2000  
 Pelling Henry, *American Labor*. University of Chicago 1960  
 Pessen Edward, *Jacksonian Panorama*. Bobbs-Merrill, 1976  
 Sellers Charles, May Henry and McMillen Neil, *A Synopsis of American History*; 2 volumes. Rand McNally College Pub. Co., 1976  
 Tripathi Dwijendra and Tiwari S.C., *Themes and Perspectives in American History* American Studies Research Centre, 1978.  
 Weinstein James, *The Corporate Ideal in the Liberal state. 1900-1918* Beacon Press, 1985

## Skill Enhancement Courses (SEC –A & B) Credits,-2 each

### SEC –A (1): Archives and museums

This course introduces students to the institutions that house and maintain documentary, visual and material remains of the past. Museums and archives are among the most important such repositories and this course explains their significance and how they work. Students will be encouraged to undertake collection, documentation and exhibition of such materials in their localities and colleges. Visit to National Archives and National Museum are an integral part of the course.

#### **I. Definition and history of development (with special reference to India)**

**II. Types of archives and museums:** Understanding the traditions of preservation in India Collection policies, ethics and procedures Collection: field exploration, excavation, purchase, gift and bequests, loans and deposits, exchanges, treasure trove confiscation and others. Documentation: accessioning, indexing, cataloguing, digital documentation and de-accessioning Preservation: curatorial care, preventive conservation, chemical preservation and restoration

#### **III. Museum Presentation and Exhibition:**

**IV. IV. Museums, Archives and Society:** (Education and communication Outreach activities

#### **Essential Readings:**

Agrawal, O.P., Essentials of Conservation and Museology, Sundeep Prakashan, New Delhi, India, 2007.

Choudhary, R.D. Museums of India and their maladies. Calcutta: Agam Kala Prakashan, New Delhi, 1998 (In Bengali).

Guha, Thakurta, Tapati, Monuments, Objects, Histories: Institution of Art in Colonial Post Colonial India, New York, 2004

Kathpalia, Y. P. Conservation and Restoration of Archive Materials. UNESCO, 1973

Mathur Saloni, India by Design: Colonial History and Cultural Display, University of California, 2007

Nair, S.M. Bio-Deterioration of Museum Materials. 2011

Roychowdhury, Madhuparna. Displaying India's Heritage : Archaeology and the Museum Movement in Colonial India. Delhi: Orient Blackswan 2015

Sengupta, S. Experiencing History Through Archives. Delhi: Munshiram Manoharlal. 2004.



## **SEC –B (1) Understanding Popular Culture**

The paper examines some popular cultures expressed in different mediums like visual, oral and cultural. In the process of their evolution, these cultures eclectically draw from traditions, articulate anxieties, and even give rise to new traditions. The paper endeavours to equip students with understanding such phenomena historically, with special reference to India. It is imperative that the students use electronic devices to view, record, and document the subject matter.

### **I Introduction: Defining popular culture and understanding it historically**

### **II Visual expressions Folk art, calendar art, photography**

**III. Performance: Theatre; music;** folk tales/songs/swang and Nautanki: Identifying themes, functionality, anxieties

### **IV. The audio-visual: cinema and television:**

Indian cinema: Mapping the influence of the national struggle for independence (1930s and 40s); Idealized nationalism (1950s), disillusionment and the anti-establishment mood (1970s and 80s); documentary films Expressions of popular culture in television

### **V. Fairs, Festivals and Rituals:**

Disentangling mythological stories, patronage, regional variations

### **VI. Popular culture in a globalized world:**

The impact of the Internet and audio-visual media

### **Essential Readings:**

Dissanayake, W. and K. M. Gokul Singh, Indian Popular Cinema, Trentham Book, London, 2004

John Storey, Cultural Theory and Popular Culture, London, 2001

Oberoi, Patricia, Freedom and Destiny: Gender, Family and Popular Culture in India, Delhi, 2009

Christopher Princy, Camera Indica: The Social Life of Indian Photographs, Chicago, 1998

### **Suggested Readings:**

Ramanujan, A.K. Folktales from India A Selection of Oral Tales from Twenty-two Languages (Only Introduction). New York : Pantheon Books, ©1991.

Ramaswamy, V. 'Women and the 'Domestic' in Tamil Folk Songs' in Kumkum Sangari and Uma Chakravarti, eds., From Myths to Markets: Essays on Gender, Shimla, 1999

Singh, Lata (ed.), Theatre in Colonial India: Playhouse of Power, New Delhi, 2009

## **SEC –A (2) Understanding Heritage**

This course will enable students to understand the different facets of heritage and their significance. It highlights the legal and institutional frameworks for heritage protection in India as also the challenges facing it. The implications of the rapidly changing interface between heritage and history will also be examined. The course will be strongly project-based and will require visits to sites and monuments. At least two Projects will be based on visits to Museums/Heritage Sites.

### **I. Defining Heritage**

Meaning of 'antiquity', 'archaeological site', 'tangible heritage', 'Intangible heritage' and 'art treasure'

### **II. Evolution of Heritage Legislation and the Institutional Framework:**

Conventions and Acts— national and international Heritage-related government departments, museums, regulatory bodies etc.

Conservation Initiatives

### **III. Challenges facing Tangible and Intangible Heritage**

Development, antiquity smuggling, conflict (to be examined through Specific case studies)

### **IV. Evolution of Heritage Legislation and the Institutional Framework:**

Conventions and Acts— national and international Heritage-related government departments, museums, regulatory bodies etc.

Conservation Initiatives

### **V. Challenges facing Tangible and Intangible Heritage:**

Development, antiquity smuggling, conflict (to be examined through specific case studies)

### **VI. Heritage and Travel:**

Viewing Heritage Sites - The relationship between cultural heritage, Landscape and travel recent trends

### **Essential Readings**

David Lowenthal, *Possessed By The Past: The Heritage Crusade and The Spoils of History*, Cambridge, 2010

Layton, R. P. Stone and J. Thomas. *Destruction and Conservation of Cultural Property*, London: Rutledge, 2001

Lahiri, N., *Marshaling the Past - Ancient India and its Modern Histories*. Ranikhet: Permanent Black. 2012. Chapters 4 and 5.

S.S. Biswas, *Protecting the Cultural Heritage (National Legislations and International Conventions)*. New Delhi: INTACH, 1999.

### **Suggested Readings**

Acts, Charters and Conventions are available on the UNESCO and ASI websites ([www.unesco.org](http://www.unesco.org); [www.asi.nic.in](http://www.asi.nic.in))

Agrawal, O.P., Essentials of Conservation and Museology, Delhi, 2006

Chainani, S. 2007. Heritage and Environment. Mumbai: Urban Design Research Institute, 2007

## **SEC –B (2): Art Appreciation: an Introduction to Indian Art**

The purpose of this course is to introduce students to Indian art, from ancient to contemporary times, in order to understand and appreciate its diversity and its aesthetic richness. The course will equip students with the abilities to understand art as a medium of cultural expression. It will give students direct exposure to Indian art through visuals, and visits to sites and museums.

**I. Prehistoric and protohistoric art:** \_Rock art; Harappan arts and crafts

**II. Indian art (c. 600 BCE – 600 CE):**

World Heritage Site Managers, UNESCO World Heritage Manuals  
[Can be downloaded/ accessed at [www.unesco.org](http://www.unesco.org)]

Notions of art and craft Canons of Indian paintings Major developments in stupa, cave, and temple art and architecture Early Indian sculpture: style and iconography Numismatic art

**III. Indian Art (c. 600 CE – 1200 CE) :** Temple forms and their architectural features Early illustrated manuscripts and mural painting traditions Early medieval sculpture: style and iconography Indian bronzes or metal icons

**IV. Indian art and architecture (c. 1200 CE – 1800 CE) :**

Sultanate and Mughal architecture Miniature painting traditions: Mughal, Rajasthani, Pahari  
Introduction to fort, palace and haveli architecture

**V. Modern and Contemporary Indian art and Architecture:**

The Colonial Period Art movements: Bengal School of Art, Progressive Artists Group, etc.  
Major artists and their artworks Popular art forms (folk art traditions)

### **Essential Readings**

Neumayer, Erwin, Lines of Stone: The pre-historic rock-art of India,  
South Asia Books, 1993

Goswamy, B.N., Essence of Indian Art, Asian Art Museum of San  
Francisco, 1986

Huntington, Susan, The Art of Ancient India: Hindu, Buddhist, Jain, Weatherhill, 1985

Guha-Thakurta, Tapati, The making of a new modern Indian art: Aesthetics and nationalism in  
Bengal, 1850-1920, Cambridge University Press, 1992

### **Suggested Readings:**

Mitter, Partha, Indian Art, Oxford History of Art series, Oxford University Press, 2001

Dhar, Parul Pandya, ed., 2011, Indian Art History Changing Perspectives, New Delhi: D.K.  
Printworld and National Museum Institute (Introduction).

Beach, M.C., The New Cambridge History of India I: 3, Mughal and Rajput Painting, Cambridge  
University Press, 1992.

Ray, Niharranjan, An Approach to Indian Art, Calcutta, 1970

**CBCS SYLLABUS**  
**IN**  
**HISTORY (GENERAL)**

**CALCUTTA UNIVERSITY**

**2018**

## University of Calcutta

### HIS-G (General)-CBCS Syllabus in History, 2018

#### **4 Core Courses. (CC.) 2 Discipline-specific Elective; (DSE-A & DSE-B) 2 Generic Elective (GE) 2 Skill Enhancement/Skill based Courses (SEC- A & SEC-B)**

- Each course carries 80 marks. Minimum 60 classes.
- Each course: 6 credits (5 Theoretical + 1 Tutorial-related). Teaching time: 6 hrs per week or  $6 \times 14 = 84$  hrs
- Exception: Skill Enhancement/Skill-based Courses: 2 credits (no Tutorial).
- 65 marks for theoretical segment:
- Question Pattern for subjective/descriptive segment of 50 marks: 3 questions out of 6 (within 500 words;  $10 \times 3 = 30$ ) + 4 questions out of 8 (within 250 words; one from each module  $5 \times 4 = 20$ ) and 15 objective type questions carrying 1 mark each ( $15 \times 1 = 15$ ).
- 15 marks for tutorial-related segments as suggested below (any one from each mode):
- Any one of the following modes: upto 1000 words for one Term Paper/upto 500 words for each of the two Term Papers/ equivalent Book Review --- based on syllabus related and/or current topics [The modes and themes and/or topics are to be decided by the concerned faculty of respective colleges.]
- Core Courses (CC) in Semesters 1- 4 ; Generic Elective (GE) courses in Semesters 1-4; Skill Enhancement courses ( SEC-A) in Semesters 3/5 & ( SEC- B) in Semesters 4/6 Discipline-specific Elective( DSE –A) in Semester 5 (DSE –B) in Semester 6
- **Skill Enhancement/Skill-based Courses: 2 credits (no Tutorial).**
- Each course carries 80 marks. Teaching time: 2hrs per week or  $2 \times 14 = 28$  hrs
- 80 marks for theoretical segment.
- Question Pattern for subjective/descriptive segment of 80 marks: 4 questions out of 8 (within 500 words;  $10 \times 4 = 40$ ) + 5 questions out of 10 (within 250 words;  $5 \times 5 = 25$ ) and 15 objective type questions carrying 1 mark each ( $15 \times 1 = 15$ ).

**IMPORTANT NOTES:**

- The Readings provided below (except Bengali books) include those of the UGC Model CBCS Syllabus in History. For Course Objectives and references it is advised that the UGC model CBCS syllabus concerning relevant courses and topics should be given due importance and primarily consulted.
- Bengali are not necessarily substitutes, but supplementary to the English books.
- The format is subject to the CBCS Common Structural Format of the University.

<b>LIST OF COURSES FOR GENERAL PROGRAMME</b>	
<b>COURSE CODE</b>	<b>(6 Credits per Core Course)</b>
<b>CORE COURSES FOR GENERAL &amp; GENERIC ELECTIVE FOR HONOURS</b>	
<b>Subject-Hon-Core-Semester-Paper-Th &amp; TU</b>	
HIS-G-CC/GE-1-1-TH&TU	
HIS-G-CC/GE-2-2-TH&TU	
HIS-G-CC/GE-3-3-TH&TU	
HIS-G-CC/GE-4-4-TH&TU	
<b>Skill Enhancement Course (2 Credits per Course)</b>	
<b>GROUP-A</b>	<b>HIS-G-SEC- 3/5-A(1) or A (2)-TH</b>
SEC-A-(1)	
SEC-A-(2)	
<b>GROUP-B</b>	<b>HIS-G-SEC- 4/6-B(1) or B(2)-TH</b>
SEC-B-(1)	
SEC-B-(2)	
<b>DISCIPLINE SPECIFIC ELECTIVE (6 Credits per Course)</b>	
<b>GROUP-A</b>	<b>HIS-G-DSE- 5-A(1) or A(2)-TH&amp;TU</b>
DSE-A-(1)	
DSE-A-(2)	
<b>GROUP-B</b>	<b>HIS-G-DSE-6-B(1) or B (2)-TH&amp;TU</b>
DSE-B-(1)	
DSE-B-(2)	

## **Structure of B.A General (Programme)**

### **HIS-G - CC -1- 4 /GE -1-4 TH&TU**

1. History of India from the Earliest Times upto 300 CE
2. History of India from C.300 to 1206.
3. History of India from C. 1206 to 1707
4. History of India from 1707 to 1950

### **Discipline Specific Elective (DSE -A & DSE- B) TH&TU Any One from DSE-A in Semester 5 & Any One from DSE-B in Semester 6**

1. National liberation Movements in 20th Century World.
2. Some Aspects of European History: C.1780-1945.
3. Patterns of Capitalism in Europe: C.16th Century to early 20th Century
4. Some Aspects of Society & Economy of Modern Europe: 15 – 18 Century

### **Skill Enhancement Courses SEC –A & B: Any One from SEC-A1/ SEC-A2 in Semester 3/5. Any One from SEC-B1/ SEC-B2 in Semester 4/6**

SEC -A 1: Historical Tourism: Theory & Practice

SEC -B 1: Museums & Archives in India

SEC –A 2: Indian History & Culture

SEC-B 2: Orality and Oral Culture in India

### **Semester wise Courses for HIS-G**

	SEM-1	SEM-2	SEM-3	SEM-4	SEM-5	SEM-6
CC	CC-1 2TH +2TU	CC -2 2TH +2TU	CC-3 2TH +2TU	CC-4 2TH +2TU		
GE	GE-1 TH +TU	GE-2 TH +TU				
AECC	AECC-1 TH	AECC-2 TH				
DSE			DSE-A TH +TU	DSE-B TH +TU	DSE-A TH +TU	DSE-B TH +TU
SEC			SEC-A -1 TH	SEC-B -1 TH	SEC-A 2 TH	SEC-B 2 TH

**CC: 4 courses each from 2 disciplines. (One course from each subject under each semester) Each course is of 6 credits.**

**GE: Two courses from one subject different from the core subject. Each course is of 6 credits.**

**AECC:-1 Communicative English AECC-2- Environmental studies (Each course has 2 credits)**  
**DSE: 2 courses each from 2 disciplines. Each course is of 6 credits.**  
**SEC: 2 courses each from 2 disciplines ((Each course has 2 credits)**  
**DSE/ SEC : Choice must be group specific to each semester**

## **CC -1/GE-1 : History of India from Earliest Times up to 300 CE**

**I. Sources & Interpretation**

**II. A broad survey of Palaeolithic, Mesolithic and Neolithic Cultures.**

**III. Harappan Civilization : Origin, Extent, dominant features & decline, Chalcolithic age.**

**IV. The Vedic Period: Polity, Society, Economy and Religion, Iron Age with reference to PGW & Megaliths.**

**V. Territorial States and the rise of Magadha,**

**Conditions for the rise of Mahajanpadas and the Causes of Magadha's success**

**VI. Iranian and Macedonian Invasions, Alexander's Invasion and impact**

**VII. Jainism and Buddhism: Causes, Doctrines, Spread, Decline and Contributions**

**VIII. The Satavahanas Phase: Aspects of Political History, Material Culture, Administration, Religion**

**VIII. Emergence and Growth of Mauryan Empire; State Administration, Economy, Ashoka's Dhamma, Art & Architecture**

**IX. The Satvahana Phase: Aspects of Political History, Administration, Material Culture, & Religion**

**X. The Sangam Age: Sangam Literature, The three Early Kingdoms, Society & the Tamil language**

**XI. The age of the Indo-Greeks, Shakas: Parthians & Kushanas: Aspects of Polity, Society, Religion, Arts & Crafts, Coins, Commerce and Towns.**

### **References:**

Agrawal, D.P. The Archaeology of India. Curzon Press, 1982

Basham, A.L. The Wonder that was India: A Survey of the Culture of the Indian Sub-Continent before the Coming of the Muslims. Picador, 2004

Chakrabarti, D.K. Archaeology of Ancient Indian Cities OUP India; 1998

Jaiswal, Suvira, Caste: Origin, Function and Dimensions of Change. Manohar Publishers 1998



Subramanian, N. Sangam Polity

Thapar, Romila The Penguin History of Early India: From the Origins to AD 1300 University of California Press; 1st edition 2004

Allchin, F.R. and B Origins of a Civilization: The Prehistory and Early Archaeology of South Asia New Delhi : Viking, 1997.

Jha, D.N. Ancient India in Historical Outline .Manohar, New Delhi (1998 edn.)  
Kosambi, D.D. Culture and Civilization of Ancient India World Publishing Company, 1969

Ray, H.P. Monastery and guild : commerce under the Sātavāhanas  
Delhi ; New York : Oxford University Press, 1986.

Sastri, K.A.N. A History of South India :From Prehistoric Times to the Fall of Vijayanagar OUP India 1976

R.S Sharma, India's Ancient Past Delhi: Oxford University Press 2005

Ray, Niharranjan , Maurya and Post Maurya Art: A Study in Social and Formal Contrasts .  
Indian Council of Historical Research, 1975

Sharma, R.S., Aspects of Political Ideas and Institutions in Ancient India (1991 edn.)  
Thapar, Romila Ashoka and the Decline of the Mauryas Oxford University Press (1997 edn)  
Yazdani, G. Early History of Deccan Aspects of Political Ideas and Institutions in Ancient India (1991 edn.)

