

# GOVERNMENT COLLEGE (AUTONOMOUS), BHAWANIPATNA

(College with potential for excellence)



## COURSES OF STUDIES

### FOR THREE YEAR DEGREE COURSE IN **SCIENCE** (UNDER CBCS)

### SUB: ZOOLOGY

Semester-I	2017	Semester-II	2018
Semester-III	2018	Semester-IV	2019
Semester-V	2019	Semester-VI	2020

Published by:  
Government College (Autonomous), Bhawanipatna  
Bhawanipatna-766001, Kalahandi (Odisha)  
Copyright reserved

## COURSE STRUCTURE

		<b>Paper Code</b>	<b>Credit Points</b>
<b>Semester-I</b>	1	AECC-1	02
	2	GE-1	06
	3	CORE-1	06
	4	CORE-2	06
		<b>TOTAL</b>	<b>20</b>
<b>Semester-II</b>	1	AECC-2	02
	2	GE-2	06
	3	CORE-3	06
	4	CORE-4	06
		<b>TOTAL</b>	<b>20</b>
<b>Semester-III</b>	1	SEC-1	02
	2	GE-3	06
	3	CORE-5	06
	4	CORE-6	06
	4	CORE-7	06
		<b>TOTAL</b>	<b>26</b>
<b>Semester-IV</b>	1	SEC-2	02
	2	GE-4	06
	3	CORE-8	06
	4	CORE-9	06
	4	CORE-10	06
		<b>TOTAL</b>	<b>26</b>
<b>Semester-V</b>	1	CORE-11	06
	2	CORE-12	06
	3	DSE-1	06
	4	DSE-2	06
		<b>TOTAL</b>	<b>24</b>
<b>Semester-VI</b>	1	CORE-13	06
	2	CORE-14	06
	3	DSE-3	06
	4	DSE-4	06
		<b>TOTAL</b>	<b>24</b>
		<b>GRAND TOTAL</b>	<b>140</b>

## C O N T E N T

	<b>Paper Code</b>	<b>Page No.</b>
1	AECC	03
2	SEC	07
3	GE	09
4	CORE	16
5	DSE	28

## ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

### SEMESTER-I

#### AECC-I : ENVIRONMENTAL STUDIES (ENVS)

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

#### MODULE-1: Introduction to environmental studies and Ecosystem [BOTANY Dept]

Multidisciplinary nature of environmental studies;

Scope and importance; Concept of sustainability and sustainable development.

#### Ecosystems : [ZOOLOGY Dept]

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: Food chains, food webs and ecological succession. Case studies of the aquatic ecosystems (ponds) (8 lectures)

#### MODULE-2:

##### Natural Resources : Renewable and Non-renewable Resources [ZOOLOGY Dept]

- Land resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, Biodiversity and tribal populations.
- Water : Use and over---exploitation of surface and ground water, floods, droughts, conflicts Over water (international & inter-state).
- Energy resources : Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. (8 lectures)

#### MODULE-3: Biodiversity and Conservation [BOTANY Dept]

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones Of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions;
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. (8 lectures) [BOTANY Dept]

#### MODULE-4: Environmental Pollution [CHEMISTRY Dept]

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Global warming, ozone layer depletion. (8 lectures)

#### References:

1. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S.Chand Publishing, New Delhi.
2. Das and Mishra. *Man and Environment*.
3. S. Swain. *Environmental Studies*.
4. M C Dash. *Fundamental of Ecology*.
5. Shukla and Chandel. *A Text Book of Plant Ecology*.

☆☆☆☆

# ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

## SEMESTER-II

### AECC-II : ENGLISH

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

This course aims at enhancing the English language proficiency of undergraduate students in humanity, science and commerce streams to prepare them for the academic, social and professional expectations during and after the course. The course will help develop academic and social English competencies in speaking, listening, pronunciation, reading and writing, grammar and usage, vocabulary, syntax, and rhetorical patterns.

Students, at the end of the course, should be able to use English appropriately and effectively for further studies or for work where English is used as the language of communication.

#### MODULE-1: Reading Comprehension [15]

- Locate and remember the most important points in the reading
- Interpret and evaluate events, ideas, and information
- Read "between the lines" to understand underlying meanings
- Connect information to what they already know

#### MODULE-2: Writing [15]

Expanding an Idea	Writing a Memo	Report Writing
Creative Writing	News Story	Setting in Creative Writing
Writing a Business Letter	Letters to the Editor	Précis Writing
CV & Resume Writing	Dialog writing	Covering Letter
Writing Formal Email	Elements of Story Writing	Note Making
Information Transfer	Interviewing for news papers	

#### MODULE-3: Language functions in listening and conversation [06]

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually

(Practice to be given using speaking activities from the prescribed textbooks)

#### Grammar and Usage [14]

Simple and Compound Sentences; Complex Sentences; Noun Clause; Adjective Clause; Adverb Clause; The Conditionals in English; The Second Conditional; The Third Conditional; Words and their features; Phrasal Verbs; Collocation; Using Modals; Use of Passives; Use of Prepositions; Subject-verb Agreement; Sentence as a system; Common Errors in English Usage

#### Examination pattern

Each reading and writing question will invite a 200 word response.

Language function questions set in context will carry 01 mark per response. There will be 15 bit questions.

<b>Midterm test:</b>	Writing : 1 question	04 x 01qn = 04 marks
	Speaking: 2 questions	03x02 qns = 06 marks
	Total	10 marks

<b>Term End :</b>	MODULE-1	Reading: 05 questions	03x 05 qns= 15 marks
		(3 prose and two poetry questions)	
	MODULE-2	Writing: 03 questions	05 x 03 qns= 15 marks
	MODULE-3	Grammar & usage: 10 qns	01x 10 qns = 10 marks
	Total		40 marks

Grammar questions must be set in contexts; not as isolated sentences as used for practice in the prescribed textbook.

#### Book Prescribed

*Vistas and Visions: An Anthology of Prose and Poetry.* (Ed.)Kalyani Samantray, Himansu S. Mohapatra, Jatindra K. Nayak, Gopa Ranjan Mishra, Arun Kumar Mohanty. OBS

**Texts to be studied :** Prose (Decoding Newspapers, The Gold Frame, Of Truth, Lifestyle English)

**Poetry** (Lines Composed a few miles above Tintern Abbey; Sonnet 46 (Shakespeare); Pigeons)

All grammar and writing activities in the textbook



**AECC-II : ODIA  
SEMESTER-II**

ଆସ୍ଥାମୂଲ୍ୟାଂକ - ୨, ମୋଟ୍ ଶ୍ରେଣୀ ପାଠଦାନ-୨୦ ଘଣ୍ଟା, ପୂର୍ଣ୍ଣସଂଖ୍ୟା - ୫୦, ପରୀକ୍ଷା ସମୟ- ୨ ଘଣ୍ଟା  
ପାଠ୍ୟର କୌଣସି ଗୋଟିଏ ପାଠ୍ୟକୁ ବାଛିବାକୁ ହେବ।

**ପାଠ୍ୟ-୧ / Course-1 :**

- ଉପାଂଶ-୧: (ଗନ୍ଧବିଭାଗ) ଗନ୍ଧ ତରଂଗ-ପ୍ରକାଶକ ସମ୍ବଲପୁର ସାହିତ୍ୟ ସଂସଦ  
ଭଗବାନ ମଲାପରେ-ମହାପାତ୍ର ନୀଳମଣି ସାହୁ  
ବିଷକନ୍ୟାର କାହାଣୀ-ମନୋଜ ଦାସ  
ଦ୍ଵିତୀୟ ଶ୍ଵଶାନ-ରାମଚନ୍ଦ୍ର ବେହେରା  
ଫୁଟି ପ୍ରଶ୍ନୋତ୍ତରାଟିଏ ପ୍ରଶ୍ନର ଉତ୍ତର ପାଞ୍ଚଶହ ଶବ୍ଦରେ ଲେଖିବାକୁ ହେବ। (୧୦)
- ଉପାଂଶ-୨: (କବିତାଶ୍ରୀ) ଅଦ୍ଭୁତବାଚ -କୁମ୍ଭସାସ ମହାନ୍ତି  
ଲକ୍ଷନ-ରମାକାନ୍ତ ରଥ  
କୁମ୍ଭପତିସଭାସଭେ -ପ୍ରତିଭା ଶତପଥୀ  
ଫୁଟି ପ୍ରଶ୍ନର ଗୋଟିଏ ପ୍ରଶ୍ନର ଉତ୍ତର ପାଞ୍ଚଶହ ଶବ୍ଦରେ ଲେଖିବାକୁ ହେବ। (୧୦)
- ଉପାଂଶ-୩: (ଅବବୋଧ) ଏକଶହପଚାଶ ଶବ୍ଦର ଏକ ଅନୁଚ୍ଛଦ ପ୍ରଦାନ କରାଯିବ।  
୫ଟି ପ୍ରଶ୍ନ ପଡିବ ଏବଂ ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନର ମୂଲ୍ୟ ୨। (୫X୨=୧୦)
- ଉପାଂଶ-୪: (ଭାବ ସଂପ୍ରସାରଣ) କୌଣସି ଏକ ଭୂମିକୁ ପ୍ରଶ୍ନଭାବରେ ପ୍ରଦାନ କରାଯିବ। (୧୦)
- ଉପାଂଶ-୫: (ବିଭକ୍ତି) ବ୍ୟାକରଣ। ଆଠରୁ ପାଞ୍ଚଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ। ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନର ମୂଲ୍ୟ ୨ ନମ୍ବର। (୫X୨=୧୦)

