# ST. JOSEPH'S COLLEGE (AUTONOMOUS), DEVAGIRI, CALICUT 8

**Syllabus**

for

# M.Sc. ZOOLOGY PROGRAMME

**(UNDER SJCCSS SYSTEM)**

## (Effective from 2016 Admission)

### CURRICULUM AND SYLLABUS FOR

### M. Sc. ZOOLOGY COURSE

**SEMESTER -I**

| Course Code | Course | Credits | External Mark | Internal Mark |
|---|---|---|---|---|
| DZOL1B01T | Biochemistry | 4 | 80 | 20 |
| DZOL1B02T | Biophysics and Biostatistics | 4 | 80 | 20 |
| DZOL1B03T | Systematics and Evolution | 4 | 80 | 20 |
| DZOL2B04P | Biochemistry, Biophysics & Biostatistics | EXAMINATION IN THE SECOND SEMESTER | | |

**SEMESTER-II**

| Course code | Course | Credits | External Mark | Internal Mark |
|---|---|---|---|---|
| DZOL2B05T | Cell & Molecular Biology | 4 | 80 | 20 |
| DZOL2B06T | Ecology & Ethology | 4 | 80 | 20 |
| DZOL2B07T | Developmental Biology & Endocrinology | 4 | 80 | 20 |
| DZOL2B04P | Biochemistry, Biophysics & Biostatistics | 4 | 80 | 20 |
| DZOL2B08P | Systematics, Evolution, Ecology & Ethology | 4 | 80 | 20 |
| DZOL2B09P | Cell & Molecular Biology, Developmental | 4 | 80 | 20 |

| | | | | |
|---|---|---|---|---|
| | Biology & Endocrinology | | | |

**SEMESTER - III**

| Course code | Course | Credits | External | Intern |
|---|---|---|---|---|
| DZOL3B10T | Physiology | 4 | 80 | 20 |
| DZOL3B11T | Immunology & Cytogenetics | 4 | 80 | 20 |
| DZOL3B12T | Microbiology & Biotechnology | 4 | 80 | 20 |
| DZOL4B13P | Physiology, Microbiology, Imunology, Biotechnology Microtechniques & Histochemistry | EXAMINATION IN THE FOURTH SE | | |

**SEMESTER-IV**

| Course code | Course | Credits | External | Internal |
|---|---|---|---|---|
| DZOL4E01T | Enivironmental Biology- I Man, Environment & Natural Resources | 4 | 80 | 20 |
| DZOL4E02T | Environmental Biology- II Environmental Pollution | 4 | 80 | 20 |
| DZOL4E03T | Environmental Biology -III Environmental Conservation | 4 | 80 | 20 |
| DZOL4E04P | Environmental Biology- I | 4 | 80 | 20 |
| DZOL4E05P | Environmental Biology- II & III | 4 | 80 | 20 |
| DZOL4B13P | Physiology, Microbiology, Imunology, Biotechnology Microtechniques & | 4 | 80 | 20 |
| DZOL4B14D | Project Work | 4 | 80 | 20 |
| DZOL4B15V | VIVA- VOCE | 2 | 50 | |

| | | | |
|---|---|---|---|
| Total number of theory courses | 12 | Total number of practical courses | |
| Credit for each theory course | 4 | Credit for each practical course | |
| Total credits for theory course | 48 | Total credits for practical courses | 2 |
| Total credits for viva voce | 4 | Total credits for project work | |
| **Total credits** | **80** | | |

1. Continuous Internal Evaluation (CIE) and End Semester Evaluation (ESE) will be in the ratio 20 : 80 i.e. 1 : 4.
2. Criteria for continuous evaluation shall include attendance, test papers, practical course, assignments, seminar, viva voce etc.

**Distribution of Marks**

| | |
|---|---|
| Two test papers (2X5) | 10 marks |
| Attendance | 3 marks |
| Assignment | 3 marks |
| Seminar | 4 marks |
| **Total** | **20 marks** |

**For each Test paper**

| | |
|---|---|
| 80 – 100% marks | 5 marks |
| 60 – below 80% | 4 marks |
| 40 – below 60% | 3 marks |
| 20 – below 40% | 2 marks |
| 10 – below 20% | 1 marks |
| Below 10% | Nil |

**For attendance**

| | |
|---|---|
| 90 – 100% | 3 marks |
| 80 – below 90% | 2 marks |
| 75 – below 80% | 1 marks |
| Below 75% | Nil |

**For Practical Course**

| | |
|---|---|
| Attendance | 3 marks |
| Practical Skill | 2 marks |
| Record (Neatness and regularity) | 3 marks |
| Test Paper I | 6 marks |
| Test Paper II | 6 marks |
| **Total** | **20 marks** |