বাসাম এ এল, অতীতের উজ্জ্বল ভারত, (The Wonder That Was India), প্রগ্রেসিভ পাবলিশার্স, কলকাতা, ২০০৫

চক্রবর্তী রণবীর, ভারত ইতিহাসের আদি পর্ব, কলকাতা, ২০০৭

হাবিব ইরফান, ভারতবর্ষের সাধারণ মানুষের ইতিহাস

প্রথম খন্ড – প্রাক-ইতিহাস, (Pre-history) এন বি এ, কলকাতা, ২০০২

দ্বিতীয় খন্ড: সিন্ধু সভ্যতা, (The Indus Civilisation) এন বি এ, কলকাতা, ২০০২

তৃতীয় খন্ড – বৈদিক সভ্যতা, (The Vedic Age) এন বি এ, কলকাতা, ২০০২

ঝা ডি এন, আদি ভারত – একটি সংক্ষিপ্ত ইতিহাস, (Ancient India: An Introduction,) প্রগ্রেসিভ পাবলিশার্স, কলকাতা

কোশান্বী ডি ডি, ভারত ইতিহাস চর্চার ভূমিকা (An Introduction to the Study of Indian History) বাগডি কে পি এন্ড কোং, কলকাতা, ২০০২

রত্নাগর শিরিণ, হরপ্পা সভ্যতার সন্ধান (Understanding Harappa) এন বি এ, কলকাতা, ২০০৩

রায়চৌধুরী হেমচন্দ্র, প্রাচীন ভারতের রাজনৈতিক ইতিহাস, (Political History of Ancient India), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা

থাপার রোমিলা, ভারতবর্ষের ইতিহাস, ওরিয়েন্ট লংম্যান, কলকাতা

ভট্টাচার্য নরেন্দ্রনাথ, প্রাচীন ভারতে ধর্ম, কলকাতা, ১৯৮৮

ভট্টাচার্য নরেন্দ্রনাথ, প্রাচীন ভারতীয় সমাজ, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা  
ভট্টাচার্য সুকুমারী, ইতিহাসের আলোকে বৈদিক সাহিত্য, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা  
ভট্টাচার্য সুকুমারী, প্রাচীন ভারত- সমাজ ও সাহিত্য, আনন্দ পাবলিশার্স, কলকাতা  
চক্রবর্তী দিলীপ কুমার - ভারতবর্ষের প্রাক ইতিহাস আনন্দ পাবলিশার্স, কলকাতা, ১৯৯৯  
গঙ্গোপাধ্যায় দিলীপ কুমার - ভারত ইতিহাসের সঙ্কলনে, (২ খন্ডে), ২০০৭  
চক্রবর্তী রণবীর, প্রাচীন ভারতের অর্থনৈতিক ইতিহাসের সঙ্কলনে, আনন্দ পাবলিশার্স, কলকাতা ২০০২  
(সংশোধিত সংস্করণ)  
চানানা দেবরাজ, প্রাচীন ভারতে দাস প্রথা, (Slavery in Ancient India as depicted in Pali and Sanskrit Texts), কে পি বাগচি এন্ড কোং, কলকাতা ১৯৯৫  
রায় নীহাররঞ্জন, বাঙালির ইতিহাস, কলকাতা, ১৯৮০(দ্বিতীয় সংস্করণ)  
শর্মা রামশরণ, প্রাচীন ভারতে বস্তুগত সংস্কৃতি ও সমাজ সংগঠন, (Material Cultures and Social Formations in Ancient India), ওরিয়েন্ট লংম্যান, ১৯৯৮  
শর্মা রামশরণ, আদি মধ্যযুগের ভারতীয় সমাজ : সমস্ত-প্রক্রিয়া বিষয়ে এক সমীক্ষা(Early Medieval Indian Society : A Study in Feudalism) ওরিয়েন্ট লংম্যান, ২০০৩  
শর্মা রামশরণ, ভারতের সমাজতন্ত্র, (Indian Feudalism), কে পি বাগচি এন্ড কোং, কলকাতা  
শর্মা রামশরণ, আর্যদের অনুসন্ধান, (Looking for the Aryans), প্রগ্রেসিভ পাবলিশার্স, কলকাতা  
শর্মা রামশরণ, আর্যদের ভারতে আগমন, (Advent of the Aryans), ওরিয়েন্ট লংম্যান, ২০০১  
শর্মা রামশরণ, প্রাচীন ভারতে শূদ্র, (Sudras in Ancient India), কে পি বাগচি এন্ড কোং, কলকাতা  
থাপার রোমিলা, অশোক ও মৌর্যদের পতন, (Asoka and the Decline of the Mauryas), কে পি বাগচি এন্ড কোং, কলকাতা  
চট্টোপাধ্যায় সুনীল, প্রাচীন ভারতের ইতিহাস (১ম খন্ড), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, একাদশ মুদ্রণ, এপ্রিল ২০০৪  
চট্টোপাধ্যায় সুনীল, প্রাচীন ভারতের ইতিহাস (২য় খন্ড), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ৮ম মুদ্রণ, ফেব্রুয়ারি ২০০৪  
মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস (১ম খন্ড) (প্রাচীন ও মধ্যযুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, প্রথম মুদ্রণ নভেম্বর ১৯৯৭

## **CC-2/GE- 2: History of India from. C.300 to1206**

I. The Rise & Growth of the Guptas: Administration, Society, Economy, Religion, Art, Literature, and Science & Technology.

II. Harsha & His Times: Harsha's Kingdom, Administration, Buddhism & Nalanda

III. South India: Polity, Society, Economy & Culture

IV. Towards the Early Medieval: Changes in Society, Polity Economy and Culture with reference to the Pallavas, Chalukayas and Vardhanas.

V. Evolution of Political structures of Rashtrakutas, Pala & Pratiharas.

VI. Emergence of Rajput States in Northern India: Polity, Economy & Society.

VII. Arabs in Sindh: Polity, Religion & Society.

VIII. Struggle for power in Northern India & establishment of Sultanate.

### **References:**

R. S. Sharma: Indian Feudalism 1980.

R. S. Sharma -India's Ancient Past, New Delhi, 2005.

B. D. Chattopadhyay: Making of Early Medieval India , 1994.

Derryl N. Maclean: Religion and Society in Arab Sindh Leiden ; New York : E.J. Brill, 1989.

K. M. Ashraf: Life and Conditions of the People of Hindustan, New Delhi, 1967.

M. Habib and K.A. Nizami: A Comprehensive History of India Vol.V, Delhi, 1993.

Tapan Ray Chaudhary and Irfan Habib (ed.) : The Cambridge Economic History of India, Vol.I, Cambridge University Press .1982

Peter Jackson: Delhi Sultanate: A Political and Military History, Keele University 2003.

Tara Chand: Influence of Islam on Indian Culture, Indian Press, 1936.

Satish Chandra: A History of Medieval India, 2 Volumes Orient Black Swan 2009

Percy Brown, : Islamic Architecture, Taraporevala Sons, 1943.

রোমিলা থাপার, অশোক ও মৌর্যদের পতন, (Asoka and the Decline of the Mauryas), কে পি বাগচি এন্ড কোং, কলকাতা

সুনীল চট্টোপাধ্যায়, প্রাচীন ভারতের ইতিহাস (১ম খন্ড), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, একাদশ মুদ্রণ, এপ্রিল ২০০৪

সুনীল চট্টোপাধ্যায়, প্রাচীন ভারতের ইতিহাস (২য় খন্ড), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ৮ম মুদ্রণ, ফেব্রুয়ারি ২০০৪

হীরেন্দ্রনাথ মুখোপাধ্যায়, ভারতবর্ষের ইতিহাস (১ম খন্ড) (প্রাচীন ও মধ্যযুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, প্রথম মুদ্রণ নভেম্বর ১৯৯৭

বামশাম এ এল, অতীতের উজ্জ্বল ভারত, (The Wonder That Was India), প্রগ্রেসিভ পাবলিশার্স, কলকাতা, ২০০৫

মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস (১ম খন্ড) (প্রাচীন ও মধ্যযুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, প্রথম  
মুদ্রণ নভেম্বর ১৯৯৭  
ভট্টাচার্য, নরেন্দ্রনাথ, ধর্ম ও সংস্কৃতিক: প্রাচীন ভারতীয় প্রেক্ষাপট  
চক্রবর্তী রণবীর, প্রাচীন ভারতের অর্থনৈতিক ইতিহাসের সন্ধান, আনন্দ পাবলিশার্স, কলকাতা ২০০২  
চক্রবর্তী রণবীর, ভারত ইতিহাসের আদি পর্ব, ওরিয়েন্ট লংম্যান, কলকাতা, ২০০৭  
সেন সমরেন্দ্রনাথ, বিজ্ঞানের ইতিহাস, শৈব্যা প্রকাশন, ১৯৯৬  
শর্মা রামশরণ, ভারতের সামন্ততন্ত্র, (Indian Feudalism), কে পি বাগচি এন্ড কোং, কলকাতা  
শর্মা রামশরণ, আদি মধ্যযুগের ভারতীয় সমাজ: সামন্ত-প্রক্রিয়া বিষয়ে এক সমীক্ষা(Early Medieval Indian  
Society: A Study in Feudalisation), ওরিয়েন্ট লংম্যান, ২০০৩

### **CC-3/GE-3 : History of India from 1206 to1707**

- I. Foundation, Expansion & consolidation of the Delhi Sultanate; Nobility & Iqta system.
- II. Military, administrative & economic reforms under the Khiljis & the Tughlaqs.
- III. Bhakti & Sufi Movements.

IV. Provincial kingdoms: Mewar, Bengal, Vijaynagara & Bahamanis.

V. Second Afghan State.

VI. Emergence and consolidation of Mughal State, C.16<sup>th</sup> century to mid 17th century.

VII. Akbar to Aurangzeb: administrative structure-Mansab & Jagirs, State & Religion, Socio-Religious Movements.

VIII. Economy, Society & Culture under the Mughals.

IX. Emergence of Maratha Power.

### References:

- Irfan Habib: The Agrarian System of Mughal India 1556-1707, Oxford University Press, 1999  
M. Athar Ali: Mughal Nobility under Aurangzeb, Dept. of History, Aligarh Muslim University, 1966  
Shireen Moosvi: The Economy of the Mughal Empire Oxford University Press, 2015  
S.A.A. Rizvi: Muslim Revivalist Movements in Northern India during 16th and 17th Centuries  
R.P. Tripathi: The Rise and Fall of the Mughal Empire, 2 vol. Surjeet Publications, 2014  
I. H. Siddiqui: Some Aspects of Afghan Despotism, Three Men Publication, 1969  
Kesvan Veluthat: Political Structure of Early Medieval South India, Orient Blackswan; 2012  
P.J. Marshall: The Eighteenth Century in Indian History. Oxford University Press 2005  
Stewart Gordon, : The Marathas 1600-1818, Cambridge University Press, 1993  
Percy Brown, Islamic Architecture Taraporevala Sons, 1943.

রায় মিহিরকুমার, ভারতের ইতিহাস (তুরক-আফগান যুগ), পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, দ্বিতীয় মুদ্রণ,  
ফেব্রুয়ারী ১৯৯২

হাবিব ইরফান, মধ্যযুগের ভারতের অর্থনৈতিক ইতিহাস, (Economic History of Medieval India: A  
Survey), প্রগ্রেসিভ পাবলিশার্স

হাবিব ইরফান, মধ্যকালীন ভারত ১-৪ খন্ড (Medieval India) কে পি বাগচি এন্ড কোং, কলকাতা

হাবিবুল্লাহ এ বি এম, ভারতে মুসলিম শাসনের প্রতিষ্ঠা ১২০৬-১২৯০, (The Foundation of Muslim Rule in  
India), প্রগ্রেসিভ পাবলিশার্স, কলকাতা

রায় অনিরুদ্ধ ও চট্টোপাধ্যায় রঞ্জাবলী, মধ্যযুগে বাংলার সমাজ ও সংস্কৃতি, কে পি বাগচি এন্ড কোং, কলকাতা  
১৯৯২

রায় অনিরুদ্ধ, মধ্যযুগের ভারতের ইতিহাস : সুলতানি আমল, ওরিয়েন্ট লংম্যান, কলকাতা

করিম আব্দুল, বাংলার ইতিহাস : সুলতানি আমল, ঢাকা

## **CC-4/GE-4 History of India; 1707-1950.**

- I. Interpreting the 18th Century.
- II. Emergence of Independent States & establishment of Colonial power.
- III. Expansion & consolidation of Colonial Power upto 1857.
- IV. Uprising of 1857: Causes, Nature & Aftermath.
- V. Colonial economy: Agriculture, Trade & Industry.

VI.Socio-Religious Movements in the 19th century.

VII. Emergence &Growth of Nationalism with focus on Gandhian nationalism.

VIII. Communalism: Genesis, Growth and partition of India.

IX. Advent of Freedom: Constituent Assembly, establishment of Republic.

**References:**

- Sugata Bose and Ayesha Jalal: Modern South Asia: History, Culture, Political Economy, New Delhi, 1998
- Sekhar Bandyopadhyay From Plassey to Partition, Orient Longman, 2004.
- Barbara D Metcalf and T.R. Metcalf A Concise History of India, Cambridge, 2002
- C.A. Bayly, An Illustrated History of Modern India 1600 - 1947, London 1990
- Sumit Sarkar, Modern India 1885 - 1947, Macmillan, 1983
- Mushirul Hasan, John Company to the Republic: A story of Modern India, Lotus Collection, 2001
- R.P. Dutt, India Today. 1949
- Thomas Metcalf Ideologies of the Raj. Cambridge University Press, 1995
- R. Jeffery, J Masselos, From Rebellion to the Republic. New Delhi : Sterling Publishers, 1990.
- Bipan Chandra: Nationalism and Colonialism. Sangam Books, 1996.
- Urvashi Butalia The Other side of Silence. Duke University Press, 2000
- Francine Frankel India's Political Economy 1947- 1977. Princeton University Press, 1978.
- Paul Brass The Politics of India since Independence. Publisher: Cambridge University Press, 1994
- Lloyd and Susan Rudolph In Pursuit of Laxmi: the Political Economy of the Indian State, Chicago, 1987
- Bipan Chandra, Aditya Mukherjee, India After Independence, Viking, 1999.
- Gail Omvedt Dalits and Democratic Revolution. Dr. Ambedkar and the Dalit Movement in Colonial India. Pakistan Institute of Development Economics, 1994
- Ramachandra Guha The Fissured Land. Oxford University Press, 1992.
- K.G. Subramanian The Living Tradition: Perspectives on Modern Indian Art. Calcutta : Seagull Books, 1987.
- Radha Kumar A History of Doing. New Delhi: Kali for. Women, 1993.

বন্দ্যোপাধ্যায় শেখর, অষ্টাদশ শতকের মুঘল সংকট ও আধুনিক ইতিহাস চিন্তা, কলকাতা, ১৯৮৩

বন্দ্যোপাধ্যায় শেখর, পলাশী থেকে পার্টিশন: আধুনিক ভারতের ইতিহাস, ওরিয়েন্ট লংম্যান, ২০০৪

ভট্টাচার্য্য সব্যসাচী, ঔপনিবেশিক ভারতের অর্থনীতি, কলকাতা, ২০০০

সুনীল সেন, ভারতে কৃষিকার্য ১৭৯৩-১৯৪৭, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৫

চৌধুরী বিনয় ভূষণ, ঔপনিবেশিক আমলে বাংলার কৃষি ইতিহাস, কে পি বাগচি এন্ড কোং, কলকাতা

ইসলাম, সিরাজুল, বাংলার ইতিহাস ঔপনিবেশিক শাসনকার্যামো, চয়নিকা, ঢাকা, ২০০২

চক্রবর্তী মৃণাল, সিরাজ-উদ্-দৌলা, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা, ১৯৮১

রায় রজতকান্ত, পলাশীর ষড়যন্ত্র ও সেকালের সমাজ, আনন্দ পাবলিশার্স, কলকাতা

চৌধুরী সুনীল, পলাশীর অজানা কাহিনী, আনন্দ পাবলিশার্স, কলকাতা

আলি এম আখার, আওরঙ্গজেবের সময়ে মুঘল অভিজাত শ্রেণী(The Mughal Nobility under Aurangzeb) কে পি বাগচি এন্ড কোং, কলকাতা

বন্দ্যোপাধ্যায় শেখর, অষ্টাদশ শতকের মুঘল সংকট ও আধুনিক ইতিহাস চিন্তা, কলকাতা, ১৯৮৩

ভদ্র গৌতম, মুঘল যুগে কৃষি অর্থনীতি ও কৃষক বিদ্রোহ, সুবর্ণরেখা, কলকাতা, ১৯৮৩

চন্দ্র সতীশ, মুঘল দরবারে দল ও রাজনীতি, (Parties and politics at the Mughal Court 1707-1740) কে পি বাগচি এন্ড কোং, কলকাতা

চৌধুরী বিনয় ভূষণ ও অন্যান্যরা, বাংলার কৃষি সমাজের গঠন, কে পি বাগচি এন্ড কোং, কলকাতা

হাবিব ইরফান, মধ্যকালীন ভারত, খন্ড ১-৪, কে পি বাগচি এন্ড কোং, কলকাতা

হাবিব ইরফান, মুঘল সাম্রাজ্য ও তার পতন- একটি সমীক্ষা, পশ্চিমবঙ্গ ইতিহাস সংসদ, ২০০০

হাবিব ইরফান, মুঘল ভারতের কৃষি ব্যবস্থা, (The Agrarian System of Mughal India(1556-1707)), কে পি বাগচি এন্ড কোং, কলকাতা

হাবিব ইরফান, মধ্যযুগের ভারতের অর্থনৈতিক ইতিহাস, (Economic History of Medieval India: A Survey), প্রগ্রেসিভ পাবলিশার্স, কলকাতা, ২০০৯

হাবিব ইরফান, ভারতের ইতিহাস প্রসঙ্গ: মার্কসীয় চেতনার আলোকে(Essays in Indian History: Towards a Marxist Perception), ন্যাশনাল বুক এজেন্সি, কলকাতা, ১৯৯৯