**ପାଠ୍ୟ-୨ / Course-2 : ସଂପର୍କ ଅନୁକ୍ରମ**

- ଉପାଂଶ-୧: ସଂପର୍କର ଭିତ୍ତି, ପରିଭାଷା, ଅନୁକ୍ରମ ଓ ପରିସର  
ଉପାଂଶ-୨: ସଂପର୍କର ପ୍ରକାରଭେଦ: କଥିତ-ଲିଖିତ, ବ୍ୟକ୍ତିଗତ-ସାମାଜିକ-ସାଂସ୍କୃତିକ-ବ୍ୟାବସାୟିକ-ସାହିତ୍ୟିକ  
ଉପାଂଶ-୩: ସଂପର୍କର ବାଧକ ଓ ସଫଳସାଧନର ଦିଗ  
ଉପାଂଶ-୪: ସଂପର୍କରେ ସାହିତ୍ୟର ଭୂମିକା  
ଉପାଂଶ-୫: ସଫଳ ସଂପର୍କର ଭାଷା

**ପାଠ୍ୟ-୩ / Course-3 : ସଂପର୍କର ରୀତି / ଭଙ୍ଗୀ ଓ ମାଧ୍ୟମ**

- ଉପାଂଶ-୧: ସ୍ଵଗତକଥନ ଓ ସାଂଳାପିକ ଭଙ୍ଗୀ / ସାହିତ୍ୟ-ମାଧ୍ୟମ ଓ ଯୋଗାଯୋଗ  
ଉପାଂଶ-୨: ଦଳଗତ ଆଲୋଚନା ଓ ବିତର୍କ  
ଉପାଂଶ-୩: ସାକ୍ଷାତ୍‌କାର  
ଉପାଂଶ-୪: ପତ୍ରଲିଖନ ପଦ୍ଧତି / ବିବରଣୀ ଲିଖନ  
ଉପାଂଶ-୫: ବୈଷ୍ଟିକ ପଦ୍ଧତି ଓ ସଂପର୍କର ଭାଷା (ଫୁଲଭାଷ, ସଂକ୍ଷିପ୍ତ ଫୁନା ପ୍ରେରଣ, ଦୃଶ୍ୟଶ୍ରାବ୍ୟ ସଂଚାର ବିଧାନ, ଝେଦ୍‌ସାଇଟ୍, ଆନ୍ତର୍ଜାତିକ ପଦ୍ଧତି / ଇଣ୍ଟରନେଟ୍)

**ଗୁଣ୍ଡ ତାଲିକା**

- ୧- ଗନ୍ଧତରଂଗ- ପ୍ରକାଶକ ସମ୍ବଲପୁର ସାହିତ୍ୟ ସଂସଦ।  
୨- ସଂଯୋଗ ଅନୁକ୍ରମ/ବ୍ୟାବହାରିକ ଓଡ଼ିଆ ଭାଷା ଓ ପ୍ରୟୋଗାତ୍ମକ ବ୍ୟାକରଣ, ସନ୍ତୋଷ ତ୍ରିପାଠୀ, ନାଳନ୍ଦା, କଟକ।  
୩- ପ୍ରାୟୋଗିକ ଓଡ଼ିଆ ଭାଷା- ଓଡ଼ିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା।  
୪- ସମ୍ବାଦ ଓ ସାମ୍ବାଦିକତା- ଚନ୍ଦ୍ରଶେଖର ମହାପାତ୍ର, ଓଡ଼ିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା।  
୫- ଆଧୁନିକ ଓଡ଼ିଆ ବ୍ୟାକରଣ – ଧନେଶ୍ଵର ମହାପାତ୍ର।



**AECC-II : HINDI**  
**SEMESTER-II**  
**(CREDITS: 2, Theory=2)**  
**(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)**

**MODULE-1: कविता**

- (i) कबीर - साखी : १ से १०
- (ii) तुलसी - विनयपत्रिका - पद १ और २
- (iii) प्रसाद - मधुमय देश
- (iv) निराला - भिक्षुक
- (v) अज्ञेय - हिरोशिमा

**MODULE-2: गद्य**

- (i) रामचन्द्र शुक्ल - उत्साह
- (ii) हजारी प्रसाद द्विवेदी - कुटज
- (iii) हरिशंकर परसाई - सदाचार का तावीज

**MODULE-3: शब्द ज्ञान**

- (i) शब्द सुद्धि
- (ii) वाक्य सुद्धि
- (iii) पययिवाची शब्द
- (iv) विलोम शब्द

**MODULE-4: सामान्य ज्ञान**

- (i) निबंध लेखन

**अंक विभाजन:**

विभाग - (क)	अपर्युक्त इकाइयों ६, ६६ और ६७ से ०३ प्रश्न पूछे जाएँगे। उनमें से ०२ के उत्तर लिखने होंगे। (प्रत्येक उत्तर ७००-१००० शब्दों के बिच)	10X2=20
विभाग - (ख)	अपर्युक्त इकाइयों ६ और ६६ से ०४ पद्यांश / गद्यांश पूछे जाएँगे। जिनमें से ०२ के उत्तर लिखने होंगे। (प्रत्येक उत्तर ४००-५०० शब्दों के बिच)	05X2=10
विभाग - (ग)	युनिट ६६६ से अति संक्षीप्त प्रश्न पूछे जाएँगे।	02X5=10
	End Semester	40
	Internal	10
	Total	50

**पाठ्य पुस्तक:**

हिन्दी प्रसून - सं डॉ अंजुमन आरा, प्लानेट भी, कटक

☆☆☆☆

## SKILL ENHANCEMENT COURSE (SEC)

### SEMESTER-III

#### SEC-1: BASIC COMPUTER APPLICATION (BCA)

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

##### **MODULE-1: 4 classes**

**Introduction: Introduction to computer system:** Computer, Hardware, Software, Types of software, Types of Computer, uses of computer.

##### **MODULE-2: 6 Classes**

**Human Computer Interface:** Operating system as user interface, utility programs, Input and output devices: Keyboard, Mouse, Joystick, Scanner (OCR, OBR, OMR, MICR), Digital Camera, Touch Screen. Monitor, Printer, Plotter,

**Windows-**Introduction, functions, properties and different versions, Working with Start Menu, Control Panel, Explorer, Desktop and Icons, My computer, Recycle bin, My Document, Good practices to make the windows run efficiently.

##### **MODULE-3: 6 classes**

**Memory:** Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks, USB storage, Memory Card, C.P.U., registers, ALU, Control Unit, system bus, processors(only basic idea about function and type).

##### **MODULE-4: 5 classes**

**VIRUS** –Meaning, function, characteristics and types, Uses of Firewall and Antivirus.

**Electronic mail and its features-** inbox, composing mails, sending mail, trash, spam folder in email.

##### **MODULE-5: 9 classes**

Introduction to Ms.Office:

**Ms.Word:** Creating a file, Page formatting, editing, printing, saving a file, bullet and numbering, spell check, indenting, paragraph formatting, find and replace.

**Ms. Excel:** Spread sheet and its uses, Setting column and row, Inserting formula and uses of various functions (AND, IF, NOT, OR, SUM, MAX, COUNT, COUNTA, COUNTIF, AVERAGE), use of Auto sum, Formatting cell, printing, copying and saving.

**Ms.Power Point:** Features, Uses, Menus, Tool bar, template and wizard, creating animation and effects, saving, deleting and opening a presentations. characteristics of a good presentation.

##### **Reference Book:**

1. Computer Fundamental by PK Sinha – BPB publication.
2. Ms.Office 2007 by Rutkoshy, Seguin – BPB publication.
3. Goel, Computer Fundamentals, Pearson Education, 2010.

☆☆☆☆☆

## SEMESTER-IV

### SEC-2: COMMUNICATIVE ENGLISH AND WRITING SKILL (CEWS)

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

#### MODULE-1: Communication Process 10 Marks (1 long question / 2 short questions)

- Process of Communication, Characteristics of Business Communication, Inter-personal, Intra-personal and Group communication
- Definition, Objectives, Process, Channels and importance of Communication
- Principles of effective communication and Barriers to effective Communication.
- Types of Communication – Written, Verbal, Non-verbal, informal and Formal and Grape-vine
- Written Communication – Writing letters for inquiries, orders, complaints and claims, Condolence, Complement letters.