3. Grade point = percentage of marks / 10
4. Practical Examination shall be conducted at the end of second and fourth semesters.
5. Project work/ dissertation will be at the end of fourth semester.
6. Viva voce will be conducted at the end of second and fourth semesters.
7. Practical examinations and project evaluation will be conducted by one external examiner and one internal examiner. Viva- voce will be conducted by external examiners.
8. Project work: Credits-4 (3 credit for dissertation and 1 for viva voce) (Project report / dissertation shall be presented by Power point software)
9. The teacher who gives guidance to project work can select any topic from the syllabi including the elective course and the topic shall be assigned to each student. The research work on this topic shall be carried out by each student under the supervision of the teacher. The report of the research work shall be submitted by each student in the form of a Dissertation duly attested by the Head of the Department, a day prior to the date of viva-voce pertaining to the dissertation. A declaration by the student to the effect that the dissertation submitted by him/ her has not previously been formed the basis for the award of any degree or diploma and a certificate by the supervising teacher to the effect that the dissertation is an authentic record of work carried out by the student under his/ her supervision are to be furnished in the dissertation.
10. Marks for each core and elective theory course shall be 80 for the external examination and 20 for the internal examination.
11. Marks for each external core and elective practical course shall be 80 for the external examination and 20 for the internal core and elective practical examination.
12. Theory examination question paper shall contain 10 compulsory short answer questions with marks 2 each , 9 short essay questions out of which 6 has to answered with 5 marks each and 4 essay questions with 15 marks

each out of which 2 has to be answered.

13. Marks for the external practical examination can be distributed as follows:

| **With submission** | | **Without submission** | |
|---|---|---|---|
| Major question (1 No.) | 25 marks | Major question (1 No.) | 25 marks |
| Minor question (2 Nos.) | 2X15= 30 marks | Minor question (2 Nos.) | 2X15= 30 marks |
| Spotters (2 Nos.)/ Minor | 2X2.5= 5 marks | Spotters (5 Nos)/ Minor | 5X3= 15 marks |
| Record | 10 marks | Record | 10 marks |
| Submission (slides) | 10 marks | | |
| **Total** | **80 marks** | **Total** | **80 marks** |

14. No submission is required for the practical in elective course.

15. A candidate has to submit the following at the time of practical examination related to DZOL3B014P.

Whole mount : 4 numbers
Slides: Histology : 4 numbers
Slides: Histochemistry : 2 numbers (To test the presence of carbohydrate and protein)

1 If a candidate fails to submit the field study / tour report, no weightage for the record be awarded.

2 A minimum of two test papers for each course have to be conducted and the average shall be counted for internal evaluation in each semester.

3 One seminar for each course is compulsory.

| | **Criteria for the evaluation of dissertations** | **Marks** |
|---|---|---|
| 1. | Introduction, review of literature etc. | 5 |
| 2. | Objectives and relevance of the study | 5 |
| 3. | Methodology | 5 |
| 4. | Results | 15 |
| 5. | Discussion and interpretation | 5 |
| 6. | Involvement of the students | 5 |
| 7. | Style and neatness of the dissertation | 5 |
| 8. | References | 5 |
| | Subtotal | 50 |

| Criteria for the Project work Viva-voce | |
|---|---|
| Presentation of project work- (POWER POINT Presentation) | **Marks** |
| 1. Quality and correctness of slides | 5 |
| 2. Presentation | 10 |
| 3. Answers to questions | 15 |
| Subtotal | 30 |
| **Total** | **80** |

**General Viva-voce:**

| | |
|---|---|
| 1. Knowledge of the student | 10 |
| 2. Communications | 10 |
| 3. Answers to questions | 20 |
| **Total** | **40** |

## PATTERN OF QUESTION PAPER

I/II/III/IV **SEMESTER M.Sc. DEGREE EXAMINATION (SJCSS),** Month & Year
Branch: Zoology
Course Code**:** Course Name

Time :**3**hrs Maximum Marks:**80**

**Part A**

(Answer **all** the questions. Each question carries 2 marks)

1.
2.
3.
4.
5.
6.

7.
8.
9.
10.

**Part B**

(Answer **any six** questions. Each question carries 5 marks)

11.
12.
13.
14.
15.
16.
17.
18.
19.

**Part C**

(Answer **any two** questions. Each question carries 15 marks)

20.
21.
22.
23.