রায় অনিরুদ্ধ, মধ্যযুগের ভারতের অর্থনৈতিক ইতিহাস, ১২০০-১৭৫৭, প্রগ্রেসিভ পাবলিশার্স, কলকাতা

রায় অনিরুদ্ধ, মুঘল যুগের অর্থনৈতিক ইতিহাস, কে পি বাগচি এন্ড কোং, কলকাতা

সরকার জগদীশ নারায়ণ, মুঘল অর্থনীতি: সংগঠন এবং কার্যক্রম, (Mughal Economy : Organisation and Working) পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা ১৯৯১

সিদ্দিকী নোমান আহমেদ, মোঘল রাজত্বে ভূমিরাজস্ব পরিচালন ব্যবস্থা (১৭০০ – ১৭৫০)(Land Administration Under the Mughals (1700 -1750)) পার্ল পাবলিশার্স, কলকাতা, ১৯৮০

মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস (২য় খন্ড)

(মুঘল ও ব্রিটিশ ভারত, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, কলকাতা ১৯৯৮

চট্টোপাধ্যায় রত্নাবলী, মুঘল যুগের দরবারি চিত্রকলা, থীমা, কলকাতা

বন্দ্যোপাধ্যায় শেখর, পলাশি থেকে পার্টিশান (From Plassey to Partition), ওরিয়েন্ট লংম্যান

দেশাই এ আর, ভারতীয় জাতীয়তাবাদের সামাজিক পটভূমি, (Social Background to Indian Nationalism)

কে পি বাগচি এন্ড কোং, কলকাতা

জয়া চ্যাটার্জী, বাংলা ভাগ হল: হিন্দু সাম্প্রদায়িকতা ও দেশ-বিভাগ, ১৯৩২-১৯৪৭

(Bengal Divided : Hindu Communalism and Partition 1932 – 1947) এল আলমা পাবলিকেশনস, কলকাতা, ২০০৩

দত্ত রজনী পাম, আজিকার ভারত (India Today)

সরকার সুশোভন, বাংলার রেনেসাঁস, (Notes on Bengal Renaissance), দীপায়ন, কলকাতা

ত্রিপাঠী অমলেশ, ভারতের মুক্তিসংগ্রামে চরমপন্থী পর্ব, (The Extremist Challenge) আনন্দ পাবলিশার্স, কলকাতা

মুখোপাধ্যায় হীরেন্দ্রনাথ, ভারতবর্ষের ইতিহাস(২য় খন্ড) (মুঘল ও ব্রিটিশ ভারত) পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ৪র্থ মুদ্রণ, ১৯৯৮

সুর নিখিল, ভারতীয় জাতীয়তাবাদী আন্দোলনের পটভূমি, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৮৯

চট্টোপাধ্যায় প্রণবকুমার, আধুনিক ভারত (১৮৫৮-১৯২০) (১ম খন্ড) পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৯৮



চট্টোপাধ্যায় প্রণবকুমার, আধুনিক ভারত (১৯২০-১৯৪৭) (২য় খন্ড) পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ, ১৯৯৯  
সেন সুনীল, ভারতে কৃষিসম্পর্ক(১৭৯৩-১৯৪৭)(Agrarian Relations in India (1793-1847)) পশ্চিমবঙ্গ  
রাজ্য পুস্তক পর্ষদ, ১৯৮৫

## **DSE Discipline Specific Elective (Any Two):**

### **DSE –A -1: National Liberation Movements in 20th century World**

I.Nationalism: Theory and Practice.

II. Nature of Imperialism and colonialism

III. National Movements in Nigeria, Kenya, Congo, Angola  
&South Africa.

IV.China between 1911-1949:Revolution of 1911,May Fourth Movement and Cultural  
Revolution under Mao Tse Tung. Indonesian Revolution 1945-1949.

V. National Movement in India.

#### **References:**

Lucian Bianco, Origins of the Chinese Revolution, 1915-1946. Stanford University Press, 1971.

A.J.Temu & Roger Owen eds , Studies in the theory of Imperialism,1970.

E.F.Penrose, ed., European Imperialism the partition of Africa,1980.

Milton Osborne, Southeast Asia: An Introductory History. 1995

Sumit Sarkar, Modern India, Macmillan, 1984.

ত্রিপাঠী অমলেশ, স্বাধীনতা সংগ্রামে ভারতের জাতীয় কংগ্রেস, আনন্দ পাবলিশার্স, কলকাতা

চন্দ্র বিপান, আধুনিক ভারতঃ ঔপনিবেশিকতাবাদ ও জাতীয়তাবাদ(Nationalism and Colonialism), কে পি  
বাগচি এন্ড কোং, কলকাতা

চন্দ্র বিপান এবং অন্যান্য, ভারতের স্বাধীনতা সংগ্রাম, (India's Struggle for Independence) কে পি বাগচি  
এন্ড কোং, কলকাতা

চন্দ্র বিপান এবং অন্যান্য, ভারতবর্ষ – স্বাধীনতার পরে, (India after Independence), আনন্দ পাবলিশার্স, কলকাতা

## **DSE- A -2: Some Aspects of European History: C.1780-1945**

I.The French Revolution: Genesis Nature & Consequences

II.Napoleonic Era and aftermath.

III.Revolutions of 1830 & 1848.

IV.Unification of Italy & Germany.

V.Social and economic Changes.

VI. Imperialist Conflicts: World War I

VII.Rise of Fascism and Nazism.

VIII. Origins of World War II

### **References:**

E.J. Hobsbawm: The Age of Revolution. London : Weidenfeld & Nicolson, 1962.

Lynn Hunt: Politics, Culture and Class in the French Revolution. Berkeley: University of California Press, 1984.

Andrew Porter, European Imperialism, 18760 -1914 (1994).

E.J. Hobsbawm, The Age of Extremes, 1914 - 1991, New York: Vintage, 1996

Carter V. Findley and John Rothey, Twentieth-Century World,Boston: Houghton-Mifflin, 5th ed. 2003

## **DSE- B-1: Patterns of Capitalism in Europe: C.16TH Century to early 20th Century**

I.Definitions & Concepts

II.Commercial Capitalism: 1500-1700

III.Industrial Revolution in England: Causes &Nature

IV.Industrial Capitalism in France: Genesis & Nature

V. Growth of Industries in Germany

VI.Impact of Industrial Revolution on European Society, Polity & Economy.

### **References:**

Jerry Müller, *The Mind &the Market*, Knopf Doubleday Publishing Group, 2007

Karl Polanyi, *The Great Transformation : The Political and Economic Origins of Our Time.*  
Boston: Beacon Press 1944.

Joseph Schumpeter, *Capitalism, Socialism &Democracy* New York: Harper & Row, 1942.

Wallerstein, *World System Analysis: An Introduction*, 2004

Cipolla Carlo, M, *Fontana Economic History of Europe*, VOL I&II Collins, 1973.

Christopher Hill, *From Reformation to Industrial Revolution*, Weidenfeld and Nicolson, 1967

Jan De Vries, *The Industrial Revolution &the Industrious Revolution*, 1994

## **DSE-B-2: Some aspects of Society & Economy of Modern Europe: 15<sup>th</sup> – 18<sup>th</sup> Century**

I: Historiographical Trends

II. Feudal Crisis: Main strands

III. Renaissance: Origin, Spread & Dominant Features

IV. European Reformation: Genesis, nature & Impact

V. Beginning of the era of colonization: motives; mining and plantation; the African slaves

VI. Economic developments of the sixteenth century; Shift of economic balance from the Mediterranean to the Atlantic

VII. Transition from Feudalism to Capitalism: Industrial Revolution in England

### **References:**

J H Plumb, *The Pelican Book of the Renaissance*, Penguin, 1982

G. R. Elton, *Reformation Europe 1517, 1559*, Wiley, 1999

Ralph Davis, *The Rise of the Atlantic Economies*, New York, 1973

Arvind Sinha, *Europe in Transition*, Delhi, 2010

Rodney Hilton, *The Transition from Feudalism to Capitalism*, Delhi, 2006.

Fernand Braudel, *Civilization and Capitalism*, Vols. I, II, III, California, 1992

Butterfield, Herbert. *The origins of modern science*. Vol. 90507. Free Press, 1997

গৌতম চট্টোপাধ্যায় সম্পাদিত: দুশো বছরের আলোকে, পশ্চিমবঙ্গ ইতিহাস সংসদ, ১৯৮৯  
চক্রবর্তী, ফরাসী বিপ্লব, পশ্চিমবঙ্গ পুস্তক পর্ষদ, কলকাতা  
চক্রবর্তী সুভাষ রঞ্জন, ইউরোপের ইতিহাস, পশ্চিমবঙ্গ পুস্তক পর্ষদ, কলকাতা, ১৯৮৬  
জ্যাকসন টি এ, ফরাসী বিপ্লব – দশ দিগন্ত, কে পি বাগচি এন্ড কোং, কলকাতা ২০০৪  
টমসন ডেভিড, বিশ্ব ইতিহাসের প্রেক্ষাপটে ইউরোপ, ১ম খন্ড (১৭৮৯-১৮৫০), ২য় খন্ড (১৮৫১-১৯১৪)  
প্রগ্রেসিভ পাবলিশার্স, কলকাতা ২০০২ ও ২০০৩  
রায় সিদ্ধার্থ গুহ, আধুনিক ইউরোপ: ফরাসী বিপ্লব থেকে দ্বিতীয় বিশ্বযুদ্ধ, প্রগতিশীল প্রকাশক, কলকাতা, ২০১৩

## **Skill Enhancement Elective Course (SEC) Credits,-2**

### **SEC-A- 1: Historical Tourism: Theory &Practice**

#### **I. Defining Heritage**

Art &Architecture in India: An overview:

Field Work: Visit to historical sites &Museums

#### **II. Understanding Built Heritage:**

Stupa Architecture

Temple Architecture

Indo Persian Architecture, Forts, Palaces, Mosques

Colonial Architecture

Present day structures

#### **III. Field Work: Visit to site &Conducting of research**

#### **IV. Modalities of conducting tourism**

#### **References:**

Sunil Kumar, The Present in Delhi's Past, Delhi, Gyan Publishing House, 2002

Peter Howard, Heritage: Management, Interpretation, Identity, and London, 2003

V.S Agarwal, Indian Art, Varanasi, Prithvi Prakasahan, 1972

Percy Brown, Indian Architecture, Bombay, D.B.Taraporevala Sons &Co, 1940

James Harle, The Art & Architecture of the Indian Subcontinent, Harmondsworth, Penguin, 1988

S.K.Bhowmik, Heritage Management: Care, Understanding & Appreciation of Cultural Heritage, Jaipur, 2004.

### **SEC-B -1: Museums &Archives in India**

#### **I. Definitions**

#### **II. History of setting up of Museums and Archives: Some case Studies**

III. Field Work; Studying of structures & Functions

IV. Training & Employment

**References:**

G. Edson & Dean David, Handbook for Museum, London, Routledge, 1986  
John Ridener, From Folders to Post Modernism: A Concise History of Archival Theory, 2009  
Roychowdhury, Madhuparna. Displaying India's Heritage : Archaeology and the Museum Movement in Colonial India. Delhi: Orient Blackswan 2015  
Sengupta, S. Experiencing History Through Archives. Delhi: Munshiram Manoharlal. 2004.

## **SEC-A -2: Indian History & Culture**

**I. Environment; Culture, Tradition & Practices:**

- Historical overview
- Oral & codified information on medicinal Plants
- Water & Water Bodies
- Fieldwork

**II. Urbanization & Urbanism:**

- Issues of settlements & Landscapes
- Social differentiations
- Communication networks

**III. Social inequality & Gender:**

- Status within Households: An overview
- Present context
- Issues of Violence
- Employment, distribution of resources

**IV. Cultural Heritage:**

- Main components
- Built Heritage
- Historical Tourism

**V. Cultural Forms & Cultural Expressions:**

- Performing Arts
- Fairs & Festivals
- Fieldwork

**References:**

Indu Banga, ed. The City in Indian History: Urban Demography, Society & Polity, Delhi, Manohar, 1991  
Koch, E. Mughal Art & Imperial Ideology, New Delhi ; New York : Oxford University Press, 2001.  
Radha Kumar, History of Doing: An Illustrated Account of Movements for Women's Rights & Feminism in India 1880-1990, Zubaan, 2007  
V. Vasudev, Fairs & Festivals, Incredible India Series, 2007  
V. Singh, The Human Footprint on Environment: Issues in India, New Delhi, and Macmillan, 2012

B. Parikh, Composite Culture in a multicultural Society, Delhi, NBT, 2007  
N. Mehta, Introduction: Satellite Television, Identity & Globalization in Contemporary India in  
N. Mehta, ED, Television in India, New York, Routledge, 2008

## **SEC-B- 2: Orality and Oral Culture in India**

I. Defining orality

II. History & Historiography of Orality

III. Life Histories: Sociological Aspects

IV. Research Methodologies

V. Documentation: Written & Visual

### **References:**

H. Roberts. Ed. Doing Feminist Research, London: Routledge & Kegan Paul, 1981  
John Miles Foley, Oral Formulaic-Theory: An Introduction & Annotated Bibliography, New York & London: Garland, 1985  
M.F.D. Knowledge & Control, London, 1971  
  
Prasad M. Mahadeva, Ideology of the Hindi Film: A Historical Construction. Delhi: OUP, 1998  
Srirupa Roy, 'The Post Colonial State & Visual Representations of India' Contributions to Indian Sociology, 2006, 36, 1&2: 233-263  
  
Stephen Humphries: The Handbook of Oral History: recording life stories. University of Michigan : Inter-Action Inprint, 1984.  
  
Veena Das, ed, Mirrors of Violence: Communities, Riots & Survivors in South Asia, Delhi, OUP, 1990

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# UNIVERSITY OF CALCUTTA

## Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

### List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies ( General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE  
KOLKATA-700073  
The 4<sup>th</sup> June, 2018

*Paul*  
4/6/18  
(Dr. Santanu Paul)  
Deputy Registrar

**UNIVERSITY OF CALCUTTA**

**CBCS SYLLABUS OF ZOOLOGY  
2018**

**F  
O  
R**

**THREE-YEAR HONOURS  
DEGREE COURSE OF STUDIES**



## Outline Structure of CBCS Curriculum for Zoology (Hons), C.U.

<b>PART I; SEM I</b>				
Subject Code	Name of Paper	Theory	Practical	Internal assessment
CC 1	Non Chordata – I (Protists to Pseudocoelomates)	50	30	20
CC 2	Molecular Biology	50	30	20
<b>PART I; SEM II</b>				
CC 3	Non Chordata – II (All Coelomate Phyla)	50	30	20
CC 4	Cell Biology	50	30	20
<b>PART II; SEM III</b>				
CC 5	Chordata	50	30	20
CC 6	Animal Physiology: Controlling & Co-ordinating System	50	30	20
CC 7	Fundamentals of Biochemistry	50	30	20
SEC-A (1/2)	Apiculture / Sericulture	80	NA	20
<b>PART II; SEM IV</b>				
CC 8	Comparative Anatomy of Vertebrate	50	30	20
CC 9	Animal Physiology: Life sustaining system	50	30	20
CC 10	Immunology	50	30	20
SEC- B(1/2)	Aquarium Fisheries/ Medical Diagnosis	80	NA	20
<b>PART III; SEM V</b>				
CC 11	Ecology	50	30	20
CC 12	Principle of Genetics	50	30	20
DSE A(1/2)	Parasitology/Biology of Insect	50	30	20
DSE B (1/2)	Endocrinology/Reproductive Biology	50	30	20
<b>PART III; SEM VI</b>				
CC 13	Developmental Biology	50	30	20
CC 14	Evolutionary Biology	50	30	20
DSE A (1/2)	Animal Biotechnology/Animal Cell Biotechnology	50	30	20
DSE B (1/2)	Animal Behaviour & Chronology/Fish & Fisheries	50	30	20

### Abbreviations:

CC: Core Course; DSE A/B: Discipline Specific Elective A/B; SEC A/B: Skill Enhancement Course.