#### MODULE-2: Analytical Grammar 10 Marks (1 x 10 = 10)

- **Vocabulary** : Phrasal Verbs, Synonyms, Antonyms, Idioms, Commercial Terms, Countable and uncountable Nouns, Tense Patterns, Modal Verbs, Prepositions and Phrasal Verbs, The Imperatives, Interrogative, The Passive, Direct and Reported Speech.

#### MODULE-3: WRITING SKILL: 10 Marks (1 long question/ 2 short questions)

- Writing paragraph, developing ideas into paragraphs, writing personal letters and notes, writing applications, official letters and business letters, writing curriculum vitae/resume, writing e-mails, sms, advertisement and short notes.

#### MODULE-4: Creative Skills 10 Marks (1 long question)

- Reporting (on issues, events and business matters), Note making and summarising, Description of objects/events/process, Writing and designing pamphlet/brochure, Writing Review/ comment.

#### Recommended reading:

1. Fluency in English – Part I & II, Oxford University Press.
2. A. J. Thomson & A. V. Matrinet, Practice English Grammar.
3. L. Gartside (ELBS) Modern Business Letters.
4. Business English, Pearson, 2008
5. Pradhan, Bhende and Thakur – Business Communication, Himalaya Publishing House.
6. U. S. Rai & M. S. Rai, Business Communication, Himalaya Publishing House, Bombay.
7. Language, Literature and Creativity, Orient Blackswan 2013

☆☆☆☆



## GENERIC ELECTIVE (GE)

### BOTANY

#### SEMESTER-I

#### GE-1 : BIODIVERSITY(MICROBIOLOGY, ALGAE, FUNGI AND ARCHEGONIATE

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

**MODULE-1: Microbes** : Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

**MODULE-2: Algae**: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and lifecycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae.

**Fungi** : Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition , nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens

**MODULE-3: Introduction to Archegoniate** : Unifying features of archegoniates, Transition to land habit, Alternation of generations.

**Bryophytes** : General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and

*Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

**MODULE-4: Pteridophytes** : General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.

**MODULE-5: Gymnosperms**: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

#### Suggested Readings :

1. Pelczar M.J, Chan E.C.S., Kreig N.R; Microbiology; Tata McGraw Hill publishing Company, New Delhi.
2. R.P.SINGH; MICROBIOLOGY; Kalyani Publisher.
3. R.C.Dubey And P.K.Maheswari; Microbiology; S,Chand.
4. Vashistha B.R.; Botany for Degree Students : Algae; S. Chand and Company, New Delhi.
5. Kumar, H.D.; Introductory Phycology; Affiliated East-West Press Ltd. New Delhi
6. Vashistha B.R.; Botany for Degree Students :Fungi; S. Chand and Company, New Delhi
7. Dube, H.C; An Introduction to Fungi; Vikash Publishing House Pvt. Ltd., Delhi.
8. Vashistha B.R.; Botany for Degree Students :Bryophyta; S. Chand and Company, New Delhi
9. Puri, P.; Bryophyta; Atma Ram & Sons. Delhi.
10. B.P. Pandey; Bryophyta; S. Chand and Company, New Delhi
11. Vashistha B.R.; Botany for Degree Students : Pteridophyta; S. Chand and Company, New Delhi.
12. Rashid, A; Introduction to Pteridophytes; Vikash Publishing House, New Delhi
13. Vashistha P.C; Gymnosperm.; S. Chand and Company, New Delhi.
14. Sharma O.P., Dixit, S.; Gymnosperm; Pragati Prakash, Merut, New Delhi.



# BOTANY

## SEMESTER-II

### GE- 2: PLANT PHYSIOLOGY AND METABOLISM

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

#### MODULE-1: Introduction:

2 lectures

**Meristematic and permanent tissues** : Root and shoot apical meristems; Simple and complex tissues

5 lectures

**Organs** : Structure of dicot and monocot root stem and leaf.

3 lectures

**MODULE-2: Secondary Growth** : Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem. Wood (heartwood and sapwood) **6 lectures**

**Adaptive and protective systems:** Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes. **5 lectures**

**MODULE-3: Structural organization of flower** : Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac. **5 lectures**

**Pollination and fertilization** : Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms. **6 lectures**

**MODULE-4: Embryo and endosperm** : Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship

**MODULE-5: Apomixis and polyembryony** : Definition, types and Practical applications **5 lectures**

#### Practicals:

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous / campylootropous.
9. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

#### Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt.Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

☆☆☆☆☆

## CHEMISTRY

### SEMESTER-I

#### GE- 1: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

#### SECTION A (INORGANIC CHEMISTRY-1)

##### **MODULE-1: Atomic Structure**

(a) Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

(b) What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of  $\psi$  and  $\psi^2$ , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers  $m_l$  and  $m_s$ .

Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number ( $s$ ) and magnetic spin quantum number ( $m_s$ ). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

##### **MODULE-2: Chemical Bonding and Molecular Structure**

(a) Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

(b) Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds.

(c) MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO<sup>+</sup>.

#### SECTION B (ORGANIC CHEMISTRY-1)

##### **MODULE-3: Fundamentals of Organic Chemistry**

(a) Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

(b) Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

##### **MODULE-4: Stereochemistry**

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

## MODULE-5: Aliphatic Hydrocarbons

(a) **Alkanes:** (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

(b) **Alkenes:** (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk.  $\text{KMnO}_4$ ) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis.

(c) **Alkynes:** (Upto 5 Carbons) Preparation: Acetylene from  $\text{CaC}_2$  and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline  $\text{KMnO}_4$ , ozonolysis and oxidation with hot alk.  $\text{KMnO}_4$ .

☆☆☆☆

## CHEMISTRY

### SEMESTER-II

#### GE-2: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

#### Section A (Physical Chemistry-1)

### MODULE-1: Chemical Energetics

(a) Review of thermodynamics and the Laws of Thermodynamics.

(b) Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

(c) Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

### MODULE-2:

(a) **Chemical Equilibrium:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

(b) **Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

#### Section B (Organic Chemistry-2)

**MODULE-3:** (Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure)

(a) **Aromatic hydrocarbons** (i) Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid

(ii) Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

(b) **Alkyl and Aryl Halides: Alkyl Halides** (Upto 5 Carbons) (i) Types of Nucleophilic Substitution ( $\text{SN}_1$ ,  $\text{SN}_2$  and  $\text{SN}_i$ ) reactions. (ii) Preparation: from alkenes and alcohols. (iii) Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

(c) **Aryl Halides** (i) Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. (ii) Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by  $-\text{OH}$  group) and effect of nitro substituent. Benzyl Mechanism:

KNH<sub>2</sub>/NH<sub>3</sub> (or NaNH<sub>2</sub>/NH<sub>3</sub>). (iii) Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

**MODULE-4: Alcohols, Phenols and Ethers** (Upto 5 Carbons)

(a) **Alcohols:** (i) Preparation: Preparation of 1<sup>o</sup>, 2<sup>o</sup> and 3<sup>o</sup> alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

(ii) Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO<sub>4</sub>, acidic dichromate, conc. HNO<sub>3</sub>). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

(b) **Phenols:** (Phenol case) Preparation: Cumenehydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

(c) **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.

**MODULE-5: Aldehydes and ketones (aliphatic and aromatic):** (Formaldehyde, acetaldehyde, acetone and benzaldehyde);

(i) Preparation: From acid chlorides and from nitriles.

(ii) Reactions – Reaction with HCN, ROH, NaHSO<sub>3</sub>, NH<sub>2</sub>-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-PondorffVerley reduction.

☆☆☆☆

## CHEMISTRY

### SEMESTER-III

#### GE-3: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

### SECTION A

#### (INORGANIC CHEMISTRY-1)

##### MODULE-1: Atomic Structure

(a) Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

(b) What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of  $\psi$  and  $\psi^2$ , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

##### MODULE-2: Chemical Bonding and Molecular Structure

(a) Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

(b) Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds.

(c) MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO<sup>+</sup>.

## **SECTION B (ORGANIC CHEMISTRY-1)**

### **MODULE-3: Fundamentals of Organic Chemistry**

(a) Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

(b) Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

### **MODULE-4: Stereochemistry**

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

### **MODULE-5: Aliphatic Hydrocarbons**

(Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.)

**(a) Alkanes:** (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

**(b) Alkenes:** (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO<sub>4</sub>) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis.

**(c) Alkynes:** (Upto 5 Carbons) Preparation: Acetylene from CaC<sub>2</sub> and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO<sub>4</sub>, ozonolysis and oxidation with hot alk. KMnO<sub>4</sub>.