## SUBJECT/PAPER CODE FORMAT

1. Subject Code: ZOO
2. Honours Code: A
3. Course Code: a) Core Course: CC  
b) Discipline Specific Elective: DSE-A/DSE-B  
c) Skill Enhancement Course: SEC-A/SEC-B
4. Semester Code: 1/2/3/4/5/6
5. Paper No. Code: 1/2/3...../14
6. Paper Component Code: a) Theory: TH, b) Practical: P

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#### CBCS ZOOLOGY (HONOURS), Papers & Their Codes

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ZOOA-CC1-2-TH	Molecular Biology	6
ZOOA-CC1-2-P	Molecular Biology Lab	7
ZOOA-CC2-3-TH	Non-Chordate II (Coelomate Phyla) Theory	7
ZOOA-CC2-3-P	Non-Chordate II Lab	8
ZOOA-CC2-4-TH	Cell Biology Theory	8
ZOOA-CC2-4-P	Cell Biology Lab	9
ZOOA-CC3-5-TH	Chordata Theory	9
ZOOA-CC3-5-P	Chordata Lab	10
ZOOA-CC3-6-TH	Animal Physiology: Controlling & Co-ordinating system Theory	11
ZOOA-CC3-6-P	Animal Physiology: Controlling & Co-ordinating system Lab	11
ZOOA-CC3-7-TH	Fundamental of Biochemistry Theory	12
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ZOOA-CC4-8-TH	Comparative Anatomy of Vertebrate Theory	13
ZOOA-CC4-8-P	Comparative Anatomy of Vertebrate Lab	14
ZOOA-CC4-9-TH	Animal Physiology: Life Sustaining System Theory	14
ZOOA-CC4-9-P	Animal Physiology: Life Sustaining System Lab	15
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ZOOA-CC5-12-TH	Principle of Genetics Theory	17
ZOOA-CC5-12-P	Principle of Genetics Lab	18
ZOOA-CC6-13-TH	Developmental Biology Theory	18
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ZOOA-SEC(A)-4-1-TH	Aquarium Fishery	31
ZOOA-SEC(A)-4-2-TH	Medical Diagnosis	31

**PART I: SEMESTER 1**  
**CORE COURSE 1. Non-Chordates I**  
**ZOOA-CC1-1-TH**

Full Marks 50	4 Credits	50 Hours
<b>Non-Chordates I: Protists to Pseudocoelomates</b>		
<b>Unit 1: Basics of Animal Classification</b>		4
Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Concept of classification – three kingdom concept of Carl Woese, 1977 and five kingdom concept of Whittaker, 1969		
<b>Unit 2: Protista and Metazoa</b>		15
<b>Protozoa</b> General characteristics and Classification up to phylum (according to Levine <i>et. al.</i> , 1980) Locomotion in <i>Euglena</i> , <i>Paramoecium</i> and <i>Amoeba</i> ; Conjugation in <i>Paramoecium</i> . Life cycle and pathogenicity of <i>Plasmodium vivax</i> and <i>Entamoeba histolytica</i>		
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<b>Unit 3: Porifera</b>		6
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<b>Unit 4: Cnidaria</b>		10
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.), Metagenesis in <i>Obelia</i> ; Polymorphism in Cnidaria; Corals and coral reef diversity, Role of symbiotic algae in reef formation. Conservation of coral and coral reefs.		
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General characteristics		
<b>Unit 6: Platyhelminthes</b>		6
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.) Life cycle and pathogenicity and control measures of <i>Fasciola hepatica</i> and <i>Taenia solium</i>		
<b>Unit 7: Nematoda</b>		7
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.) Life cycle, and pathogenicity and control measures of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i> Parasitic adaptations in helminthes		

## Non-Chordates I Lab; ZOOA-CC-1-1-P

### Non-Chordates I: Protists to Pseudocoelomates

<b>Full Marks 30</b>	<b>60 Hours</b>	2 credits
<b>List of Practical</b>		
Study of whole mount of <i>Euglena</i> , <i>Amoeba</i> and <i>Paramecium</i>		
Identification with reason & Systematic position of <i>Amoeba</i> , <i>Euglena</i> , <i>Entamoeba</i> , <i>Paramecium</i> , <i>Plasmodium</i> , <i>Balantidium</i> , <i>Vorticella</i> (from the prepared slides)		
Identification with reason & Systematic position of <i>Sycon</i> , <i>Potterion</i> (Neptune's Cup), <i>Obelia</i> , <i>Physalia</i> , <i>Aurelia</i> , <i>Gorgonia</i> , <i>Metridium</i> , <i>Pennatulula</i> , <i>Madrepore</i> , <i>Fasciola hepatica</i> , <i>Taenia solium</i> and <i>Ascaris lumbricoides</i> .		
Staining/mounting of any protozoa/helminth from gut of <i>Periplaneta</i> sp.		

## CORE COURSE 2: Molecular Biology

### ZOOA-CC1-2-TH

<b>Full Marks 50</b>	4 Credits	50 Hours
<b>Unit 1: Nucleic Acids</b>		3
Salient features of DNA, Chargaff's Rule, Hypo and Hyperchromic shift. Watson and Crick Model of DNA. RNA types & Function.		
<b>Unit 2: DNA Replication</b>		9
Mechanism of DNA Replication in Prokaryotes, Prove that replication is Semi-conservative, bidirectional and discontinuous, RNA priming, Replication of telomeres.		
<b>Unit 3: Transcription</b>		9
Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.		
<b>Unit 4: Translation</b>		9
Genetic code, Degeneracy of the genetic code and Wobble Hypothesis. Mechanism of protein synthesis in prokaryotes.		
<b>Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA</b>		8
Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing and RNA editing		

<b>Unit 6: Gene Regulation</b>	7
Regulation of Transcription in prokaryotes: <i>lac</i> operon and <i>trp</i> operon; Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing. Epigenetic Regulation: DNA Methylation, Histone Methylation & Acetylation.	
<b>Unit 7: DNA Repair Mechanisms</b>	2
Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair	
<b>Unit 8: Molecular Techniques</b>	3
PCR, Western and Southern blot, Northern Blot	

### Molecular Biology Lab; ZOOA-CC-1-2-P

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Demonstration of polytene and lampbrush chromosome from photograph</li> <li>2. Isolation and quantification of genomic DNA from goat liver.</li> <li>3. Agarose gel electrophoresis for DNA.</li> <li>4. Histological staining of DNA and RNA in prepared slides</li> </ol>		

## PART I: SEMESTER 2

### CORE COURSE 3: Non-Chordates II – Coelomates

#### ZOOA-CC2-3-TH

<b>Full Marks 50</b>	4 Credits	50 Hours
<b>Unit 1: Introduction</b>	2	
Evolution of coelom		
<b>Unit 2: Annelida</b>	10	
General characteristics and Classification up to classes (Ruppert and Barnes, 1994) Excretion in Annelida through nephridia; Metamerism in Annelida.		
<b>Unit 3: Arthropoda</b>	16	
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Insect Eye (Cockroach only). Respiration in Prawn and Cockroach; Metamorphosis in Lepidopteran Insects; Social life in Termite		
<b>Unit 4: Onychophora</b>	2	
General characteristics and Evolutionary significance		



<b>Unit 5: Mollusca</b>	10
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Nervous system in <i>Pila sp.</i> Torsion in Gastropoda. Feeding and respiration in <i>Pila sp.</i>	
<b>Unit 6: Echinodermata</b>	8
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Water-vascular system in <i>Asterias</i> . Echinoderm larva and affinities with chordates	
<b>Unit 7: Hemichordata</b>	2
General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates	

## Non-Chordates II Lab, ZOOA-CC-2-3-P

<b>Full Marks 30</b>	<b>2 Credits</b>
<b>List of Practical</b>	
<ol style="list-style-type: none"> <li>Study of following specimens: <ol style="list-style-type: none"> <li>Annelids - <i>Aphrodite</i>, <i>Nereis</i>, <i>Chaetopterus</i>, Earthworm, <i>Hirudinaria</i></li> <li>Arthropods - <i>Limulus</i>, <i>Palaemon</i>, <i>Balanus</i>, <i>Eupagurus</i>, <i>Scolopendra</i>, <i>Peripatus</i>, Silkworm – life history stages, Termite – members of a colony and Honey bee – members of the colony</li> <li>Molluscs - <i>Dentalium</i>, <i>Patella</i>, <i>Chiton</i>, <i>Pila</i>, <i>Achatina</i>, <i>Pinctada</i>, <i>Sepia</i>, <i>Octopus</i>, <i>Nautilus</i></li> <li>Echinoderms - <i>Asterias</i>, <i>Ophiura</i>, <i>Clypeaster</i>, <i>Echinus</i>, <i>Cucumaria</i> and <i>Antedon</i></li> </ol> </li> <li>Anatomy study: Nervous system, Reproductive system (Male &amp; female), Mouth parts &amp; Salivary apparatus in <i>Periplaneta sp.</i></li> </ol>	

## PART I: SEMESTER 2

### CORE COURSE 4: Cell Biology

### ZOOA-CC2-4-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Plasma Membrane</b>		7
Ultra-structure and composition of Plasma membrane: Fluid mosaic model, Transport across membrane - Active and Passive transport, Facilitated transport, Cell junctions: Tight junctions, Gap junctions, Desmosomes		
<b>Unit 2: Cytoplasmic organelles I</b>		5
Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes; Protein sorting and mechanisms of vesicular transport		
<b>Unit 3: Cytoplasmic organelles II</b>		7
Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemiosmotic hypothesis; Peroxisomes: Structure and Functions		

Centrosome (Kinetochore and centromeric DNA): Structure and Functions	
<b>Unit 4: Cytoskeleton</b>	5
Type, structure and functions of cytoskeleton; Accessory proteins of microfilament & microtubule	
<b>Unit 5: Nucleus</b>	8
Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome),	
<b>Unit 6: Cell Cycle</b>	10
Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras. Process of Proto-oncogene activation	
<b>Unit 7: Cell Signalling</b>	8
Cell signalling transduction pathways; Types of signalling molecules and receptors (Classification and Example only): RTK & JAK/STAT. Apoptosis	

### Cell Biology Lab; ZOOA-CC-2-4-P

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Preparation of temporary stained squash of onion/arum root tip to study various stages of mitosis</li> <li>2. Study of various stages of meiosis from grasshopper testis</li> <li>3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.</li> <li>4. Preparation of permanent slide to demonstrate: <ol style="list-style-type: none"> <li>a. DNA by Feulgen reaction</li> <li>b. Cell viability study by Trypan Blue staining</li> </ol> </li> </ol>		

## PART II: SEMESTER 3.

### CORE COURSE 5 : Chordata

#### ZOOA-CC3-5-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Introduction to Chordates</b>		2
General characteristics and outline classification of Phylum Chordata (Young, 1981)		
<b>Unit 2: Protochordata</b>		7
General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes (Young, 1981). Metamorphosis in <i>Ascidia</i> . Chordate Features, structure of pharynx and feeding in <i>Branchiostoma</i>		

<b>Unit 3: Agnatha</b>	2
General characteristics and classification of cyclostomes up to order (Young, 1981)	
<b>Unit 4: Pisces</b>	7
General characteristics and classification up to living sub classes (Young, 1981); Accessory respiratory organ, Migration in fishes; Parental care in fishes; Swim bladder in fishes.	
<b>Unit 5: Amphibia</b>	7
General characteristics and classification up to living Orders (Young, 1981); Metamorphosis, Paedomorphosis, Parental care in Amphibia	
<b>Unit 6: Reptilia</b>	8
General characteristics and classification up to living Orders (Young, 1981); Poison apparatus and Biting mechanism in Snake. Poisonous & Non-Poisonous snake.	
<b>Unit 7: Aves</b>	8
General characteristics and classification up to living Sub-Classes (Young, 1981); Exoskeleton and migration in Birds; Principles and aerodynamics of flight	
<b>Unit 8: Mammals</b>	9
General characters and classification up to living sub classes (Young, 1981); Exoskeleton derivatives of mammals; Adaptive radiation in mammals with reference to locomotory appendages; Echolocation in Micro chiropterans	

### Chordata Lab; ZOOA-CC-3-5-P

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<p>Identification with Reasons</p> <ol style="list-style-type: none"> <li><b>Protochordata:</b> <i>Balanoglossus</i>, <i>Branchiostoma</i></li> <li><b>Agnatha:</b> <i>Petromyzon</i></li> <li><b>Fishes:</b> <i>Scoliodon</i>, <i>Sphyrna</i>, <i>Pristis</i>, <i>Torpedo</i>, <i>Mystus</i>, <i>Heteropneustes</i>, <i>Labeo rohita</i>, <i>Exocoetus</i>, <i>Hippocampus</i>, <i>Anabas</i>, Flat fish</li> <li><b>Amphibia:</b> <i>Necturus</i>, <i>Bufo</i> (<i>Duttaphrynus</i>) <i>melanostictus</i>, <i>Rana</i> (<i>Hoplobatrachus</i>) <i>tigerinus</i>, <i>Hyla</i>, <i>Tylotriton</i>, Axolotl larva</li> <li><b>Reptilia:</b> <i>Chelone</i>, <i>Trionyx</i>, <i>Hemidactylus</i>, <i>Varanus</i>, <i>Calotes</i>, <i>Chamaeleon</i>, <i>Draco</i>, <i>Vipera</i>, <i>Naja</i>, <i>Hydrophis</i>,</li> <li><b>Mammalia:</b> Bat (Insectivorous and Frugivorous), <i>Funambulus</i> (Indian Palm squirrel)</li> </ol> <p>Dissection of brain and pituitary – <i>ex situ</i>, digestive and Urino-genital system of <i>Tilapia</i></p> <p>Pecten from Fowl head</p> <p>Power point presentation on study of habit, habitat or behaviour of any one animal by student – for internal assessment only</p>		

## PART II: SEMESTER 3.

### CORE COURSE 6: Animal Physiology: Controlling and Co-ordinating System

#### ZOOA-CC3-6-TH

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Tissues</b>		4
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue		
<b>Unit 2: Bone and Cartilage</b>		4
Structure and types of bones and cartilages, Ossification		
<b>Unit 3: Nervous System</b>		10
Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and non-myelinated nerve fibres; Types of synapse, Synaptic transmission and Neuromuscular junction		
<b>Unit 4: Muscular system</b>		10
Histology of different types of muscle; Ultra-structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre		
<b>Unit 5: Reproductive System</b>		6
Histology of mammalian testis and ovary; physiology of mammalian reproduction – menstrual and oestrous cycle		
<b>Unit 6: Endocrine System</b>		16
Histology and function of thyroid, pancreas and adrenal. Function of pituitary  Classification of hormones; Mechanism of Hormone action; Signal transduction pathways for Steroidal and Non- steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary; Placental hormones		

### Animal Physiology: Controlling & Coordinating Systems, Lab;

#### ZOOA-CC3-6-P

Full Marks 30	60 Hours	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Recording of cardiac and simple muscle twitch with electrical stimulation</li> <li>2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells</li> <li>3. Study of permanent slides of Mammalian Skin, Spinal cord, Pancreas, Testis, Ovary, Adrenal, Lung, pyloric stomach, cardiac stomach, Thyroid, small intestine and large intestine of mammal (white rat)</li> <li>4. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues</li> </ol>		

**PART II: SEMESTER 3**  
**CORE COURSE 7: Fundamentals of Biochemistry**  
**ZOOA-CC3-7-TH**

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Carbohydrates</b>		8
Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosaccharides; Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis		
<b>Unit 2: Lipids</b>		7
Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpenoids. Lipid metabolism: $\beta$ -oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleic acid {unsaturated (C 18:2)}; Fatty acid biosynthesis		
<b>Unit 3: Proteins</b>		10
Amino acids: Structure, Classification, General and Electro chemical properties of $\alpha$ -amino acids; Physiological importance of essential and non-essential amino acids, Proteins Bonds stabilizing protein structure; Levels of organization; Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids		
<b>Unit 4: Nucleic Acids</b>		10
Structure of Purines, Pyrimidines, Nucleosides and Nucleotides; Nucleic Acid Metabolism: Catabolism of adenosine, Guanosine, cytosine and thymine.		
<b>Unit 5: Enzymes</b>		13
Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition.		
<b>Unit 5: Oxidative Phosphorylation</b>		2
Redox systems; Mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System		

## Fundamentals of Biochemistry Lab; ZOOA-CC-7-3-P

Fundamentals of Biochemistry		
Full Marks 30	60 Hours	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Qualitative tests for carbohydrates, proteins and lipids</li> <li>2. Qualitative estimation of Urea &amp; Uric acid</li> <li>3. Paper chromatography of amino acids.</li> <li>4. Quantitative estimation of water soluble proteins following Lowry Method</li> </ol>		

### PART II: SEMESTER 4

#### CORE COURSE 8.Comparative Anatomy of Vertebrates

#### ZOOA-CC4-8-TH

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Integumentary System</b>		10
Structure, function and derivatives of integument in amphibian, birds and mammals		
<b>Unit 2: Digestive System</b>		6
Comparative anatomy of stomach; dentition in mammals		
<b>Unit 3: Respiratory System</b>		6
Respiratory organs in fish, birds and mammals		
<b>Unit 4: Circulatory System</b>		7
General plan of circulation, Comparative account of heart and aortic arches		
<b>Unit 5: Urinogenital System</b>		5
Succession of kidney in different vertebrate groups; evolution of urino-genital ducts		
<b>Unit 6: Nervous system and sense organs</b>		8
Comparative account of brain in vertebrates; cranial nerves; olfactory and auditory receptors in vertebrates		
<b>Unit 7: Skeletal system</b>		8
Overview of axial and appendicular skeleton – limbs, girdles of pigeon; jaw suspension in mammals		

## Comparative Anatomy of Vertebrates Lab; ZOOA-CC4-8-P

Full Marks 30	60 Hours	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs</li> <li>2. Study of disarticulated skeleton of toad, Pigeon, Guineapig (limb bones, vertebrae, limb and girdle)</li> <li>3. Comparative study of heart and brain, with the help of model/picture</li> <li>4. Identification of skulls: Pigeon, one herbivore (Guineapig) and one carnivore (Dog) animal</li> </ol>		

## PART II: SEMESTER 4

### CORE COURSE 9: Animal Physiology: Life Sustaining Systems

#### ZOOA-CC4-9-TH

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Physiology of Digestion</b>		10
Structural organisation and function of gastro-intestinal tract; Mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids and Proteins in Human		
<b>Unit 2: Physiology of Respiration</b>		10
Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning		
<b>Unit 3: Physiology of Circulation</b>		8
Structure and functions of haemoglobin; Blood clotting system; Haematopoiesis; Basic steps and its regulation; Blood groups; ABO and Rh factor		
<b>Unit 4: Physiology of Heart</b>		8
Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses; Cardiac Cycle and cardiac output		
<b>Unit 5: Thermoregulation &amp; Osmoregulation</b>		6
Thermal regulation in camel and polar bear, Osmoregulation in aquatic vertebrates		
<b>Unit 6: Renal Physiology</b>		8
Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-base balance		

## Animal Physiology: Life Sustaining Systems Lab; ZOOA-CC4-9-P

Full Marks 30	60 Hours	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Determination of ABO Blood group</li> <li>2. Estimation of haemoglobin using Sahli's haemoglobin meter</li> <li>3. Identification of blood cells from human blood</li> <li>4. Preparation of haemin crystals and haemochromogen crystals</li> <li>5. Identification of blood cells from cockroach haemolymph</li> <li>6. Demonstration of blood pressure by digital meter</li> </ol>		

## PART II: SEMESTER 4

### CORE COURSE 10: Immunology

### ZOOA-CC4-10-TH

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Overview of Immune System</b>		3
Introduction – concept of health and disease; Cells and organs of the Immune system		
<b>Unit 2: Innate and Adaptive Immunity</b>		9
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).		
<b>Unit 3: Antigens</b>		6
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes		
<b>Unit 4: Immunoglobulins</b>		10
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Monoclonal antibody production		
<b>Unit 5: Major Histocompatibility Complex</b>		6
Structure and functions of MHC molecules. Structure of T cell Receptor and its signalling, T cell development & selection		
<b>Unit 6: Cytokines</b>		3
Types, properties and functions of cytokines.		