**PRACTICAL: Mark 25 / Credit- 2**

☆☆☆☆☆

## **CHEMISTRY**

### **SEMESTER-IV**

#### **GE-4: CHEMICAL ENERGETICS, EQUILIBRIA& FUNCTIONAL ORGANIC CHEMISTRY-I**

**(CREDITS: 6, Theory=4 + Practical=2)**

**(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)**

## **SECTION A (PHYSICAL CHEMISTRY-1)**

### **MODULE-1: Chemical Energetics**

(a) Review of thermodynamics and the Laws of Thermodynamics.

(b) Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchoff's equation.

(c) Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

**MODULE-2: (a) Chemical Equilibrium:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G_0$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

**(b) Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

### **SECTION B (ORGANIC CHEMISTRY-2)**

**MODULE-3:** (Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure)

**(a) Aromatic hydrocarbons** (i) Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. (ii) Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

**(b) Alkyl and Aryl Halides: Alkyl Halides** (Upto 5 Carbons) (i) Types of Nucleophilic Substitution ( $SN_1$ ,  $SN_2$  and  $SN_i$ ) reactions. (ii) Preparation: from alkenes and alcohols. (iii) Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

**(c) Aryl Halides:** (i)Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer&Gattermann reactions. (ii) Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by  $-OH$  group) and effect of nitro substituent. Benzyne Mechanism:  $KNH_2/NH_3$  (or  $NaNH_2/NH_3$ ). (iii) Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

**MODULE-4: Alcohols, Phenols and Ethers** (Upto 5 Carbons)

**(a) Alcohols:** (i) Preparation: Preparation of  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. (ii) Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk.  $KMnO_4$ , acidic dichromate, conc.  $HNO_3$ ). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

**(b) Phenols:** (Phenol case) Preparation: Cumenehydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten – Baumann Reaction.

**(c) Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.

**MODULE-5: Aldehydes and ketones (aliphatic and aromatic):** (Formaldehyde, acetaldehyde, acetone and benzaldehyde) : (i) Preparation: from acid chlorides and from nitriles. (ii) Reactions – Reaction with HCN, ROH,  $NaHSO_3$ ,  $NH_2-G$  derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-PonndorfVerley reduction.

**PRACTICAL: Mark 25 / Credit- 2**

☆☆☆☆

## ZOOLOGY

### SEMESTER-I

#### CORE-1: DIVERSITY AND EVOLUTION OF NON-CHORDATA (PROTISTA TO PSEUDOCOELOMATES)

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

#### LECTURES: 60

**MODULE-1: Phylum Protozoa, Parazoa and Metazoa** : General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Plasmodium*, *Trypanosoma gambiense* and *Entamoeba histolytica*; Locomotion and reproduction in Protozoa; Evolution of Parazoa and Metazoa

**MODULE-2: Phylum Porifera and Ctenophora** : General characteristics and classification up to classes; Canal system in sponges; Skeleton in Sponges; General characteristics and evolutionary significance

**MODULE-3: Phylum Cnidaria** : General characteristics and classification up to classes; Metagenesis in *Obelia*; Polymorphism in Cnidaria; Corals and coral reefs; types and formation

**MODULE-4: Phylum Platyhelminthes** : General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Fasciola hepatica* and *Taenia solium*; Parasitic adaptations

**MODULE-5: Phylum Nematelminthes** : General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Ascaris lumbricoides* and *Wuchereria bancrofti*; Parasitic adaptations

**Note:** Classification to be followed from "Barnes RD (1982) Invertebrate Zoology. 5th Edition"

#### PRACTICAL: Mark 25 / Credit- 2

**Phylum Protozoa:** 1. Morphology of *Paramecium*, Binary fission and Conjugation in *Paramecium*. 2. Life stages of *Plasmodium vivax*, *Trypanosoma gambiense* and *Entamoeba histolytica* (Slides/Microphotographs). 3. Examination of pond water for protists.

**Phylum Porifera:** 1. Study of *Sycon* (including T.S. and L.S.), *Hyalonema*, and *Euplectella*. 2. Temporary mounts of spicules, gemmules and spongin fibres.

**Phylum Cnidaria:** 1. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, Ephyra larva, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia* and *Metridium* (including T.S. and L.S.).

**Phylum Ctenophora:** 1. Any one specimen/slide.

**Phylum Platyhelminthes:** 1. Study of adult *Fasciola hepatica*, *Taenia solium* and their life stages (Slides/ microphotographs).

**Phylum Nematelminthes:** 1. Study of adult *Ascaris lumbricoides*, *Wuchereria bancrofti* and their life stages (Slides/ microphotographs).

#### SUGGESTED READINGS

1. Kotpal RL(2012) Modern Text Book of Zoology: Invertebrate. Rastogi Publication.
2. Kotpal RL(2007) i) Protozoa, ii) Porifera, iii) Coelenterata, iv) Platyhelminthes, v) Nematelminthes - Rastogi Publication.
3. Parker & Haswell, Text Book of Zoology, Vol.-I, Macmillan
4. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House, New Delhi.
5. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House, New Delhi.
6. Barnes RD (1982) Invertebrate Zoology. 6th Edition. Holt Saunders International Edition.
7. Barnes RSK, Calow P, Olive PJW, Golding DW & Spicer JI (2002), The Invertebrates: A New Synthesis. 3rd Edition. Blackwell Science, USA.
8. Barrington EJW (1979) Invertebrate Structure and Functions. 2nd Edition. ELBS and Nelson.
9. Boradale LA and Potts EA (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
10. Jordan EL and Verma PS (1963) Invertebrate Zoology. Revised Edition. S. Chand, New Delhi.





## CORE-2: PERSPECTIVES IN ECOLOGY

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

### LECTURES: 60

#### MODULE-1: Introduction to Ecology

Relevance of studying ecology; History of ecology; Autecology and synecology; Levels of organization; Laws of limiting factors; Detailed study of temperature and light as physical factors.

#### MODULE-2: Population

Unitary and modular populations; Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; 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 and Predation, functional and numerical responses.

#### MODULE-3: Community

Community characteristics: dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession) with example and Theories pertaining to climax community.

#### MODULE-4: Ecosystem

Types of ecosystem; 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; Nutrient and biogeochemical cycle, Nitrogen cycle and Sulphur cycle, Carbon Cycle

#### MODULE-5: Conservation of Biodiversity

Types of biodiversity, its significance, loss of biodiversity; Conservation strategies (in situ and ex situ); Role of ZSI, WWF, IUCN; Wildlife (Protection) Act, 1972.

### PRACTICAL: Mark 25 / Credit- 2

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: fauna and flora Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO<sub>2</sub>.
4. Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary.

### SUGGESTED READINGS

1. Colinvaux PA (1993) *Ecology*. II Edition. John Wiley and Sons, Inc., USA.
2. Dash MC (1993) *Fundamentals of Ecology*. McGraw Hill Book Company, New Delhi.
3. Joshi N and Joshi PC (2012) *Ecology and Environment*. 1st Edition. Himalaya Publishing House, New Delhi.
4. Odum EP (2008) *Fundamentals of Ecology*. Indian Edition. Brooks/Cole.
5. Ricklefs, R.E., (2000). *Ecology*. 5th Edition. Chiron Press.
6. Robert Leo Smith *Ecology and field biology* Harper and Row.
7. Singh JS, Gupta SR and Singh SP (2014) *Ecology, Environmental Science and Conservation*. S.Chand, New Delhi.
8. Tiwari SK, *A Wild Life Sanctuary*
9. Anathkrishnan, *Bio Resource Ecology*
10. V B Rastogi, *Ecology and Animal Distribution*, Kedar Nath & Ram Nath.



## SEMESTER-II

### CORE-3: DIVERSITY AND EVOLUTION OF NON-CHORDATA (COELOMATE NONCHORDATES)

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

**LECTURES: 60**

**MODULE-1: Phylum Annelida**

General characteristics and classification up to classes; Evolution of Coelom; Metamerism and Excretion in Annelida

**MODULE-2: Phylum Arthropoda**

General characteristics and classification up to classes; Vision in Arthropoda; Respiration in Arthropoda; Moulting in insects, Metamorphosis in insects; Social life in insects (bees and termites) and Larval forms in Crustacea.

**MODULE-3: Phylum Onychophora**

General characteristics, evolutionary significance and affinities of *Peripatus*

**MODULE-4: Phylum Mollusca**

General characteristics and classification up to classes; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves and Evolutionary significance of trochophore larva.

**MODULE-5: Phylum Echinodermata**

General characteristics and classification up to classes; Water-vascular system in Asteroidea; Larval forms in Echinodermata and Evolutionary significance (Affinities with Chordates).

**Note:** Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, 5th Edition, Holt Saunders International Edition."

**PRACTICAL: Mark 25 / Credit- 2**

**Phylum Annelida:** 1. Study of *Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Terebella*, *Serpula*, *Chaetopterus*, *Pheretima* and *Hirudinaria*; 2. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm; 3. T.S. through crop of leech

**Phylum Arthropoda:** 1. Study of *Limulus*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*,

*Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, termite, louse, honeybee, silk moth, wasp and dragon fly.

**Phylum Onychophora:** 1. Any one specimen/slide

**Phylum Mollusca:** 1. Study of *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Mytilus*, *Loligo*, *Sepia*, *Octopus* and *Nautilus* and *Cypraea* (cowrie)

**Phylum Echinodermata:** 1. Study of echinoderm larvae; 2. Study of *Pentaceros*, *Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Echinocardium*, *Cucumaria* and *Antedon*.

**SUGGESTED READINGS**

1. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House, New Delhi.
2. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House, New Delhi.
3. Barnes RD (1982) *Invertebrate Zoology*. 6th Edition. Holt Saunders International Edition.
4. Barnes RSK, Calow P, Olive PJW, Golding DW & Spicer JI (2002) *The Invertebrates: A New Synthesis*. 3rd Edition. Blackwell Science, USA.
5. Barrington EJW (1979) *Invertebrate Structure and Functions*. 2nd Edition. ELBS and Nelson.
6. Boradale LA and Potts EA (1961) *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
7. Jordan EL and Verma PS (1963) *Invertebrate Zoology*. Revised Edition. S. Chand, New Delhi.
8. Kotpal RL(2007) i) Annelida, ii) Arthropoda, iii) Mollusca, iv) Echinodermata, - Rastogi Publication.
9. Kotpal RL(2012) *Modern Text Book of Zoology: Invertebrate*. Rastogi Publication
10. Parker & Haswell, *Text Book of Zoology*, Vol.-I, Macmillan



## **CORE-4: PHYSIOLOGY: LIFE SUSTAINING SYSTEMS**

**(CREDITS: 6, Theory=4 + Practical=2)**

**(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)**

### **LECTURES: 60**

#### **MODULE-1: Digestive System**

Structural organization, histology and functions of gastrointestinal tract and its associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Role of gastrointestinal hormones on the secretion and control of enzymes of gastrointestinal tract

#### **MODULE-2: Respiratory System**

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volume and capacity; Transport of oxygen in the blood; Oxygen- hemoglobin and myoglobin, dissociation curve and the factors influencing it; Carbon monoxide poisoning; Carbon dioxide transport in the blood; buffering action of blood and haemoglobin and Control of respiration.

#### **MODULE-3: Excretory System**

Structure of kidney and its histological details; Renal blood supply; Mechanism of urine formation and its regulation and Regulation of acid-base balance.

#### **MODULE-4: Blood**

Components of blood and their functions; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis and Coagulation of blood and Disorders of blood

#### **MODULE-5: Heart**

Structure of heart; Coronary circulation; Structure of conducting and working of myocardial fibers; Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart; Nervous and chemical regulation of heart rate; Blood pressure and its regulation and Electrocardiogram

### **PRACTICAL: Mark 25 / Credit- 2**

1. Enumeration of red blood cells using haemocytometer.
2. Estimation of haemoglobin using Sahli's haemoglobinometer.
3. Preparation of haemin and haemochromogen crystals.
4. Recording of blood pressure using a Sphygmomanometer.
5. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung and kidney.

### **SUGGESTED READINGS**

1. Arey LB (1974) Human Histology. 4th Edition. W.B. Saunders, USA
2. Chatterjee CC (2008) Human Physiology. Vol. I and II. Medical Allied Agency, Kolkata
3. Guyton AC and Hall JE (2006) Textbook of Medical Physiology. 9th Edition. W.B. Saunders Company, Philadelphia
4. Tortora GJ and Derrickson B (2012) Principles of Anatomy & Physiology. 13th Edition John Wiley and sons, USA.
5. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12th Edition. Lippincott W. & Wilkins, USA
6. Prosser and Brown, Comparative Animal Physiology
7. S C Rastogi, Essential of Animal Physiology, Rastogi Publication
8. Nagbhsan & Kudelkar Animal Physiology
9. Hill, Wyse & Anderson (2004) Animal Physiology
10. Randall Burggren & French (2005) Animal physiology

☆☆☆☆☆

## SEMESTER-III

### CORE-5: DIVERSITY AND DISTRIBUTION OF CHORDATA

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

#### LECTURES: 60

##### MODULE-1: Protochordata and Origin of Chordates

General characters of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata; Dipleurula concept and the Echinoderm theory of origin of chordates

##### MODULE-2: Introduction to Vertebrata and Agnatha

Advanced features of vertebrates over Protochordata; General characters and classification of cyclostomes up to class; Structural peculiarities and affinities of *Petromyzon* and *Myxine*

##### MODULE-3: Pisces and Amphibia

General characters of Chondrichthyes and Osteichthyes and classification up to order; Migration; Osmoregulation and Parental care in fishes; Scales in fishes; Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characters and classification up to order and Parental care in Amphibians.

##### MODULE-4: Reptilia and Aves

General characters and classification of reptilian up to order; Skull in Reptilia; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes; General characters and classification of aves up to order; Principles and aerodynamics of flight, Flight adaptations; *Archaeopteryx*- a connecting link and Migration in birds.

##### MODULE-5: Mammals and Zoogeography

General characters and classification up to order; Affinities of Prototheria and Metatheria; Dentition in mammals; Adaptive radiation with reference to locomotory appendages; Zoogeographical realms; Theories pertaining to distribution of animals and Distribution of vertebrates in different realms.

#### PRACTICAL: Mark 25 / Credit- 2

**Protochordata:** 1. *Balanoglossus*, *Herdmania*, *Branchiostoma* and Colonial Urochordata; 2. Sections of *Balanoglossus* through proboscis and branchiogenital regions; 3. Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions; 4. Permanent slide of spicules of *Herdmania*.

**Agnatha:** *Petromyzon* and *Myxine*.

**Fishes:** *Sphyrna*, *Pristis*, *Trygon*, *Torpedo*, *Chimaera*, *Notopterus*, *Mystus*, *Heteropneustes*, *Hippocampus*, *Exocoetus*, *Echeneis*, *Anguilla*, *Tetrodon*, *Diodon*, *Anabas* and Flat fish.

**Amphibia:** *Ichthyophis/Ureotyphlus*, *Necturus*, *Duttaphrynus*, *Polypedates*, *Hyla*, *Alytes* and *Salamandra*.

**Reptiles:** *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Draco*, *Ophiosaurus*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis* and *Crocodylus*; Key for Identification of poisonous and non-poisonous snakes.

**Aves:** Study of six common birds from different orders; Types of beaks and claws; Types of feathers.

**Mammalia:** *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus*, *Loris*, *Herpestes* and *Hemiechenis*.

#### SUGGESTED READINGS

1. Agarwal VK (2011) Zoology for degree students. S. Chand, New Delhi.
2. Arora MP (2006) Chordata-1. 1st Edition. Himalaya Publishing House, New Delhi.
3. Hall BK and Hallgrímsson B (2008) *Strickberger's Evolution*. 4th Edition. Jones and Bartlett Publishers Inc., USA.
4. Jordan EL and Verma PS (1963) Chordate Zoology. Revised Edition. S. Chand, New Delhi.
5. Young JZ (2004) *The Life of Vertebrates*. 3rd Edition. Oxford University Press, USA.
6. Kotpal RL (2012) Modern Text Book of Zoology: Vertebrate. Rastogi Publication

☆☆☆☆

## CORE-6: PHYSIOLOGY – CONTROLLING AND COORDINATING SYSTEM

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

### LECTURES: 60

**MODULE-1: Tissues and Glands, Bone and cartilage** : Structure, location, function and classification of Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue; Types of glands and their functions; Structure and types of bones and cartilages; Ossification, bone growth and resorption.

**MODULE-2: Nervous System** : Structure of neuron, resting membrane potential; Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; types of synapsis, Synaptic transmission; Neuromuscular junction; Reflex action and its types, Reflex arc and Physiology of hearing and vision.

**MODULE-3: Muscle** : Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor Unit, summation and tetanus

**MODULE-4: Reproductive System** : Histology of male and female reproductive systems; Puberty; Physiology of reproduction of male and female; Methods of contraception (depicted through flow chart)

**MODULE-5: Endocrine System** : Functional Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, thymus, pancreas, adrenals, placenta; Hormones secreted by them and their mechanism of action; Gonadal hormones; Classification of hormones; Regulation of their secretion; Mode of hormone action; Signal transduction pathways utilized by steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland), principal nuclei involved in neuroendocrine control of anterior pituitary

### PRACTICAL: Mark 25 / Credit- 2

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells.
3. Examination of sections of mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.