<b>Unit 7: Complement System</b>	5
Components and pathways of complement activation.	
<b>Unit 8: Hypersensitivity</b>	4
Gell and Coombs' classification and brief description of various types of hypersensitivities.	
<b>Unit 9: Vaccines</b>	4
Various types of vaccines. Active & passive immunization (Artificial and natural).	

### Immunology Lab; ZOOA-CC4-10-P

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Demonstration of lymphoid organs (by picture).</li> <li>2. Histological study of Bursa fabricius, spleen, thymus and lymph nodes through slides/ photographs</li> <li>3. Demonstration of ELISA</li> </ol>		

### PART III: SEMESTER 5

#### CORE COURSE 11.Ecology

#### ZOOA-CC5-11-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Introduction to Ecology</b>	4	
Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.		
<b>Unit 2: Population</b>	20	
Unitary and Modular populations Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors, Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition.		
<b>Unit 3: Community</b>	11	
Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect; Ecological succession with one example.		

<b>Unit 4: Ecosystem</b>	8
Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow, Ecological pyramids and Ecological efficiencies; Nitrogen cycle.	
<b>Unit 5: Applied Ecology</b>	7
Types & level of biodiversity Mega-diversity countries, Biodiversity Hot spot, Flagship species, Keystone species, Wildlife Conservation ( <i>in situ</i> and <i>ex situ</i> conservation), concept of protected areas. Red data book, Indian wild life act & Schedule. Concept of corridor, advantages and problem of corridor. <u>Threats to survival and conservation strategies for Tiger, Olive ridley, White Rumped Vulture.</u>	

### Ecology Lab, ZOOA-CC5-11-P

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community</li> <li>2. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, salinity, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO<sub>2</sub></li> <li>3. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/ any place of ecological interest/ ecological uniqueness/ Zoological garden</li> </ol>		

3. Report was prepared on threat to survival and conservation strategies for Tiger/Olive Ridley/White rumped vulture .

### PART III: SEMESTER 5

#### CORE COURSE 12.Principle of Genetics

#### ZOOA-CC5-12-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>Class</b>
<b>Unit 1: Mendelian Genetics and its Extension</b>	12	
Principles of inheritance, Incomplete dominance and co-dominance, Epistasis, Multiple alleles, Isoallele (White eye mutations), Pseudoallele (Lozenge Locus) & Cis-trans test for allelism, Lethal alleles, Pleiotropy, Penetrance & Expressivity		
<b>Unit 2: Linkage, Crossing Over and Linkage Mapping</b>	8	
Linkage and Crossing, Complete & Incomplete Linkage, Measuring Recombination frequency and linkage map construction using three factor crosses, Interference and coincidence Sex linkage in <i>Drosophila</i> (White eye locus) & Human (Haemophilia).		

<b>Unit 3: Mutations</b>	12
Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example from <i>Drosophila</i> and Human of each), variation in chromosome number; Non-disjunction of X chromosome in <i>Drosophila</i> ; Non-disjunction of Human Chromosome 21. Molecular basis of mutations in relation to UV light and chemical mutagens. Mutation detection in <i>Drosophila</i> by attached X method. Biochemical mutation detection in <i>Neurospora</i> .	
<b>Unit 4: Sex Determination</b>	8
Mechanisms of sex determination in <i>Drosophila</i> and in man; Dosage compensation in <i>Drosophila</i> & Human	
<b>Unit 5: Extra-chromosomal Inheritance</b>	2
Kappa particle in <i>Paramoecium</i> , Shell spiralling in snail	
<b>Unit 6: Genetic Fine Structure</b>	2
Complementation test in Bacteriophage (Benzer's experiment on rII locus)	
<b>Unit 7: Transposable Genetic Elements</b>	6
IS element in bacteria, Ac-Ds elements in maize and P elements in <i>Drosophila</i> , LINE, SINE, Alu elements in humans	

### Principles of Genetics Lab, ZooA-CC5-12-P

<b>Full marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Chi-square analyses for genetic ratio test</li> <li>2. Identification of chromosomal aberration in <i>Drosophila</i> and man from photograph</li> <li>3. Pedigree analysis of some inherited traits in animals</li> </ol>		

### PART III: SEMESTER 6

#### CORE COURSE 13: Developmental Biology

#### ZOOA-CC6-13-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Early Embryonic Development</b>		20
Gametogenesis: Spermatogenesis, Oogenesis (sea urchin & mammal); Types of eggs, Egg membranes; Fertilization in sea urchin and mammal; Planes and patterns of cleavage; Types of Blastula [frog and chick]; Fate map in chick embryo, fate mapping using vital dye and radioactive technique; Gastrulation in frog and chick; Embryonic induction and organizers in <i>Xenopus</i> (Spemann & Mangold's experiment)		

<b>Unit 2: Late Embryonic Development</b>	10
Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	
<b>Unit 3: Post Embryonic Development</b>	8
Development of brain and Eye in Chick. Molecular Induction in Brain and Eye development.	
<b>Unit 4: Implications of Developmental Biology</b>	12
<i>In vitro</i> fertilization (IVF), Stem cell: Concept of potency, types, markers and applications of stem cell therapy in bone marrow transplantation and cartilage regeneration	

### Developmental Biology Lab; ZOOA-ZooA-CC6-13-P

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, and 96 hours of incubation</li> <li>Study of the developmental stages and life cycle of <i>Drosophila</i></li> <li>Study of different sections of placenta (photomicrograph/ slides)</li> <li>Identification of Invertebrate larva through slides/ photographs of Phylum Annelida, Arthropoda, Mollusca and Echinodermata</li> </ol>		

### PART III: SEMESTER 6

#### CORE COURSE 14.Evolutionary Biology

#### ZOOA-CC6-14-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1</b>		<b>5</b>
Origin of Life (Chemical basis), RNA world hypothesis		
<b>Unit 2</b>		<b>5</b>
Historical review of Evolutionary concepts: Lamarkism, Darwinism and Neo Darwinism		
<b>Unit 3</b>		<b>6</b>
Geological time scale, Fossil: types and age determination by Carbon dating, Evolution of horse		
<b>Unit 4</b>		<b>6</b>
Natural Selection: Modes with Examples;		

<b>Unit 5</b>	<b>10</b>
Species concept, Isolating mechanisms, modes of speciation; Speciation by chromosome rearrangement in <i>Drosophila</i> . Adaptive radiation/macroevolution (exemplified by Galapagos finches).	
<b>Unit 6</b>	<b>2</b>
Origin and Evolution of Man, Unique Hominid characteristics contrasted with primate characteristic	
<b>Unit 7</b>	<b>10</b>
Population genetics: Hardy-Weinberg Law; factors disrupting H-W equilibrium (Genetic Drift, Migration and Mutation and Selection in changing allele frequencies (only derivations required). Simple problems related to estimation of allelic and gene frequencies.	
<b>Unit 8</b>	<b>3</b>
Extinction, back ground and mass extinctions, detailed example of K-T extinction	
<b>Unit 9</b>	<b>5</b>
Phylogenetic trees, construction and interpretation of Phylogenetic tree using parsimony, convergent and divergent evolution.	

### Evolutionary Biology Lab, ZooA-CC6-14-P

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of fossils from models/ pictures: Dickinsonia, Paradoxides (Trilobita), Asteroceas (Ammonoid), Pentremites (Blastoid Echinoderm), Ichthyosaur, Archaeopteryx, Cynodont.</li> <li>2. Study of homology and analogy from suitable specimens.</li> <li>3. Phylogenetic trees, Construction &amp; interpretation of Phylogenetic tree using parsimony, Construction of dendrogram following principles of phenetics &amp; cladistics from a data table.</li> </ol>		

## Discipline Specific Elective

[Students will choice either of ZOOA-DSE(A)-5-1-TH or ZOOA-DSE(A)-5-2-TH]

### PART III: SEMESTER 5

#### DSE1. Parasitology

#### ZOOA-DSE(A)-5-1-TH

Full Marks 50	4 Credits	50 hours
<b>Unit 1: Introduction to Parasitology</b>		2
Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector); Host parasite relationship		
<b>Unit 2: Parasitic Protists</b>		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Giardia intestinalis</i> , <i>Trypanosoma gambiense</i> , <i>Leishmania donovani</i>		
<b>Unit 3: Parasitic Platyhelminthes</b>		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Schistosoma haematobium</i> , <i>Taenia solium</i>		
<b>Unit 4: Parasitic Nematodes</b>		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> , <i>Wuchereria bancrofti</i> , Nematode plant interaction.		
<b>Unit 5: Parasitic Arthropods</b>		10
Biology, importance and control of ticks: Soft tick ( <i>Ornithodoros</i> ), Hard tick ( <i>Ixodes</i> ), mites ( <i>Sarcoptes</i> ), Lice ( <i>Pediculus</i> ), Flea ( <i>Xenopsylla</i> ) and Bug ( <i>Cimex</i> ). Parasitoid.		
<b>Unit 6: Parasite Vertebrates</b>		2
Cookicutter Shark, Hood Mocking bird, Vampire bats their parasitic behaviour and effect on host.		

#### Parasitology Lab, ZOOA-DSE(A)-5-1-P

Full Marks 30	60 Hours	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of life stages of <i>Giardia intestinalis</i>, <i>Trypanosoma gambiense</i>, <i>Leishmania donovani</i>, <i>Plasmodium vivax</i>, <i>Plasmodium falciparum</i> through permanent slides/micro photographs</li> <li>2. Study of adult and life stages of <i>Schistosoma haematobium</i>, <i>Taenia solium</i> through permanent slides/micro photographs</li> <li>3. Study of adult and life stages of <i>Ancylostoma duodenale</i> through permanent slides/micro photographs.</li> </ol>		

4. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
5. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by-product] & Goat.

Submission of a brief report on parasitic vertebrates

### **PART III: SEMESTER 5**

#### **DSE2. Biology of Insects**

#### **ZOOA-DSE(A)-5-2-TH**

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Insect Taxonomy</b>		<b>4</b>
Basis of insect classification; Classification of insects up to orders (Ruppert and Barnes, 1994)		
<b>Unit 2: General Morphology of Insects</b>		<b>6</b>
External Features; Head – Eyes, Types of antennae, Mouth parts with respect to feeding habits Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat Abdominal appendages and genitalia		
<b>Unit 3: Physiology of Insects</b>		<b>20</b>
Structure and physiology of Insect body systems - Digestive, respiratory, endocrine and nervous system Photoreceptors: Types, Structure and Function Metamorphosis: Types and Neuroendocrine control of metamorphosis		
<b>Unit 4: Insect Society</b>		<b>7</b>
Social insects with special reference to termites Trophallaxis in social insects such as ants, termites and bees		
<b>Unit 5: Insect Plant Interaction</b>		<b>4</b>
Theory of co-evolution, role of allelochemicals in host plant mediation Host-plant selection by phytophagous insects, Major insect pests in paddy		
<b>Unit 6: Insects as Vectors</b>		<b>9</b>
Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important vectors		

## Biology of Insect Lab, ZOOA-DSE(A)-5-2-P

<b>Full Marks 30</b>	<b>60 Hours</b>	2 Credits
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### List of Practical

1. Study of life cycle of Mosquito
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Mounting of insect wings any insects
4. Methodology of collection, preservation and identification of insects.
5. Morphological studies of various castes of *Apis*, *Ant-Camponotus*, Termite-*Odontotermes*
6. Study of major insect pests of paddy and their damages
7. Study of Mulberry silk moth as beneficial insect

**Students will choice either of ZOOA-DSE(B)-5-1-TH or ZOOA-DSE(B)-5-2-TH**

## PART III: SEMESTER 5

### DSE1. Endocrinology

#### ZOOA-DSE(B)-5-1-TH

<b>Full Marks 50</b>	4 Credits	50 Hours
<b>Unit 1: Introduction to Endocrinology</b>		<b>6</b>
General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neuro-secretions and Neuro-hormones: Examples and Functions		
<b>Unit 2: Hypothalamo-Hypophyseal Axis</b>		12
Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms, Hypothalamo-Hypophyseal-Gonadal Axis. Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophyseal portal system		
<b>Unit 3: Peripheral Endocrine Glands</b>		12
Structure, Hormones and Functions of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis. Disorders of endocrine glands ( <i>Diabetes mellitus</i> type I & Type II; Graves' Disease).		
<b>Unit 4: Regulation of Hormone Action</b>		12
Mechanism of action of steroidal, non-steroidal hormones with receptors (cAMP, IP3-DAG), Calcium and Glucose homeostasis in mammals. Bioassays of hormones using RIA & ELISA, Estrous cycle in rat and menstrual cycle in human.		



<b>Unit 5. Non Mammalian Vertebrate Hormone</b>	<b>8</b>
Functions of Prolactin in Fishes, Amphibia & Birds Function of Melanotropin in Teleost fishes, Amphibians and Reptiles.	

### **Endocrinology Lab, ZOOA-DSE(B)-5-1-P**

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Dissect and display of Endocrine glands in laboratory bred rat.</li> <li>2. Study of the permanent slides of all the endocrine glands</li> <li>3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland.</li> <li>4. H-E staining of Histological slides.</li> </ol>		

## **PART III: SEMESTER 5**

### **DSE2. Reproductive Biology**

### **ZOOA-DSE(B)-5-2-TH**

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Reproductive Endocrinology</b>		<b>10</b>
Mechanism of action of steroid and glycoprotein hormones. Hypothalamo – Hypophyseal – gonadal axis, regulation of gonadotrophin secretion in human (male and female); Reproductive system: Development and differentiation of gonads, genital ducts and external genitalia		
<b>Unit 2: Functional anatomy of male reproduction</b>		<b>14</b>
Histoarchitecture of testis in human; Spermatogenesis and its hormonal regulation; Androgen synthesis and metabolism; Accessory glands functions		
<b>Unit 3: Functional anatomy of female reproduction</b>		<b>18</b>
Histoarchitecture of ovary in human; Oogenesis and its hormonal regulation; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (human) and their regulation, Fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, fetomaternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation		
<b>Unit 4: Reproductive Health</b>		<b>8</b>
Infertility in male and female: causes, diagnosis and management, Assisted Reproductive Technology: Sex selection, sperm banks, frozen embryos, <i>in vitro</i> fertilization IVF & IUI Modern contraceptive technologies		

## Reproductive Biology Lab, ZOOA-DSE(B)-5-2-P

<b>Full Marks 50</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals ( only demonstration through chart).</li> <li>2. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland.</li> <li>3. H-E staining of histological slides.</li> <li>4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.</li> </ol>		

**Students will choice either of ZOOA-DSE(A)-6-1-TH or ZOOA-DSE(A)-6-2-TH**

### PART III: SEMESTER 6

#### DSE1. Animal Cell Biotechnology

#### ZOOA-DSE(A)-6-1-TH

<b>Full Marks 50</b>	4 Credits	50 Hours
<b>Unit 1: Introduction</b>		2
Concept and Scope of Biotechnology		
<b>Unit 2: Techniques in Gene manipulation</b>		15
Recombinant DNA technology, Restriction endonucleases. Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries Transformation techniques: Cloning in bacteria and detection technique of clone		
<b>Unit 3: Animal cell Culture</b>		15
Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media – Natural and Synthetic, Stem cells, Cryopreservation of cultures. Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, Polymerase chain reaction: Allele specific, RAPD & RT PCR.		
<b>Unit 4: Fermentation</b>		10
Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred tank, Air Lift, Fixed Bed and Fluidized. Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.		

<b>Unit 5: Application in Health</b>	8
Hybridoma technology, Production of recombinant Proteins: Insulin and growth hormones.	

### Animal Cell Biotechnology Lab, ZOOA-DSE(A)-6-1-P

<b>Full Marks 50</b>	<b>60 Hours</b>	2 Credits
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Packing and sterilization of glass and plastic wares for cell culture.</li> <li>2. Preparation of culture media.</li> <li>3. Preparation of genomic DNA from E. coli/animals/ human.</li> <li>4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).</li> <li>5. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays (By Photograph).</li> </ol>		

### PART III: SEMESTER 6

#### DSE2. Animal Biotechnology

#### ZOOA-DSE(A)-6-2-TH

<b>Full Marks 50</b>	4 Credits	Class
<b>Unit 1: Introduction</b>		5
Organization of <i>E.coli</i> and <i>Drosophila</i> genome.		
<b>Unit 2: Molecular Techniques in Gene manipulation</b>		23
Recombinant DNA technology, Restriction endonucleases. Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries Transformation techniques: Cloning in bacteria and detection technique of clone Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, Polymerase chain reaction: Allele specific, RAPD & RT PCR, DNA Fingerprinting		
<b>Unit 3: Genetically Modified Organisms</b>		12
Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock-out mice.		
<b>Unit 4: Culture Techniques and Applications</b>		10
Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of		

genetic diseases (Cystic fibrosis, Sickle cell anaemia, Thalassemia). Dolly & Polly cloning Genetically modified economically important animal Gene Therapy	
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### **Animal Biotechnology Lab, ZOOA-DSE(A)-6-2-P**

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Genomic DNA isolation from <i>E. coli</i> and Plasmid DNA isolation (pUC 18/19) from <i>E. coli</i></li> <li>2. To study following techniques through photographs - Southern Blotting, Northern Blotting, Western Blotting, PCR, DNA fingerprinting</li> <li>3. Project report on animal cloning &amp; Application &amp; ethical Issues.</li> </ol>		

**Students will choice either of ZOOA-DSE(B)-6-1-TH or ZOOA-DSE(B)-6-2-TH**

## **PART III: SEMESTER 6**

### **DSE1. Animal Behaviour and Chronobiology**

#### **ZOOA-DSE(B)-6-1-TH**

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Patterns of Behaviour</b>		10
Stereotyped Behaviours (Orientation, Reflex); Individual Behavioural patterns; Instinct vs. Learned Behaviour; FAP, Associative learning, classical and operant conditioning, Habituation, Imprinting.		
<b>Unit 2: Social and Sexual Behaviour</b>		20
Social organisation in termites; Communication (dance & pheromones in Bees) Social behaviour: Altruism (Hamilton's rule and concept of haplodiploidy), Cooperation and Selfishness Sexual Behaviour: Sexual dimorphism, Mate choice in peacock, Intra-sexual selection (male rivalry in red deer) Kinship theory: Relatedness & inclusive fitness; parental care in fishes (Nest Building & coast benefit), conflict within families: parent offspring conflict and sibling rivalry		
<b>Unit 3: Chronobiology &amp; Biological Rhythm</b>		20
Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms, Circannual rhythms; Photic and non-photic zeitgebers; Role of melatonin. Biological clock and its adaptive significance. Circannual rhythm in bird migration.		