### SUGGESTED BOOKS

1. Arey LB (1974) Human Histology. 4th Edition. W.B. Saunders, USA
2. Chatterjee CC (2008) Human Physiology. Vol. I and II. Medical Allied Agency, Kolkata
3. Guyton AC and Hall JE (2006) Textbook of Medical Physiology. 9th Edition. W.B. Saunders Company, Philadelphia
4. Tortora GJ and Derrickson B (2012) Principles of Anatomy & Physiology. 13th Edition John Wiley and sons, USA.
5. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12th Edition. Lippincott W. & Wilkins, USA
6. Prosser and Brown, Comparative Animal Physiology
7. S C Rastogi, Essential of Animal Physiology, Rastogi Publication
8. Nagbhsan & Kudelkar Animal Physiology
9. Hill, Wyse & Anderson (2004) Animal Physiology
10. Randall Burggren & French (2005) Animal physiology

☆☆☆☆

## CORE-7: COMPARATIVE ANATOMY OF VERTEBRATES

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

### LECTURES: 60

**MODULE-1: Integumentary System and Skeletal System:** Structure, functions and derivatives of integument; Axial and appendicular skeletons (excluding skull); Jaw suspensorium in vertebrates

**MODULE-2: Digestive and Respiratory System :** Alimentary canal and associated glands; Skin, gills, lungs and air sacs and Accessory respiratory organs in fishes.

**MODULE-3: Circulatory System :** General plan of circulation; Evolution of heart and aortic arches

**MODULE-4: Urinogenital System :** Succession of kidney; Evolution of urinogenital ducts and Types of mammalian uteri

**MODULE-5: Nervous System and Sense Organs :** Comparative account of brain; Autonomic nervous system; Spinal Nerves; Spinal cord; Cranial nerves in Mammals; Classification of receptors; visual receptors, chemo-receptors and mechanoreceptors.

### PRACTICAL: Mark 25 / Credit- 2

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, *Varanus*, Fowl and Rabbit
3. Carapace and plastron of turtle or tortoise
4. Mammalian skulls (One herbivorous and one carnivorous animal)

### SUGGESTED READINGS

1. Hilderbrand M and Gaslow GE. Analysis of Vertebrate Structure. John Wiley and Sons., USA.
2. Kardong KV (2005) Vertebrates' Comparative Anatomy, Function and Evolution. 4th Edition. McGraw-Hill Higher Education, New York.
3. Kent GC and Carr RK (2000) Comparative Anatomy of the Vertebrates. 9th Edition. The McGraw-Hill Companies, New York.
4. Weichert CK and William Presch (1970) Elements of Chordate Anatomy. Tata McGraw Hill, New York.

☆☆☆☆

## SEMESTER-IV

### CORE-8: BIOCHEMISTRY OF METABOLIC PROCESSES

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

### LECTURES: 60

**MODULE-1: Biomolecules :** Structures and properties of important mono-, di- and polysaccharides; Fatty acids, triglycerides and steroids; and amino acids and proteins

**MODULE-2: Carbohydrate Metabolism :** Glycolysis; Citric acid cycle; pentose phosphate pathway; Gluconeogenesis; Shuttle systems (Malateaspartate shuttle, Glycerol 3-phosphate shuttle); Glycogenolysis; Glycogenesis.

**MODULE-3: Lipid Metabolism :**  $\beta$ -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid and Ketogenesis and its regulation.

**MODULE-4: Protein Metabolism :** Catabolism of amino acids: Transamination, Deamination; Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

**MODULE-5: Enzymes and Oxidative Phosphorylation :** Kinetics and Mechanism of action of enzymes; Inhibition of enzyme action; Allosteric enzymes; Oxidative phosphorylation in mitochondria; Respiratory chain, ATP synthase, Inhibitors and Uncouplers

### PRACTICAL: Mark 25 / Credit- 2

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose).
2. Colour tests of functional groups in protein solutions.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH on the action of salivary amylase.
5. Effect of temperature on the action of salivary amylase.
6. Estimation of total protein in given solutions by Lowry's method.

## SUGGESTED READINGS

1. Berg JM, Tymoczko JL and Stryer L (2007) Biochemistry. 6th Edition. W. H. Freeman and Co., New York.
2. Cox MM and Nelson DL (2008) Lehninger Principles of Biochemistry. 5th Edition. W.H. Freeman and Co., New York.
3. Devesena T (2014) Enzymology. 2nd Edition. Oxford University Press, UK.
4. Hames BD and Hooper NM (2000) Instant Notes in Biochemistry. 2nd Edition. BIOS Scientific Publishers Ltd., U.K.
5. Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Weil PA (2009) Harper's Illustrated Biochemistry. 28th Edition. International Edition. The McGraw-Hill Companies Inc., New York.

☆☆☆☆

## CORE-9: CELL BIOLOGY

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

### LECTURES: 60

#### MODULE-1: Cells and Plasma Membrane

Prokaryotic and Eukaryotic cells; Mycoplasma; Virus, Viroids, Virions and Prions; Various models of plasma membrane; Transport across membranes; Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata.

#### MODULE-2: Endomembrane System, Mitochondria and Peroxisomes

The Endoplasmic Reticulum; Golgi apparatus; Mechanism of vesicular transport; Lysosomes; Structure and function of mitochondria: Chemi-osmotic hypothesis; Semiautonomous nature of mitochondria; Endosymbiotic hypothesis and Peroxisomes.

#### MODULE-3: Cytoskeleton and Nucleus

Structure and functions of intermediate filament, microtubules and microfilaments; Ultra structure of nucleus; Nuclear envelope: Structure of nuclear pore complex; Chromosomal DNA and its packaging; Structure and function of Nucleolus.

#### MODULE-4: Cell Cycle and Cell Signaling

Cell cycle, Regulation of cell cycle; Signaling molecules and their receptors

#### MODULE-5: Apoptosis and Cancer

Extrinsic (Death Receptor) Pathway and Intrinsic (Mitochondrial) Pathway; Growth and development of tumors and Metastasis

### PRACTICAL: Mark 25 / Credit- 2

1. Gram's staining technique for visualization of prokaryotic cells.
2. Study various stages of mitosis from permanent slides.
3. Study various stages of meiosis from permanent slides.
4. Study the presence of Barr body in human female blood cells/cheek cells. (Preparation of permanent slides)
5. Cytochemical demonstration (Preparation of permanent slides): DNA by Feulgen reaction; Mucopolysaccharides by PAS reaction; Proteins by Mercurobromophenol blue; DNA and RNA by Methyl Green Pyronin.

(In practical examination, 05 marks should be of permanent slide submission; one mark each for DNA, PAS, Proteins, MGP and Barr body slide.)

## SUGGESTED READINGS

1. Becker WM, Kleinsmith LJ, Hardin J and Bertoni G P (2009) The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008) Molecular Biology of the Cell. 5th Edition. Garland publishing Inc., New York.
3. Cooper GM and Hausman RE (2009) The Cell: A Molecular Approach. 5th Edition. ASM Press, Washington D.C.
4. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc., USA.

☆☆☆☆

## CORE-10: PRINCIPLES OF GENETICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

### LECTURES: 60

**MODULE-1: Mendelian Genetics and its Extension** : Principles of inheritance; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles; Epistasis; Pleiotropy; Sex-linked inheritance.

**MODULE-2: Linkage, Crossing Over and Chromosomal Mapping** : Linkage and crossing over; Cytological basis of crossing over; Molecular mechanisms of crossing over; Recombination frequency as a measure of linkage intensity; Two factor and three factor crosses; Interference and coincidence and Somatic cell hybridization.

**MODULE-3: Mutations** : Gene mutations; Chromosomal mutations: Deletion, duplication, inversion, translocation; Aneuploidy and polyploidy; Induced versus spontaneous mutations; Backward and forward mutations; Suppressor mutations; Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method and DNA repair mechanisms.

**MODULE-4: Sex Determination and Quantitative Genetics** : Chromosomal mechanisms of sex determination; Sex-linked, sex-influenced and sex limited characters; Polygenic inheritance and Transgressive variation.

**MODULE-5: Extra-chromosomal Inheritance** : Criteria for extra-chromosomal inheritance; Antibiotic resistance in *Chlamydomonas*; Mitochondrial mutations and maternal effects

### PRACTICAL: Mark 25 / Credit- 2

1. To study the Mendelian laws and gene interactions and their verification by Chisquare analyses using seeds/beads/*Drosophila*.
2. Identification of various mutants of *Drosophila*.
3. To calculate allelic frequencies by Hardy-Weinberg Law.
4. Linkage maps based on data from crosses of *Drosophila*.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.
7. Preparation of polytene chromosomes from larva of *Chironomous/Drosophila*.
8. To study mutagenicity in *Salmonella/E. coli* by Ames test.