## Animal Behaviour and Chronobiology Lab, ZOOA-DSE(B)-6-1-P

<b>Full Marks 50</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. To study nests and nesting habits of the birds and social insects.</li> <li>2. To study the behavioural responses of wood lice to dry and humid conditions(demonstration only).</li> <li>3. To study geotaxis behaviour in earthworm.</li> <li>4. To study the phototaxis behaviour in insect larvae.</li> <li>5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.</li> <li>6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).</li> </ol>		

### PART III: SEMESTER 6

#### DSE2. Fish and Fisheries

#### ZOOA-DSE(B)-6-2-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Introduction and Classification</b>		<b>4</b>
Feeding habit, habitat and manner of reproduction. Classification of fish (upto Subclasses) (Romar, 1959)		
<b>Unit 2: Morphology and Physiology</b>		<b>14</b>
Types of fins and their modifications; Locomotion in fish; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Electric organ, Bioluminescence		
<b>Unit 3: Fisheries</b>		<b>10</b>
Inland Fisheries; Marine Fisheries; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations		
<b>Unit 4: Aquaculture</b>		<b>16</b>
Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products		
<b>Unit 5: Fish in research</b>		<b>6</b>
Transgenic fish Zebra fish as a model organism in research		

## Fish and Fisheries Lab, ZOOA-DSE(B)-6-2-P

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Morphometric and meristic characters of fishes</li> <li>2. Identification of <i>Petromyzon</i>, <i>Myxine</i>, <i>Pristis</i>, <i>Exocoetus</i>, <i>Hippocampus</i>, <i>Gambusia</i>, <i>Labeo</i>, <i>Heteropneustes</i>, <i>Anabas</i></li> <li>3. Study of different types of scales (through permanent slides/ photographs).</li> <li>4. Study of crafts and gears used in Fisheries (Photographs)</li> <li>5. Water quality criteria for Aquaculture: Assessment of pH, alkalinity, Salinity.</li> <li>6. Study of air breathing organs in <i>Channa</i>, <i>Heteropneustes</i>, <i>Anabas</i> and <i>Clarias</i></li> <li>7. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.</li> </ol>		

### Skill Enhancement courses (SEC)

[A student will choice either ZOOA-SEC(A)-3-1 or ZOOA-SEC(A)3-2]

#### PART II: SEMESTER 3

##### SEC-1 Apiculture

##### ZOOA-SEC(A)-3-1-TH

<b>Full Marks 80</b>	<b>2 Credits</b>	<b>30 Hours</b>
<b>Unit 1: Biology of Bees</b>		<b>2</b>
<i>Apis</i> and Non- <i>Apis</i> Bee species and their identification. General Morphology of <i>Apis</i> Honey Bees Social Organization of Bee Colony		
<b>Unit 2: Rearing of Bees</b>		<b>14</b>
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth box Bee Pasturage Selection of Bee Species for Apiculture Modern Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern)		
<b>Unit 3: Diseases and Enemies</b>		<b>6</b>
Bee Diseases and Enemies Control and Preventive measures		
<b>Unit 4: Bee Economy</b>		<b>2</b>
Products of Apiculture Industry and its Uses – Honey, Bees Wax, Propolis, Pollen etc.		
<b>Unit 5: Entrepreneurship in Apiculture</b>		<b>6</b>
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens		

## PART II: SEMESTER 3

### SEC-2.Sericulture

#### ZOOA-SEC(A)-3-2-TH

Full Marks 80	2 Credits	30 Hours
<b>Unit 1: Introduction</b>		<b>6</b>
Sericulture: Definition, history and present status; Silk route Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture		
<b>Unit 2: Biology of Silkworm</b>		<b>4</b>
Life cycle of <i>Bombyx mori</i> Structure of silk gland and secretion of silk		
<b>Unit 3: Rearing of Silkworms</b>		<b>10</b>
Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances. Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing Types of mountages Spinning, harvesting and storage of cocoons		
<b>Unit 4: Pests and Diseases</b>		<b>7</b>
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases		
<b>Unit 5: Entrepreneurship in Sericulture</b>		<b>3</b>
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture Visit to various sericulture centres.		

[A student has to choose either ZOOA-SEC(B)-4-1 or ZOOA-SEC(B)4-2]

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**PART II: SEMESTER 4**  
**SEC-1.Aquarium Fish Keeping**  
**ZOOA-SEC(B)-4-1-TH**

<b>Full Marks 80</b>	<b>2 Credits</b>	<b>30 Hours</b>
<b>Unit 1: Introduction to Aquarium Fish Keeping</b>		<b>2</b>
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes		
<b>Unit 2: Biology of Aquarium Fishes</b>		<b>10</b>
Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish		
<b>Unit 3: Food and feeding of Aquarium fishes</b>		<b>8</b>
Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator		
<b>Unit 4: Fish Transportation</b>		<b>5</b>
Live fish transport - Fish handling, packing and forwarding techniques.		
<b>Unit 5: Maintenance of Aquarium</b>		<b>5</b>
General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry		

**PART II: SEMESTER 4**  
**SEC-2.Medical Diagnostic Technique**  
**ZOOA-SEC(B)-4-2-TH**

<b>Full Marks 80</b>	<b>2 Credits</b>	<b>30 Hours</b>
<b>Unit 1: Diagnostics Methods Used for Analysis of Blood</b>		<b>8</b>
Blood composition, Differential Leucocyte Count (DLC) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV)		
<b>Unit 2: Diagnostic Methods Used for Urine Analysis</b>		<b>4</b>
Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture		
<b>Unit 3: Non-infectious Diseases</b>		<b>6</b>
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type		



II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit	
<b>Unit 4: Infectious Diseases</b>	<b>3</b>
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based)	
<b>Unit 5: Clinical Biochemistry</b>	<b>1</b>
Lipid profiling, Liver function test. PSA test	
<b>Unit 6: Clinical Microbiology</b>	<b>1</b>
Antibiotic Sensitivity Test	
<b>Unit 7: Tumours</b>	<b>2</b>
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).	
<b>Unit 8: Visit to Pathological Laboratory and Submission of Project</b>	<b>6</b>

**UNIVERSITY OF CALCUTTA**

**CBCS SYLLABUS FOR ZOOLOGY**

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**THREE-YEAR GENERAL  
DEGREE COURSE OF STUDIES**



**ZOOLOGY**

**2018**

## Outline Structure of CBCS Curriculum For Zoology (General), C.U.

<b>PART I; SEM I</b>				
Subject Code	Name of Paper	Theory	Practical	Internal assessment
CC1/GE1	Animal Diversity	50	30	20
<b>PART I; SEM II</b>				
CC2/GE2	Comparative Anatomy & Developmental Biology	50	30	20
<b>PART II; SEM III</b>				
CC 3/GE3	Physiology and Biochemistry	50	30	20
SEC-A (1)	Apiculture	80	NA	20
<b>PART II; SEM IV</b>				
CC 4/GE4	Genetics and Evolutionary Biology	50	30	20
SEC- B(1)	Aquarium Fish Keeping	80	NA	20
<b>PART III; SEM V</b>				
DSE A(1)	Applied Zoology	50	30	20
DSE B (1)	Aquatic biology	50	30	20
SEC-A (1)	Sericulture	80	NA	20
<b>PART III; SEM VI</b>				
DSE A (1)	Biology of Insect	50	30	20
DSE B (2)	Ecology & Wild life Biology	50	30	20
SEC-B (1)	Medical diagnosis	80	NA	20

### Abbreviations:

CC: Core Course; DSE A/B: Discipline Specific Elective A/B; SEC A/B: Skill Enhancement Course.

### SUBJECT/PAPER CODE FORMAT

4. Subject Code: ZOO
5. Honours Code: G
6. Course Code: a) Core Course:CC  
b) Discipline Specific Elective: DSE-A/DSE-B  
c) Skill Enhancement Course: SEC-A/SEC-B
4. Semester Code: 1/2/3/4/5/6
5. Paper No. Code: 1/2/3...../14
6. Paper Component Code: a) Theory:TH, b) Practical: P

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**PART I: SEMESTER 1.**  
**CORE COURSE 1. Animal Diversity**  
**ZOOG-CC1-1-TH**

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Kingdom Protista</b>		2
General characters and classification up to classes (Levine et. al., 1980); Locomotory Organelles and locomotion in <i>Amoeba</i> and <i>Paramecium</i>		
<b>Unit 2: Phylum Porifera</b>		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.); Canal System in <i>Sycon</i>		
<b>Unit 3: Phylum Cnidaria</b>		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.); Metagenesis in <i>Obelia</i>		
<b>Unit 4: Phylum Platyhelminthes</b>		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.); Life history of <i>Taenia solium</i>		
<b>Unit 5: Phylum Nematelminthes</b>		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.); Life history of <i>Ascaris lumbricoides</i> and its adaptation		
<b>Unit 6: Phylum Annelida</b>		4
General characters and classification up to classes (Rupert and Barnes, 1994, 6 <sup>th</sup> Ed.); Metamerism in Annelida		
<b>Unit 7: Phylum Arthropoda</b>		4
General characters and classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.); Eye in Cockroach, Metamorphosis in Lepidoptera		
<b>Unit 8: Phylum Mollusca</b>		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.); Respiration in <i>Pila</i>		
<b>Unit 9: Phylum Echinodermata</b>		4
General characters and classification up to classes (Ruppert and Barnes, 1994, 6 <sup>th</sup> Ed.); Water-vascular system in Asteroidea		
<b>Unit 10: Protochordates</b>		2
General Characters ; Pharynx and feeding mechanism in <i>Amphioxus</i>		
<b>Unit 11: Agnatha</b>		2
General features of Agnatha and classification of cyclostomes up to classes (Young, 1981)		

<b>Unit 12: Pisces</b>	4
General features and Classification up to orders (Young, 1981); Osmoregulation in Fishes	
<b>Unit 13: Amphibia</b>	4
General features and Classification up to orders (Young, 1981); Parental care	
<b>Unit 14: Reptiles</b>	4
General features and Classification up to orders (Young, 1981); Poisonous and non-poisonous snakes, Biting mechanism	
<b>Unit 15: Aves</b>	4
General features and Classification up to orders (Young, 1981); Flight adaptations in birds	
<b>Unit 17: Mammals</b>	4
Classification up to orders (Young, 1981); Hair, Horn & Antler, Nail & claw	

### Animal Diversity, ZOOG-CC1-1-P

Full Marks: 30	60 Hours	2 Credits
List of Practicals		
1. Identification with reasons of the following specimens: <i>Amoeba, Euglena, Paramecium, Sycon, Obelia, Aurelia, Metridium, Taenia solium, Ascaris lumbricoides</i> (Male and female), <i>Aphrodite, Nereis, Hirudinaria, Palaemon, Cancer, Limulus, Apis, Chiton, Dentalium, Unio, Sepia, Octopus, Echinus, Cucumaria</i> and <i>Antedon, Balanoglossus, Branchiostoma, Petromyzon, Torpedo, Labeo rohita, Exocoetus, Salamandra, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Bat, Funambulus</i>		
2. Key for Identification of poisonous and non-poisonous snakes		
3. Study of anatomy of digestive system, salivary gland, mouth parts of <i>Periplaneta</i> , Study of reproductive system of female cockroach		
An “animal album” containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose		

## PART I: SEMESTER 2.

### CORE COURSE 2.Comparative Anatomy & Developmental Biology

#### ZOOG-CC2-2-TH

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Integumentary System</b>	4	
Derivatives of integument with respect to glands in Birds & Mammals		
<b>Unit 2: Digestive System</b>	4	
Stomach and Dentition		
<b>Unit 3: Respiratory System</b>	6	

Brief account of Gills, lungs, air sacs and swim bladder	
<b>Unit 4: Circulatory System</b>	6
Evolution of heart and aortic arches	
<b>Unit 5: Urino-genital System</b>	6
Succession of kidney, Evolution of urino-genital ducts	
<b>Unit 6: Early Embryonic Development</b>	14
Gametogenesis: Spermatogenesis and oogenesis with respect to mammals. Fertilization: Sea-Urchin; Early development of frog; structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula; types of morphogenetic movements; Fate of germ layers	
<b>Unit 7: Late Embryonic Development</b>	10
Placenta types and function; Metamorphic events in frog life cycle and its hormonal regulation	

### Comparative Anatomy & Developmental Biology Lab, ZOOG-CC2-2-P

<b>Full marks 30</b>	<b>60 hours</b>	<b>2 Credits</b>
<b>List of Practical:</b>		
1. Osteology: Limb bones, girdle and vertebra of Pigeon & Guineapig, Mammalian skulls: One herbivorous; Guinea pig and one carnivorous; Dog.		
2. Larval stages: Veliger, Nauplius, Trochophore, Mysis.		
3. Study of the different types of placenta- histological sections through photomicrographs.		
4. Developmental stages of chick embryo: 24 Hrs., 48 Hrs, 72 Hrs., 96 Hrs.		

### PART II: SEMESTER 3.

#### CORE COURSE 3. PHYSIOLOGY AND BIOCHEMISTRY

##### ZOOG-CC3-3-TH

<b>Full Marks 50</b>	<b>4 Credits</b>	<b>50 Hours</b>
<b>Unit 1: Nerve and muscle</b>		<b>8</b>
Structure of a neuron, resting membrane potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction		
<b>Unit 2: Digestion</b>		<b>6</b>
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids		
<b>Unit 3: Respiration</b>		<b>6</b>
Pulmonary ventilation, Transport of Oxygen and carbon		
<b>Unit 4: Cardio-vascular system</b>		<b>6</b>

Composition of blood, Structure of Heart, Origin and conduction of the cardiac impulse, cardiac cycle	
<b>Unit 5: Excretion</b>	6
Structure of nephron, Mechanism of Urine formation; Counter-current Mechanism	
<b>Unit 6: Reproduction and Endocrine Glands</b>	10
Physiology of male reproduction: Histology of testis, hormonal control of spermatogenesis; Physiology of female, reproduction: Histology of ovary, hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, pancreas and adrenal.	
<b>Unit 7: Carbohydrate Metabolism</b>	4
Glycolysis, Krebs's cycle, Glycogenesis, Electron Transport Chain.	
<b>Unit 8: Lipid metabolism</b>	
Beta oxidation of Palmitic acid {saturated (C 16:0)} and Linoleic acid {unsaturated (C 18:2)}	
<b>Unit 9: Protein Metabolism</b>	4
Transamination, Deamination, Urea cycle	
<b>Unit 10. Enzyme</b>	2
Enzyme Classification, factors affecting enzyme action, Inhibition.	

### PHYSIOLOGY AND BIOCHEMISTRY Lab; ZOOG-CC3-3-P

<b>Full Marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
1. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland. 2. Study of permanent histological sections of mammalian duodenum, liver, lung, kidney. 3. Qualitative test for carbohydrate samples.		

### PART II: SEMESTER 4.

#### CORE-COURSE 4. Genetics & Evolutionary Biology

#### ZOOG-CC4-4-TH

Full Marks 50	4 Credits	50 Hours
<b>Unit 1: Mendelian Genetics and its Extension</b>	10	
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, lethal alleles, sex linked inheritance in <i>Drosophila</i> (White eye locus) & Human (Thalassemia).		
<b>Unit 2: Linkage, Crossing Over</b>	8	
Linkage and crossing over, Complete & Incomplete Linkage, Recombination frequency as a measure of linkage intensity. Holiday Model		
<b>Unit 3: Mutation</b>		



Chromosomal mutation, Deletion, duplication, inversion, translocation, aneuploidy, gene mutation, induced mutation, types & example	8
<b>Unit 4: Sex determination</b>	8
Genic Balance theory and dosage compensation in <i>Drosophila</i> .	
<b>Unit 5: Origin of Life</b>	2
Chemical Origin of life	
<b>Unit 6: Evolutionary Theories</b>	6
Lamarckism, Darwinism, Neo-Darwinism.	
<b>Unit 7: Process of Evolutionary changes</b>	4
Isolating mechanism, Natural Selection.	
<b>Unit 8: Speciation</b>	4
Sympatric, Allopatric, Parapatric	

### Genetics and Evolutionary Biology Lab ZOOG-CC4-4-P

<b>Full marks 30</b>	<b>2 Credits</b>
<b>List of Practical:</b>	
Verification of Mendelian Ratio using Chi square test. Identification of Human Aneuploidy using photo graph of karyotype. Phylogeny of horse with diagram of limb and skull. Study and identification of Darwin Finches from photographs. Visit to natural history museum and submission of report.	

## Discipline specific courses

Elective Course (Any One from DSE-A)

**Semester-5**

**DSE-A**

### Applied Zoology.ZOOG-DSE-A-5-1-TH

<b>Full Marks 50</b>	<b>Credits 4</b>	<b>50 Hours</b>
<b>Unit I: Host &amp; Parasite Relationship</b>		2
Type of Host, Types of Parasites, Other types of Relations.		
<b>Unit 2: Epidemiology of Diseases</b>		5

Transmission, Prevention and Control of Tuberculosis and Typhoid.	
<b>Unit 3: Parasitic Protozoa</b>	7
Life History and pathogenicity of <i>Entamoeba histolytica</i> , <i>Plasmodium vivax</i> and <i>Trypanosoma gambiense</i> .	
<b>Unit 4: Parasitic Helminthes</b>	8
Life History and pathogenicity of <i>Alcylostoma duodenale</i> , <i>Wuchereria bancrofti</i> .	
<b>Unit 5: Insect of Economic Importance</b>	8
Biology, Control and Damage caused by <i>Helicoverpa armigera</i> , <i>Pyrilla perpusilla</i> , <i>Sitophilus oryzae</i> and <i>Tribolium castaneum</i> .	
<b>Unit 6: Insect of Medical Importance</b>	2
Medical Importance and control of <i>Anopheles</i>	
<b>Unit 8: Animal Husbandry</b>	6
Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle	
<b>Unit 9: Poultry Farming</b>	6
Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs	
<b>Unit 10: Fish Technology</b>	6
Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed	

## Applied Zoology. ZOOG-DSE-A-5-1-P

<b>Full marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical:</b>		
<ol style="list-style-type: none"> <li>1. Study of <i>Plasmodium vivax</i>, <i>Entamoeba histolytica</i>, <i>Trypanosoma gambiense</i>, <i>Ancylostoma duodenale</i> and <i>Wuchereria bancrofti</i> and their life stages through permanent slides/photomicrographs or specimens.</li> <li>2. Study of arthropod vectors associated with human diseases: <i>Pediculus</i>, <i>Culex</i>, <i>Anopheles</i>, <i>Aedes</i></li> <li>3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.</li> <li>4. Identifying feature and economic importance of <i>Helicoverpa</i>; <i>Heliothis armigera</i>, <i>Papilio demoleus</i>, <i>Pyrilla perpusilla</i>, <i>Callosobruchus chinensis</i>, <i>Sitophilus oryzae</i> and <i>Tribolium castaneum</i></li> <li>5. Visit to poultry farm or animal breeding centre. Submission of visit report</li> <li>6. Maintenance of freshwater aquarium(demonstration only)</li> </ol>		

# Discipline specific courses

Elective Course (Any One from DSE-A)

Semester-5

DSE-A

## AQUATIC-BIOLOGY. ZOOG-DSE-A-5-2-TH

Full Marks 50	Credits 4	Class 60
<b>Unit 1: Aquatic Bionics</b>		15
Brief introduction of the aquatic biomes: Freshwater ecosystem; lakes, wetlands, streams and rivers, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.		
<b>Unit 2: Freshwater Biology lakes</b>		15
Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases; Oxygen, Carbon dioxide. Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.		
<b>Streams:</b> Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.		
<b>Unit 3: Marine Biology</b>		15
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.		
<b>Unit 4: Management of Aquatic Resources</b>		15
Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation ;legislations, Sewage treatment Water quality assessment - BOD and COD		

## AQUATIC BIOLOGY. ZOOG-DSE-A-5-2-P

Full Marks 30	60 Hours	2 Credits
<ol style="list-style-type: none"> <li>1. Determine the area of a lake using graphimetric and gravimetric method.</li> <li>2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.</li> <li>3. Determine the amount of dissolved Oxygen, and free Carbon dioxide, in water collected from a nearby lake / water body.</li> <li>4. Visit to any aquatic Ecosystem and preparation and submission of report.</li> </ol>		

**Discipline specific courses**  
**Elective Course (Any One from DSE-B)**  
**Semester-6**  
**DSE-B**

**Biology of Insect. ZOOG-DSE-B-6-1-TH**

<b>Full Marks 50</b>	<b>Credits 4</b>	<b>50 Hours</b>
<b>Unit I: Introduction to Insects</b>		<b>6</b>
General Features of Insects, Morphological features, Head, Eyes, Types of antennae, Mouth parts with respect to feeding habits		
<b>Unit II: Concept of Vectors</b>		<b>6</b>
Brief introduction of Carrier and Vectors; mechanical and biological vector, Reservoirs, Host-vector relationship, Adaptations as vectors, Host Specificity		
<b>Unit III: Insects as Vectors</b>		<b>8</b>
Classification of insects up to orders, detailed features of orders with insects as vectors - Diptera, Siphonaptera, Siphunculata, Hemiptera		
<b>Unit IV: Dipteran as Disease Vectors</b>		<b>14</b>
Dipterans, as important insect vectors - Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases - Dengue, Viral encephalitis, Filariasis; Control of mosquitoes.		
<b>Unit V: Siphonaptera as Disease Vectors</b>		<b>6</b>
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases - Plague, Typhus fever; Control of fleas		
<b>Unit VI: Siphunculata as Disease Vectors</b>		<b>4</b>
Human louse; Head, Body and Pubic louse as important insect vectors; Study of louse-borne diseases -Typhus fever, Relapsing fever, Trench fever; Control of human louse		
<b>Unit VII: Hemiptera as Disease Vectors</b>		<b>6</b>
Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures		

**Biology of Insect. ZOOG-DSE-B-6-1-P**

<b>Full marks 25</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Study of different kinds of mouth parts of insects</li> <li>2. Study of following insect vectors through permanent slides/photographs: <i>Aedes</i>, <i>Culex</i>, <i>Anopheles</i>, <i>Pediculus humanuscapitis</i>, <i>Pediculus humanuscorporis</i>, <i>Phlebotomus argentipes</i>, <i>Musca domestica</i>,</li> <li>3. Submission of a project report on any one of the insect vectors and disease transmitted by the insect.</li> </ol>		

## Ecology & Wild life Biology; ZOOG-DSE-B-6-2-TH

<b>Full Marks 50</b>	<b>Credits 4</b>	<b>Class 60</b>
<b>Unit 1: Introduction to Ecology</b>		<b>4</b>
Ecosystem, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.		
<b>Unit 2: Population</b>		<b>20</b>
Attributes of population: Life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponential and logistic growth, equation and patterns, Population regulation: density-dependent and independent factors,		
<b>Unit 3: Community</b>		<b>11</b>
Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect.		
<b>Unit 4: Ecosystem</b>		<b>10</b>
Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies		
<b>Unit 5: Wild Life</b>		<b>5</b>
Wildlife Conservation (in-situ and ex-situ conservation): Necessity for wildlife conservation; National parks & sanctuaries, Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve		

## Ecology & Wild life Biology; ZOOG-DSE-B-6-2-P

<b>Full marks 30</b>	<b>60 Hours</b>	<b>2 Credits</b>
<b>List of Practical</b>		
<ol style="list-style-type: none"> <li>1. Identification of flora, mammalian fauna, avian fauna</li> <li>2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)</li> <li>3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, etc.</li> <li>4. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, salinity, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO<sub>2</sub></li> </ol>		

## Skill Enhancement Elective Courses (SEC)

### SEMESTER –3

#### SEC-A

#### APICULTURE; ZOOG-SEC-A-3-1-TH

Full Marks 80	Credits 2	30 Hours
<b>Unit 1: Biology of Bees</b>		2
Classification and Biology of Honey Bees Social Organization of Bee Colony		
<b>Unit 2: Rearing of Bees</b>		14
Artificial Bee rearing; Apiary, Beehives - Newton and Langstroth, Bee Pasturage; Selection of Bee Species for Apiculture; Bee Keeping Equipment; Methods of Extraction of Honey; Indigenous and Modern		
<b>Unit 3: Diseases and Enemies</b>		6
Bee Diseases and Enemies Control and Preventive measures		
<b>Unit 4: Bee Economy</b>		2
Products of Apiculture Industry and its Uses ;Honey, Bees Wax, Propolis, Pollen etc		
<b>Unit 5: Entrepreneurship in Apiculture</b>		6
Bee Keeping Industry - Recent Efforts, Modern Methods in employing artificial Beehives for cross		

## Skill Enhancement Elective Courses (SEC)

### SEMESTER – 4

#### AQUARIUM FISH KEEPING; ZOOG-SEC-B-4-2-TH

Full Marks 80	Credits 2	30 Hours
<b>Unit 1: Introduction to Aquarium Fish Keeping</b>		2
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes		
<b>Unit 2: Biology of Aquarium Fishes</b>		10
Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish		
<b>Unit 3: Food and feeding of Aquarium fishes</b>		8
Use of live fish feed organisms. Preparation and composition of formulated fish feeds		
<b>Unit 4: Fish Transportation</b>		5
Live fish transport - Fish handling, packing and forwarding techniques.		
<b>Unit 5: Maintenance of Aquarium</b>		5
General Aquarium maintenance - budget for setting up an Aquarium Fish Farm as a Cottage		

## Skill Enhancement Elective Courses (SEC)

### SEMESTER –5

#### SEC-A

#### Sericulture; ZOOG-SEC-A-5-3-TH

Full Marks 80	Credits 2	30 Hours
<b>Unit 1: Introduction</b>		6
Sericulture: Definition, history and present status; Silk route; Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture		
<b>Unit 2: Biology of Silkworm</b>		4
Life cycle of <i>Bombyx mori</i> ; Structure of silk gland and secretion of silk		
<b>Unit 3: Rearing of Silkworms</b>		10
Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing Types of mountages; Spinning and harvesting and storage of cocoons.		
<b>Unit 4: Pests and Diseases</b>		7
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases		
<b>Unit 5: Entrepreneurship in Sericulture</b>		3
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.		

## Skill Enhancement Elective Courses (SEC)

### SEMESTER –6

#### SEC-B

#### Medical diagnosis; ZOOG-SEC-B-6-4-TH

Full Marks 80	Credits 2	Class 30
<b>Unit 1: Diagnostics Methods Used for Analysis of Blood</b>		8
Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentation Rate (E.S.R)		
<b>Unit 2: Diagnostic Methods Used for Urine Analysis</b>		4
Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture		
<b>Unit 3: Non-infectious Diseases</b>		6
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit		
<b>Unit 4: Infectious Diseases</b>		3
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite		

(Microscope based and ELISA based)	
<b>Unit 5: Clinical Biochemistry</b>	1
Lipid profiling, Liver function test. PSA test	
<b>Unit 6: Clinical Microbiology</b>	1
Antibiotic Sensitivity Test	
<b>Unit 8: Tumours</b>	2
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture,	
<b>Unit 9: Visit to Pathological Laboratory and Submission of Project</b>	5

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## REFERENCE BOOKS

### Non Chordata

- Anderson DT (Ed.) 2001. Invertebrate Zoology. 2nd Ed. Oxford University Press.
- Barnes R. S. K. - The Diversity of Living Organisms; Blackwell Science
- Barrington EJW. 1981. Invertebrate Structure and function. 2nd Ed. ELBS & Nelson.
- Bernays, E. A., & Chapman, R. F., Host Selection by Phytophagous insects, Chapman & Hall
- Blackwelder RE. 1967. Taxonomy- A text and reference book. John Wiley & Sons.
- Brusca RC, Brusca GJ. 2002. Invertebrates. 4th Ed. Sinauer Associates
- Chaki K C; Kundu G & Sarkar S. - Introduction to General Zoology (Vol. 1), NCBA, Kolkata
- Hyman LH. 1951. The Invertebrates (Vol-I). Mc.Graw Hill Book Company.
- Jordan EL, Verma PS. 2006. Invertebrate Zoology. S. Chand & Co. New Delhi.
- Kapoor VC. 2008. Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
- Kotpal RL. 1988 – 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata,
- Mayr E, Ashlock PD. 1991. Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
- Mayr E. Principle of Systematic Zoology (TATA McGraw Hill)
- Meglitsch PA, Schram FR. 1991. Invertebrate Zoology. Oxford University Press.
- Moore J. - An introduction to the Invertebrates; Cambridge Univ. Pr.
- Nigam H.C. - Biology of non-chordates; Vishal Pub.
- Parker TJ, Haswell W. 1972. Text Book of Zoology, Volume I. Macmillan Press, London.
- Pechenik JA. 1998. Biology of the Invertebrates, 4th Ed. McGraw Hill.
- Rupert E E, Barnes R D. 2006. Invertebrate Zoology, VIII Ed. (Harcourt Asia)
- Ruppert E E, Fox R, Barnes R D. 2003. Invertebrate Zoology: a Functional Evolutionary Approach. (Brooks Cole)
- Ruppert EE, Fox R, Barnes RD. (1991). Invertebrate Zoology: a Functional Evolutionary Approach. Brooks Cole.
- Simpson G. G. - Principles of Animal Taxonomy (Oxford IBH)
- Sinha AK, Adhikari S, Ganguly BB. Biology of Animals. Vol. I. NCBA
- Villee, C. A., W. F. Walker and R. D. Barnes - General Zoology; Saunders College Pub.
- Wilmer P. - Invertebrate inter relationship; Cambridge Univ. Pr.
- Wood R. - Reef evolution; Oxford Univ. Pr

### Chordata, Comparative Anatomy

- Arora MP. *Chordata I. Himalaya Pub Hous*
- Chaki K C; Kundu G & Sarkar S. - Introduction to General Zoology (Vol. 2), NCBA, Kolkata
- Hilderbrand M, Gaslow GE. Analysis of Vertebrate Structure, John Wiley and Sons
- Jordan EL, Verma PS. 2003. Chordate Zoology. S.Chand & Company Ltd. New Delhi.
- Kardong K V. 2005. Comparative Anatomy of Vertebrates, Function and Evolution; McGraw-Hill
- Kardong KV. 2002. Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
- Kent GC, Carr RK. 2001. Comparative anatomy of the Vertebrates. 9<sup>th</sup> Ed. Mc Graw Hill.



Marieb, E. ;1998. Human Anatomy and Physiology, IV Edition, Addison-Wesley.  
 Norman, J.R. A history of Fishes, Hill and Wang Publishers  
 Parker TJ, Haswell W. 1972. Text Book of Zoology, Volume II: Marshall and Willam Eds. Macmillan Pr.  
 Pough H, Christine MJ, Haier B. 2002. Vertebrate life, VIII Edition, Pearson Internatl.  
 Romer AS, Parsons TS. 1986. The vertebrate body. 6th Ed. Saunders College Publishing  
 Sinha KS, Adhikari S, Ganguly BB. 2001. Biology of Animals. Vol. II. NCBA  
 Young JZ. 2004. The Life of Vertebrates. III Edition. Oxford University press

## **Molecular Biology**

Alberts B et al. 2008. Molecular Biology of the Cell. V Edition, Garland publishing Inc.  
 Allison LA. 2007. Fundamental Molecular Biology. Blackwell Publishing. W.H. Freeman  
 Bergstorm CT, Dujatkin LA. 2012. Evolution. 1st Edn. W.W. Norton and Co.  
 Karp G. 2008. Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.  
 Lackie JM. 2013. Dictionary of Molecular Biology. Academic Press.  
 Lodish, B, Matsudaira, K B, Plough, A and Martin ;2016. Molecular Cell Biology. W.H. Freeman  
 Meyers R.A. – Molecular Biology and Biotechnology; VCH Pub.  
 Pal A. 2011. Textbook of Cell and Molecular Biology 3rd Edn, Books and Allied, Kolkata.  
 Russel PJ. 2010. iGenetics: A Molecular Approach, Pearson Benjamin  
 Strachan T. & A. Read – Human Molecular Genetics; BIOS Scientific  
 Turner, McLennan, Bales & White ;2005. Instant Notes in Molecular Biology. Taylor Francis  
 Twyman – Advanced Molecular Biology; Springer  
 Watson D et al. 2008. Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press  
 Watson J. D. – Molecular Biology of the gene; Pearson

## **Cell Biology, Genetics, Histology**

Banerjee P. K. – Problems on Genetics, Molecular Genetics and evolutionary genetics; NCBS  
 Becker W. M., L. J. Kleinsmith, J. Hardin – The World of Cell  
 Cohen N. – Cell Structure, Function and Metabolism; Hodder & Stoughton  
 Cooper G M – Cell Biology; Sinauer  
 Cooper G M, Hausman RE. 2009. The Cell: A Molecular Approach. V Ed. ASM Press and Sunderland  
 Cormack DH. 2003. PDQ Histology. B.C. Decker Ins., London.  
 Elrod S. and W. Stansfield – Genetics; Schaum  
 Eroschenko VP. 2008. Atlas of Histology with Functional correlations. Lippincott & Wilkins.  
 Gillespie J H. 1998. Population Genetics: a Concise Guide. John Hopkins Univ Press.  
 Hardin J, Bertoni G, Kleinsmith JL. 2012. Becker's World of the Cell, Pearson Benjamin Cummings.  
 Harvey L. 2004. Molecular Cell Biology. 5th Edn. W.H. Freeman  
 Hutchison C. & D.M. Glover – Cell cycle control; IRL Oxford Univ.  
 Junquera LC, Carneiro J. 2005. Basic histology text and atlas  
 Klug W S, Cummings MR, Spencer CA. 2012. Concepts of Genetics. Xth Ed. Benjamin Cummings  
 Lewin B. 2008. Gene IX. Jones and Bartlett.  
 Masters J R W – Animal Cell Culture – a practical approach; Oxford Univ. Pr.  
 Morgan S. J. & D. C. Darling – Animal cell culture; Oxford  
 Plopper G D, Sharp, Siroski, E (2015) Lewin's Cell 3rd Edition—Johns & Bartlett Publishers  
 Pollard MD, Earnshaw W C, Lippincott-Schwartz. 2007. Cell Biology. 2nd Edn Saunders. Press  
 Robert A. – Biology of Cancer Weinberg. 2<sup>nd</sup> edition  
 Ross M H, Pawlina W. 2010. Histology: A Text and Atlas. Lippincott Williams and Wilkins  
 Roychoudhuri S – A Text Book of Genetics & Molecular Biology; NCBA  
 Snustad D P, Simmons MJ. 2009. Principles of Genetics. V Edition. John Wiley and Sons Inc  
 Strickberger M. W – Genetics; Macmillan  
 Tamarin R. H. – Principles of Genetics; McGraw Hill  
 Weinberg R A. 2014. Biology of Cancer. 2<sup>nd</sup> edition. Garland Science, Taylor & Francis  
 Winter P. C., G. I. Hickey & H. L. Fletcher – Genetics; Viva