### SUGGESTED READINGS

1. Gardner EJ, Simmons MJ, Snustad DP (2008) Principles of Genetics. 8th Edition. Wiley India.
2. Griffiths AJF, Wessler SR, Lewontin RC and Carroll SB. Introduction to Genetic Analysis. 9<sup>th</sup> Edition. W. H. Freeman and Co., New York.
3. Klug WS, Cummings MR, Spencer CA and Palladino MA (2012) Concepts of Genetics. 10th Edition. Pearson Education, Inc., USA.
4. Russell PJ (2009) Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings, USA.
5. Snustad DP and Simmons MJ (2012) Principles of Genetics. 6th Edition. John Wiley and Sons Inc., USA.
6. Verma PS and Agarwal VK (2010) Genetics. 9th Edition. S. Chand, New Delhi.

☆☆☆☆

## SEMESTER-V

### CORE-11: DEVELOPMENTAL BIOLOGY

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

### LECTURES: 60

**MODULE-1: Introduction** : History and basic concepts: Epigenesis, preformation, Mosaic and regulative development; Discovery of induction; Cell-Cell interaction; Pattern formation; Differentiation and growth; Differential gene expression; Cytoplasmic determinants and asymmetric cell division.

**MODULE-2: Early Embryonic Development** : Gametogenesis (Spermatogenesis, Oogenesis); Types of eggs; Egg membranes; Fertilization: Changes in gametes, monospermy and polyspermy; Planes and patterns of cleavage; Early development of frog and chick up to gastrulation; Fate maps; Embryonic induction and organizers.



**MODULE-3: Late Embryonic Development** : Fate of germ layers; Extra-embryonic membranes in birds; Implantation of embryo in humans and Placenta (Structure, types and functions of placenta)

**MODULE-4: Post Embryonic Development** : Metamorphosis: Changes, hormonal regulations in amphibians; Regeneration: Modes of regeneration (epimorphosis, morphallaxis and compensatory regeneration); Ageing: Concepts and models.

**MODULE-5: Implications of Developmental Biology** ; Teratogenesis: Teratogenic agents and their effects on embryonic development; *in vitro* Fertilization; Stem cell culture and Amniocentesis.

**PRACTICAL: Mark 25 / Credit- 2**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages).
3. Study of developmental stages (above mentioned) by raising chick embryo in the laboratory.
4. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
5. Study of different types of placenta.
6. Project report on *Drosophila* culture/chick embryo development.
7. Histochemical techniques (microtomy and paraffin section preparation)

**SUGGESTED READINGS**

1. Balinsky BI and Fabian BC (1981) An Introduction to Embryology. 5th Edition. International Thompson Computer Press.
2. Gilbert SF (2010) Developmental Biology. 9th Edition. Sinauer Associates, Inc., USA.
3. Kalthoff (2008) Analysis of Biological Development. 2nd Edition. McGraw-Hill, New York.
4. Wolpert L, Beddington R, Jessell T, Lawrence P, Meyerowitz E and Smith J (2002) Principles of Development. 1st Edition, Oxford University Press, New York.

☆☆☆☆☆

**CORE-12: MOLECULAR BIOLOGY**

**(CREDITS: 6, Theory=4 + Practical=2)**

**(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)**

**LECTURES: 60**

**MODULE-1: Nucleic Acids and DNA Replication** : Salient features of DNA double helix; Watson and Crick model of DNA; DNA denaturation and renaturation; DNA topology - linking number and DNA topo-isomerases; Cot curves; Structure of RNA, tRNA and DNA and RNA associated proteins; DNA Replication in prokaryotes and eukaryotes; Mechanism of DNA replication; Role of proteins and enzymes in replication; Licensing factors; Semiconservative, bidirectional and semi-discontinuous replication; RNA priming; Replication of circular and linear ds-DNA and replication of telomeres.

**MODULE-2: Transcription** : RNA polymerase and transcription Unit; Mechanism of transcription in prokaryotes and Eukaryotes; Synthesis of rRNA and mRNA; Transcription factors and regulation of transcription

**MODULE-3: Translation** : Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

**MODULE-4: Post Transcriptional Modifications and Processing of Eukaryotic RNA** : Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing.

**MODULE-5: Gene Regulation and Regulatory RNAs** : Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencers elements; Gene silencing, Genetic imprinting; Ribo-switches, RNA interference, miRNA and siRNA.

**PRACTICAL: Mark 25 / Credit- 2**

1. Study of DNA replication using Photographs or slides and special cases, e.g., Polyteny using permanent slides of polytene chromosomes.
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
3. Estimation of the growth kinetics of *E. coli* by turbidity method.
4. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
5. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).
7. Quantitative estimation of RNA using Orcinol reaction.

**SUGGESTED READINGS**

1. Becker WM, et. al. (2009) The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, et.al. (2008) Molecular Biology of the Cell, 4th Edition. Garland publishing Inc., New York.
3. Cooper GM and Hausman RE (2007) The Cell: A Molecular Approach. 4th Edition, ASM Press, USA.
4. Lewin (2008) Genes IX
5. Watson et. al. (6th edn., 2009) Molecular Biology of the Gene.
6. Lodish et. al. (6th edn., 2008)Molecular Cell Biology
7. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
8. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc., USA.

☆☆☆☆

**SEMESTER-VI**

**CORE-13: IMMUNOLOGY**

**(CREDITS: 6, Theory=4 + Practical=2)**

**(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)**

**LECTURES: 60**

**MODULE-1: Immune System and Immunity** : Historical perspective of Immunology, Early theories of Immunology, Haematopoiesis, Cells and organs of the Immune system; Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity and Immune dysfunctions.

**MODULE-2: Antigens** : Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T - Cell epitopes.

**MODULE-3: Immunoglobulins** : Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Polyclonal sera, Monoclonal antibodies and Hybridoma technology

**MODULE-4: Major Histocompatibility Complex and Complement System** : Structure and functions of endogenous and exogenous pathway of antigen presentation; Components and pathways of complement activation.

**MODULE-5: Cytokines, Hypersensitivity and Vaccines** : Properties and functions of cytokines; Cytokine-based therapies; Gell and Coombs' classification and Brief description of various types of hypersensitivities; Types of vaccines: Recombinant vaccines and DNA vaccines.

**PRACTICAL: Mark 25 / Credit- 2**

1. Demonstration of lymphoid organs.
2. Ouchterlony's double immuno-diffusion method.
3. Determination of ABO blood group.
4. Preparation of single cell suspension of splenocytes from chick spleen, cell counting and viability test.
5. ELISA/ dot Elisa (using kit).
6. Principles, experimental set up and applications of immuno-electrophoresis, RIA

## **SUGGESTED READINGS**

1. Abbas KA and Lechtman HA (2003) Cellular and Molecular Immunology. 5th Edition. Saunders Publication, Philadelphia.
2. David M, Jonathan B, David RB and Ivan R (2006) Immunology. 7th Edition. Elsevier Publication, USA.
3. Kindt TJ, Goldsby RA, Osborne BA and Kuby J (2006) Immunology. 6th Edition. W.H. Freeman and Company, New York.

☆☆☆☆

## **CORE-14: EVOLUTIONARY BIOLOGY**

**(CREDITS: 6, Theory=4 + Practical=2)**

**(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)**

### **LECTURES: 60**

#### **MODULE-1: History of Life, theories of Evolution and Extinction**

Chemogeny, Biogeny, RNA World, Major Events in History of Life; Lamarckism; Darwinism; Neo-Darwinism; Background of extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail) and Role of extinction in evolution.

#### **MODULE-2: Evidences of Evolution**

Fossils and its types; Dating of fossils, Phylogeny of horse and human; Molecular evidences (Globin gene families as an example) and Molecular clock concept.

#### **MODULE-3: Processes of Evolutionary Change**

Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide/Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection and Artificial selection.

#### **MODULE-4: Principles of population genetics**

Concept of gene pool, Gene frequencies – equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequency without selection – Genetic drift, Mutation pressure and Gene flow and Shifts in gene frequencies with selection.

#### **MODULE-5: Species Concept and Evolution above species level**

Biological concept of species (Advantages and Limitations); Sibling species, Polymorphic species, Polytropic species, Ring species; Modes of speciation (Allopatric, Sympatric); Macro-evolutionary Principles (Darwin's Finches); Convergence, Divergence and Parallelism.

### **PRACTICAL: Mark 25 / Credit- 2**

1. Study of fossil evidences from plaster cast models and pictures.
2. Study of homology and analogy from suitable specimens/ pictures.
3. Demonstration of changing allele frequencies with and without selection.
4. Construction of cladogram based on morphological characteristics.
5. Construction of phylogenetic tree with bioinformatics tools (Clustal X and Phylip).
6. Interpretation of phylogenetic trees.