## **Animal Physiology, Nutrition**

- Bamji M S, Rao N P, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing
- Fox S I. 2011. Human Physiology. 12th Edn. Mc Graw Hill
- Ganong's Review of Medical Physiology; McGraw Hill
- Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing
- Gunstream SE. 2010. Anatomy and Physiology with integrated study guide. Mc Graw Hill.
- Guyton AC, Hall JE. 2006. Textbook of Medical Physiology. Hercourt Asia P Ltd.
- Guyton, A.C. and Hall, J.E.; 2011. Textbook of Medical Physiology, XII Edition, Saunders Company
- Hall JE. 2015. Guyton and Hall Textbook of Medical Physiology. Saunders publication.
- Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sineuer Asso
- Hoar W. S. – General and Comparative Physiology; PHI
- Kesar, S. and Vashisht, N.; 2007. Experimental Physiology, Heritage Publishers.
- Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
- Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International. P Ltd.
- McCue, D.–Comparative Physiology of Fasting, Starvation, and Food Limitation; Springer
- Metzler DE. 2001. The chemical reactions of living cells – Academic Press.
- Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; 5<sup>th</sup> Ed; New Age International Publishers
- Prosser C. L. and F. A. Brown – Comparative Animal Physiology; Saunders
- Randall D , Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W. H. Freeman.
- Refinetti R. 2000. Circadian Physiology. CRC Press, Boca Raton.
- Schmidt-Neilson K – Animal Physiology – Adaptation & Environment, Cambridge University Pr
- Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. Jaypee Pub, New Delhi
- Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn., Brooks & Cole
- Srilakshmi B. Nutrition Science; 2002; New Age International ;P Ltd.
- Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
- Tortora, G.J. and Derrickson, B.H.; 2009. Principles of Anatomy and Physiology, XII Ed, Wiley and Sons, Inc.
- Vander A, Sherman J, Luciano D. 2014. Vander's Human Physiology: The Mechanism of Body Function. XIII Edn. McGraw Hills
- Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
- Widmaier, E.P., Raff, H. and Strang, K.T. ;2008. Vander's Human Physiology, XI Edition, McGraw Hill

## **Biochemistry**

- Berg J. & G. Tomaselli – A Clinical Companion to Accompany Biochemistry –; Freeman & Co
- Berg JM, Tymoczko JL, Stryer L. 2007. Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- Campbell MK, Farrell SO. 2012. Biochemistry. 7th Edn. Brooks and Cole.
- Chatterjee MN, Shinde R. 2012. A Textbook of Medical Biochemistry. 8th Edn. Jaypee
- Conn E. E. & P. K. Stumpf – Outlines of Biochemistry –(Wiley Eastern
- Cox MM, Nelson DL. 2008. Lehninger's Principles of Biochemistry, W.H. Freeman & Co., NY
- Das D. 2000. Biochemistry. NCBA, Kolkata
- Deb A. C. – Fundamentals of Biochemistry; NCBA
- Hames BD, Hooper NM. 2000. Instant Notes in Biochemistry, II Edition, BIOS Scientific
- Harper's Illustrated Biochemistry; McGraw Hill
- Jain JL, Jain N, Jain S. 1979. Fundamentals of Biochemistry. S. Chand Pub. N. Delhi
- Lehninger Principle of Biochemistry – D. L. Nelson & M. M. Cox; Maxmillan
- Maheswari N. 2008. Clinical Biochemistry. Jaypee Pub., New Delhi
- Murray RK et al. 2009. Harper's Illustrated Biochemistry, 28<sup>th</sup> Edition, McGraw- Hill Co.
- Nelson D. L. & M. M. Cox Lehninger Principle of Biochemistry – Maxmillan
- Saltsman K., J. Berg & G. Tomaselli – A clinical companion to accompany biochemistry – Freeman
- Sathyanarayana U, Chakrapani. 2002. Biochemistry –Books & Allied ;P Ltd, Kolkata
- Voet D, Voet JG. 2004. Biochemistry –3rd edition, 2004, John Wiley & Sons, Inc.

Zubay GL. 1998. Biochemistry, 4th edition, Mc Graw-Hill.

### **Economic Zoology: Apiculture, Sericulture**

- Bisht D.S., Apiculture, ICAR Publication.  
Chaudhuri S. 2017. Economic Zoology. Kolkata: New Central Book Agency ;PLtd.  
Chun and Chen Da-Chung ;1988 Silkworm Rearing; Pub. By FAO, Rome.  
Cramp D. 2012. The Complete Step by Step Book of Beekeeping. Anness Publishing.  
Econ Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd.,  
Jolly, M. S: Appropriate Sericultural Techniques  
Krishnaswamy, Improved Method of Rearing Young age silkworm; 1986 S., Bangalore  
Mathews G. 2011. Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell  
Narasimhanna MN. 1988. Manual of Silkworm Egg Production;, CSB, Bangalore.  
Prost PJ. 1962. Apiculture. Oxford and IBH, New Delhi.  
Rangaswami G. 1976. Manual on Sericulture; Food and Agriculture Organisation, Rome  
Sarkar S; Kundu G & Chaki K C - Introduction to Economic Zoology; NCBA, Kolkata  
Sengupta, K, ;1989 A Guide for Bivoltine Sericulture  
Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.  
Ullal SR, Narasimhanna MN. Handbook of Practical Sericulture: CSB, Bangalore

### **Economic Zoology: Fish & Fisheries, Aquarium Fisheries**

- Bone Q and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.  
Chaudhuri. S, 2017: Economic Zoology, NCBS  
Evans D. H. and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK  
Khanna S.S. and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House  
Nelson JS. 2006. Fishes of the World, 4th Edn. Wiley.  
Srivastava, C.B.L. Fish Biology, Narendra Publishing House  
von der Emde, R.J. Mogdans and B.G. Kapoor. The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands

### **Immunology**

- Abbas K A, Lechtman H Andrew. 2003. Cellular and Molecular Immunology. Saunders Publication.  
Abbas KA, Andrew, LH. 2011. Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier  
Delves PJ, Martin SJ, Burton DR, Roitt I M. 2006. Roitt's Essential Immunology. Blackwell Pub.  
Kindt TJ, Goldsby RA, Osborne BA, Kuby J 2006. Immunology, W.H. Freeman and Company.  
Mohanty SK , Leela KS. 2014. Text book of Immunology. 2nd Edn. Jaypee Pub. N. Delhi  
Parija SC. 2012. Text book of Microbiology and Immunology. Elsevier.  
Playfair, JHL, Chain BM 2001. Immunology at a glance. 7 th Edn. Blackwell Pub.  
Reed JC, Green DR. 2011. Apoptosis: Physiology and Pathology. Cambridge University.  
Shetty N. 2005. Immunology: Introductory Textbook, New Age International Pub.  
Virella G. 2007. Medical Immunology, Informa Healthcare.

### **Ecology, Wild life, conservation**

- Begon M, Harper J L, Townsend CR. 2006. Ecology: Individuals, Populations & communities. 4th Ed. Blackwell sc.  
Bookhout TA. 1996. Research & Management Techniques for Wildlife & Habitats, WLS, Allen  
Cain M L, Bowman W D and Hacker S D. 2013. Ecology. 3rd ed. Sinauer associates.  
Caughley G, Sinclair ARE. 1994. Wildlife Ecology and Management. Blackwell Science.  
Chapman RL, Reiss MJ. 2000. Ecology - Principles & Application. Cambridge University Press.  
Colinvaux P. 1993. Ecology 2. John Wiley & Sons, Inc. New York.  
Faurie C, Ferra C, Medori P, Devaux J. 2001. Ecology-Science and Practice. Oxford & IBH Pub. Company.  
Ghosh, A., S. P. Agarwala & B. Sau Loss of biodiversity and its ethical implications – Sadesh

Hunter ML, Gibbs JB, Sterling EJ. 2008. Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing

Hunter, M. L., J. James & P. Gibbs – Fundamentals of Conservation Biology – John Willey & Sons

Kormondy EJ. 2002. Concepts of Ecology. 4th Indian Reprint, Pearson Education.

Krebs CJ. 2016. Ecology: The Experimental Analysis of Distribution and Abundance. Pearson India Edcn Ltd.

Mackenzie, A, A. S. Ball & S. R. Virdee – Ecology – (Viva)

Majupuria T. C. – Wildlife of India – Techpress, Bangkok

Molles Jr. MC. 2005. Ecology: Concepts and Applications. 3rd Ed. McGraw- Hill.

Mukherjee A. K. – Endangered animals of India – Z.S.I

New T. R. – Invertebrate Surveys for Conservation – Oxford Univ. Pr.

Odum EP, Barret GW. 2017. Fundamentals of Ecology. 15th Indian reprint. Cengage learning India Pltd.

Odum EP. 2008. Fundamentals of Ecology. Brooks/Cole

Ricklefs RE, Miller, GL. 2000. Ecology. 4th Ed. W. H. Freeman & Company.

Russel PJ, Wolfe LS, Hertz PE, Starr C, McMillan B. 2008. Ecology.

Saha G. K. & S. Majumdar – Threatened Mammals of India – Daya Publication House

Saha GK, Mazumdar S. 2017. Wildlife Biology : an Indian Perspective, PHI Learning,

Saharia VB. 1998. Wildlife in India. Nataraj Publishers.

Smith TM, Smith R L. 2006. Elements of Ecology. 6th Ed. Pearson Education.

Sodhi NS, Ehlich PR. 2010. Conservation Biology for All. Oxford University Press.

Stiling P. 2009. Ecology- Theories and Applications. 4th Ed. Prentice Hall of India.

Sutherland WJ. 2000. The Conservation Handbook: Research, Management & Policy. Blackwell Sc

Townsend, C.; J. L. Harper, M. Bagon – Essentials of Ecology

Van Dyke F. 2008. Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science

Wild life (Protection) Act 1972 – Wild life Society of India (Nataraj Publication)

Wilson, E. O. – Biodiversity – National Academic Press

Woodroffe R., Thirgood S, Rabinowitz A. 2005. People and Wildlife, Conflict or Co-existence? Cambridge Univ. Pr

### **Environmental biology**

Agarwal MP. Solar energy. S Chand and Co. Ltd.

Boyle G. 2004. Renewable Energy, Power for a sustainable future. Oxford University Press

Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.

Freedman B. 1989. Environmental Ecology. Academic press, Inc.

Jayakumar P. 2009. Solar Energy: Resource Assessment Handbook.

Joseph F L & B D Louver - Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.

Kasperson, J.X. , Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N. Univ Pr, New York, 2003.

Kofi Asante Duah “Risk Assessment in Environmental management”, John Wiley and sons, Singapore, 1998.

Kolluru R, Bartell S, Pitblado R, Risk Assessment and Management Handbook, McGrawHill Inc., New York, 1996.

Park – Environmental Biology

Saha G. K. – Wetland: Crisis and options; (Astral)

Walker, C. H., S. P. Hopkin, R. M. Sibley & D. B. Peakall Principles of Ecotoxicology; Taylor & Francis

Rai GD. 2004. Non-conventional energy sources. Khanna Publishers, New Delhi

Miller T, Spoolma SE. 2013. Environmental Science. Delhi: Cengage learning India Private limited.

### **Parasitology**

Ahmed N, Dawson M, Smith C, Wood Ed. 2007. Biology of Disease. Taylor and Francis Group.

Arora D R, Arora B. 2001. Medical Parasitology. II Edition. CBS Publications and Distributors

Bogitsch B J, Carter CE, Oeltmann TN. 2013. Human Parasitology. 4th Edn. Elsevier.

Bose M. 2017. Parasitoses and zoonoses. New Central Book Agency.

Chakraborty P. 2016.. Textbook of Medical parasitology, 3rd edition. New Central Book Agency.

Chatterjee K D. 2009. Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers

Dailey MD. 1996. Meyer, Olsen & Schmidt's Essentials of Parasitology. W.C. Brown Publishers

Gunn A, Pitt SJ. 2012. Parasitology: an Integrated Approach. Wiley Blackwell.

John DT, Petri WA. 2006. Markell and Voge's Medical Parasitology. Elsevier.  
 Marr JJ, Nilsen TW, Komuniecki RW. 2003. Molecular Medical Parasitology. 2<sup>nd</sup> Edn. Academic Press.  
 Muller R, Wakelin D. 2002. Worms and Human Disease. CAB International Publication.  
 Noble ER, Noble GA. 1982. Parasitology: The biology of animal parasites. Lea & Febiger  
 Paniker CKJ, Ghosh S. [Ed]; 2013. Paniker's Text Book of Medical Parasitology. Jaypee  
 Parija SC. 2013. Textbook of medical parasitology, protozoology & helminthology II Edition, All India Publishers and Distributors, Medical Books Publishers, Chennai, Delhi.  
 Prakash, G.; 2012. Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co Ltd.

### **Vector & Biology of Insect**

Chandra G. 2000. Mosquito. Sribhumi Publication Co. Kolkata  
 Chapman RF. 1998. The Insects: Structure and Function. IV Edition, Cambridge University Press  
 Klowden, M. J., Physiological system in Insects, Academic Press, USA  
 Gullan, P. J. and Cranston, P. S., The Insects, An outline of Entomology, Wiley Blackwell, UK  
 Hati A. K., Medical Entomology, Allied Book Agency, 2010  
 IMM's AD. 1977. A General Text Book of Entomology. Chapman & Hall, UK  
 Nation, J. L., Insect Physiology and Biochemistry, CRC Press, USA  
 Pedigo LP. 2002. Entomology and Pest Management. Prentice Hall Publication  
 Saunders DS. 2002. Insect Clocks. Elsevier Science.  
 Snodgrass, R. E., Principles of Insect Morphology, Cornell Univ. Press, USA  
 Wilson, E. O., The Insect Societies, Harvard Univ. Press, UK  
 Borror, D. J., Triplehorn, C. A., and Johnson, N. F. Introduction to the study of insects, Saunders Pub

### **Endocrinology**

Fox T, Brooks A, Baidya B. 2015. Endocrinology. JP Medical, London.  
 Gardner DG, Shoback D. 2011. Greenspan's Basic and Clinical Endocrinology. McGraw Hill Lange.  
 Goodendocr man HM. 2000. Basic Medical Endocrinology. Academic Press.  
 Jameson JL. 2010. Harrison's Endocrinology. McGraw Hill  
 Melmed S, Conn PM. 2005. Endocrinology: Basic and Clinical Principles. Humana Press.  
 Melmed S, Polonsky K, Larsen PR, Kronenberg H. 2016. William's Text Book of Endocrinology. Elsevier.  
 Molina PE. 2013. Endocrine Physiology. McGraw Hill Lange.  
 Neal JM. 2000. Basic Endocrinology; an Interactive Approach. Blackwell Science.  
 Norris DO. 2007. Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press  
 Strauss JF, Barbieri RL. 2014. Yen & Jaffe's Reproductive Endocrinology. Elsevier Sounders

### **Reproductive, Developmental Biology**

Carlson BM. 2014. Human Embryology and Developmental Biology. 5th Edn. Elsevier..  
 Das N. 2012. Fundamental Concept of Developmental Biology. New Central Book Agency  
 Dudek RW, Fix JD. 2013. BRS Embryology. 3rd Edn. Lippincott Williams Wilkins  
 Gardner DK. 2006. In Vitro Fertilization: a Practical Approach. CRC Press.  
 Gilbert S.F. 2010. Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers,  
 Schoenwolf GC, Bleyl SB, Brauer PR, Francis-West PH. 2009. Ladens's Human Embryology. Elsevier  
 Slack JMW. 2012. Essential Developmental Biology. Wiley-Blackwell.  
 Wolpert L. 2002. Principles of Development. 2nd Edn. Oxford Univ. Press.

### **Evolutionary Biology**

Barton NH, Birggs DEG, Elsen JA, Goldstein DB, Patel NH. 2007. Evolution. CSHL Press  
 Chattopadhyay S. 2012. Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.  
 Darlington PJ. The Geographical Distribution of Animals, R.E. Krieger Pub Co  
 Dobzhansky T, Ayala FJ, Stebbins JL, Valentine JW. 1977. Evolution. Surajeet Pub., N.Delhi  
 Freeman S, Herron JC. 2016. Evolutionary Analysis. Pearson Education Limited, Noida, India.  
 Futuyma DJ. 1997. Evolutionary Biology. Sinauer Associates.

Hall BK, Hallgrímsson B. 2008. Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc  
 Kardong K. 2004. An Introduction to Biological Evolution. McGraw Hill.  
 Page RDM, Holmes EC. 1998. Molecular Evolution: A Phylogenetic Approach. Blackwell Sc  
 Rauchfuss H. 2010. Chemical Evolution and the Origin of Life. Springer.  
 Ridley M. 1996. Evolution. 2nd Edn. Blackwell Science.  
 Smith JM. 1998. Evolutionary Genetics. 2nd Edn. Oxford Univ Press.  
 Volpe EP, Rossenbaum PA. 1999. Evolution. McGraw Hill.

### **Animal Biotechnology & Animal Cell Biotechnology**

Atlas R. M. and R. Bartha – Microbial Ecology : Fundamentals and Applications  
 Thieman W.J. and M.A. Palladino – Introduction to Biotechnology; Pearson

### **Animal Behaviour & Chronology**

Alcock J. 2013. Animal Behaviour, Sinauer Associate Inc., USA.  
 Drickamer LC, Vessey SH. 2001. Animal Behaviour. McGraw-Hill  
 Dujatkin LA. 2014. Principles of Animal Behaviour. 3rd Edn. W.W.Norton and Co.  
 Dunlap JC, Loros JJ, DeCoursey PJ. 2004. Chronobiology Biological Timekeeping. Sinauer Assoc.  
 Krebs J. R. & N. B. Davies – An introduction to Behavioural Ecology – Blackwell Scientific  
 Kumar V. 2002. Biological Rhythms. Narosa Publishing House, New Delhi.  
 Mandal F. 2010. A Text Book of Animal Behaviour. Pentice Hall India.  
 Mathur R. 2005. Animal Behaviour. Rastogi Pub.  
 Ruhela A, Sinha M. 2010. Recent Trends in Animal Behaviour. Oxford Book Co.  
 Sherman PW, Alcock J. 2013. Exploring Animal Behaviour, Sinauer Assoc Inc., Massachusetts, USA.

### **Practical**

Chatterjee A K, Chakraborty C. – Practical Zoology. (Nirmala Library)  
 Ghosh K C, Manna B. – Practical Zoology (NCBA)  
 Gunasegaran JP. 2010. A Text book of Histology and a Practical Guide. Elsevier  
 Sinha J K, Chatterjee A K. and Chattopadhyay P. – Advanced Practical Zoology (New Central Book Agency)  
 Poddar T, Mukhopadhyay S, Das S K. An advanced Laboratory Manual of Zoology (Trinity Press)