## **SUGGESTED READINGS**

1. Barton NH, Briggs DEG, Eisen JA, Goldstein DB and Patel NH (2007) Evolution. Cold Spring Harbour Laboratory Press.
2. Campbell NA and Reece JB (2011) Biology. 9th Edition. Pearson Education Inc., New York.
3. Douglas JF (1997) Evolutionary Biology. Sinauer Associates, USA.
4. Hall BK and Hallgrímsson B (2008) Evolution. 4th Edition. Jones and Bartlett Publishers, USA.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
6. Pevsner J (2009) Bioinformatics and Functional Genomics. 2nd Edition. Wiley-Blackwell, USA.
7. Ridley M (2004) Evolution. 3rd Edition. Blackwell Publishing, USA.

☆☆☆☆

## DISCIPLINE SPECIFIC ELECTIVE (DSE)

### ZOOLOGY

#### SEMESTER-V

#### DSE-1: INSTRUMENTATION AND BIO TECHNIQUES

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

#### LECTURES: 60

**MODULE-1:** Assays: Definition and criteria of reliability; Chemical assays; Biological assays: *in vivo* and *in vitro* assays; Principles and uses of analytical instruments: Balances, pH meter, calorimeter, spectrophotometer, centrifuge and ultracentrifuge.

**MODULE-2:** Microscopy: Principle of light transmission, electron, phase-contrast, fluorescence, electron, confocal, scanning electron microscopes; Microphotography: Image analysers; Microbiological techniques: Media preparation and sterilization; Inoculation and growth monitoring; Use of fermenters and Microbial assays.

**MODULE-3:** Animal Cell culture techniques: Cell viability testing; Culture media preparation and cell harvesting methods; Separation techniques in biology: Chromatography, electrophoresis (Principle and types). Immunological techniques based on antigen-antibody interactions (Principle and types)

**MODULE-4:** Radioisotope and mass isotope techniques in biology: Autoradiography and Magnetic Resonance Imaging. PCR and its variants, Application of PCR in Biology. DNA and Protein sequencing (Elementary Idea).

**MODULE-5:** Biostatistics: Concepts of biostatistics, Measure of central tendency and dispersion, Testing of hypothesis, Test of significance (t-test, F-test and Chi-square test), Simple linear regression and correlation: correlation coefficient; Bioinformatics and computational Biology: Introduction to Bioinformatics and Computational Biology; Biological databases, data query and data mining; Nucleic acid and protein sequence analysis (alignment, similarity searches including remote similarity searches, secondary structure element, motifs); Evolutionary analysis: Methods and steps of phylogenetic analysis, Classification of phylogeny: graphs, trees and cladograms

#### PRACTICAL: Mark 25 / Credit- 2

Measurement of pH of various substances; Operation of monopan balance; Separation of components of a given mixture using a laboratory scale centrifuge; Use of simple and compound microscope; Culture of animal cells; Separation of mixtures by paper/thin layer chromatography; Separation of nucleic acid mixtures by Electrophoresis; Preparation of culture media; Measurement through micrometer; Camera lucida drawing; Determination of blood group through antigen antibody reaction. PCR techniques; Mean, Median, Mode from grouped and ungrouped Data set, Standard Deviation and Coefficient of Variation, Correlation, Regression, Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test; Sequence information resource, Understanding and use of various web resources: (EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)), Understanding and using: PDB, Swissprot, TREMBL, Using various BLAST and interpretation of results, Retrieval of information from nucleotide databases, Sequence alignment using BLAST, Multiple sequence alignment using Clustalw., Construction of phylogenetic trees (PHYLIP, Clustalw).

#### SUGGESTED READING

1. Boyer R (2000) Modern Experimental Biochemistry. 3rd Edition. Addison Wesley Longman, Inc., USA.
2. Wilson K and Walker J (2010) Principles and techniques of Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press, UK.
3. Carson, Susan Molecular Biology Techniques (Third Edition)
4. Quinn & Keough, Experimental Design and Data Analysis for Biologists, Cambridge University Press
5. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
6. E. Batschelet : Introduction to Mathematics for Life Scientists, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
7. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
8. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.
9. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
10. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.



**DSE-2: ECONOMIC ZOOLOGY**

**(CREDITS: 6, Theory=4 + Practical=2)**

**(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)**

**LECTURES: 60**

**MODULE-1: Bee-keeping and Bee Economy (Apiculture)**

Varieties of honey bees and Bee pasturage; Setting up an apiary: Langstroth's/Newton's hive, bee veil, brood and storage chambers, iron frames and comb sheets, drone excluder, rearing equipments, handling of bees, artificial diet; Honey extraction techniques; Physico-chemical analysis of honey; Other beneficial products from bee; Diseases of honey bee (Visit to an apiculture institute and honey processing Units.)

**MODULE-2: Silk and Silk Production (Sericulture)**

Different types of silk and silkworms in India; Rearing of *Bombyx mori*: Rearing racks and trays, disinfectants, rearing appliances, black boxing, Chawki rearing, bed cleaning, mountages, harvesting of cocoons; Silkworm diseases: Pebrine, Flacherie, Grasserie, Muscardine and Aspergillosis, and their management; Silkworm pests and parasites: Uzi fly, Dermestid beetles and their management; Silk reeling techniques and Quality assessment of silk fibre.

**MODULE-3: Aquaculture I**

Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Prawn farming; Culture of crab; Pearl culture and Culture of air breathing fishes.

**MODULE-4: Aquaculture II (Pisciculture)**

Brood stock management; Induced breeding of fish; Management of hatchery of fish; Management of nursery, rearing and stocking ponds, Preservation and processing of harvested fish; Fishery by-products.

**MODULE-5: Dairy and Poultry Farming**

Introduction; Indigenous and exotic breeds; Rearing, housing, feed and rationing; Commercial importance of dairy and poultry farming; Varietal improvement techniques; Diseases and their management; Dairy or poultry farm management and business plan; Visit to any dairy farm or Poultry farm. \* Submission of report on anyone field visits mentioned above. .

**PRACTICAL: Mark 25 / Credit- 2**

1. Study of different types of bees (Queens, Drones and Worker bees).
2. Study of different types of silk moths.
3. Study of different types of pearls.
4. Study of different types of fish diseases.
5. Identification of different types of scales in fishes.
6. Study of different types of fins.
7. Study of different modified structures of fishes (Saw of sawfish, Hammer of hammer head fish, tail of sharks etc.)
8. Identification of various types of natural silks.

**SUGGESTED READINGS**

1. Dhyan Singh Bisht, Apiculture, ICAR Publication.
2. Dunham RA (2004) Aquaculture and Fisheries Biotechnology – Genetic Approaches. CABI publications, U.K.
3. Hafez ESE (1962) Reproduction in Farm Animals. Lea and Fabiger Publishers.
4. Knobil E and Neill JD (2006) The Physiology of Reproduction. Vol. 2. Elsevier Publishers, USA.
5. Prost PJ (1962) Apiculture. Oxford and IBH, New Delhi.
6. Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.
7. Srivastava CBL (1999) Fishery Science and Indian Fisheries. Kitab Mahal publications, India.
8. Ahsan J and Sinha SP (2010) A Hand book on Economic Zoology. S Chand, New Delhi.
9. Arora DR and Arora B (2001) Medical Parasitology. 2nd Edition. CBS Publications and Distributers.
10. Shukla, G.S. and Upadhyya, V.B. (2013) Economic Zoology. 5th Edition, Rastogi Publications, Meerut.



## SEMESTER-VI

### DSE-3: RECOMBINANT DNA TECHNOLOGY

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

#### LECTURES: 60

**MODULE-1: Introduction to Genetic Engineering:** Milestones in genetic engineering and biotechnology

**Molecular Cloning- Tools and Strategies:** Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties; Plasmid vectors: pBR and pUC series; Bacteriophage lambda and M13 based vectors; Cosmids, BACs, YACs; Use of linkers and adaptors Expression vectors: E.coli lac and T7 promoter-based vectors, yeast Ylp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

**MODULE-2: Methods in Molecular Cloning:** Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viralmediated delivery, Agrobacterium - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern – blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

**MODULE-3: DNA Amplification and DNA sequencing:** PCR: Basics of PCR, RT-PCR, Real-Time PCR Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing

**MODULE-4: Construction and Screening of Genomic and cDNA libraries:** Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

**MODULE-5: Applications of Recombinant DNA Technology:** Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules, nuclear transplantation, Retroviral method, DNA microinjection method, Dolly and Polly. Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis

#### PRACTICAL: Mark 25 / Credit- 2

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

#### SUGGESTED READINGS

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

☆☆☆☆

#### DSE-4: PROJECT (CREDIT=6 / MARKS=100)

**Research Project on Specific Biological Problem; Proposal Submission; Progress Report Presentation; Dissertation Submission; Open Viva at the End of the Semester**

☆☆☆☆