**FIRST SEMESTER THEORY**

**DZOL1B01T**

**BIOCHEMISTRY (90 hrs)**

Unit - I - Chemistry and functions of Biomolecules

1. Introduction(2 hrs)

1.1Macromolecules and their subunits

1.1. Chemical bonds of biomolecules (Covalent and Non-covalent bonds)

2. Carbohydrates (12 hrs)

2.1. Monosaccharides

2.1.1. Classification with examples-

2.1.2. Structure of glucose, fructose, galactose, mannose and ribose

2.1.3. Methods of representation of sugars (Ball and stick, projection formula and perspective formula)

2.1.4. Isomerism - Structural isomerism (functional group isomerism) and stereo isomerism (optical isomerism)- mention epimer, anomer and enantiomer with examples

2.1.5. Mutarotation

2.1.6. Reactions - Oxidation (by acids, metal hydroxides and $H_2O_2$), dehydration (by acid) and reduction (by alkali), reactions with alanine and phenyl hydrazine

2.1.7. Derivatives - ascorbic acid, acetal and hemiacetal, ketal and hemiketal, glycocosides - glycosidic bond and deoxyribose

2.1.8. Biological roles of monosaccharides

2.2. Disaccharides

2.2.1. Structure and biological roles of Maltose, Sucrose, Lactose, Cellobiose and Trehalose

2.2.2. Biosynthesis of trehalose and lactose

2.3. Polysaccharides

2.3.1. Hompolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulin and chitin

2.3.2. Mode of action of amylase on homopolysaccharides (starch and glycogen)

2.3.3. Heteropolysaccharide - Structure and biological roles of hyaluronic acid, chondroitin, chondroitin sulphate, keratan sulphate, heparin and agar-agar

3. Proteins (9 hrs)

3.1. Amino acids

3.1.1. Classification: (a) on the basis of number of amino and carboxyl group

(b) on the basis of the chemical composition of side chain (c) based on the polarity of side chain (R)

3.1.2. Amphoteric properties of amino acids

3.1.3. -Isoelectric point (pI) of amino acids

3.1.4. Peptide bond and peptides (di, tri, tetra, oligo and polypeptide)

3.2. Structure of protein

3.2.1. Primary structure, Secondary structure (α-helix -parallel & antiparallel and β pleated sheet), random coil conformation, Tertiary structure, Quarternary structure.

3.2.2. Brief note on protein domains, motifs, folds and Ramachandran plot.

3.2.3. Biological roles of proteins

4. Lipids (8 hrs)

4.1. Classification of lipids -Simple lipids (fats, oils and waxes), compound lipids (phospholipids, glycolipids, lipoproteins and sulpholipids) and derived lipids.

4.2. Brief account of the chemistry of sterols, terpenes and carotenoids.

4.3. Acid number, saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids , Rancidity

4.4. Biological roles of lipids - as food reserves (storage lipids), structural lipids in membrane, as signals, as co-factors, as pigments, as insulators, as vitamin carriers etc

4.5. Prostaglandins - Chemical nature and functions.

4.6. Fatty acids - definition; essential fatty acids

4.7. Classification with examples- Saturated, unsaturated, hydroxyl and cyclic fatty acids

4.8. Nomenclature of fatty acids - Genevan system

5. Nucleic acids (5 hrs)

5.1. Structure of nitrogen bases and nucleotides

5.2. Structural organization of DNA (Watson -Crick model)

5.3. Characteristic features of A-, B- C- and Z-DNA

5.4. Structural organization of t-RNA; brief note on micro-RNA

5.5. Biological roles of nucleotides and nucleic acids

Unit - II - Enzymes (15 hrs)

1. Classification- (I.U.B. system)
2. Specificity of enzyme action
3. Mechanism of enzyme action: Formation of enzyme substrate complex- Gibbs free energy of activation; Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Electrostatic, hydrogen and Van der Waal's bonds in Enzyme-substrate complex.
4. Enzyme kinetics - Michaelis-Menten equation - derivation; significance of $K_m$ and $V_{max}$ Values.
5. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction.
6. Enzyme inhibition - Competitive, non-competitive and uncompetitive inhibition (distinguish kinetically), suicide inhibition and feedback inhibition
7. Allosteric enzymes - positive and negative modulators
8. Factors influencing enzyme action
9. Iso-enzyme ,ribozyme, co-enzymes and zymogens
10. Classification, Structure and functions of Vitamins.
11. Vitamins as co-enzymes

Unit - III - Bioenergetics (5 hrs)

**1.** Laws of thermodynamics and biological system, Enthalpy, Entropy, Free energy concept

**2.** Energy of activation, Standard free energy change

3. Role of ATP as a free energy carrier in the biological system

Unit - IV - Metabolism and biosynthesis of biomolecules (15 hrs)

1. Carbohydrate metabolism

1.1. Glycolysis - (PFK as pacemaker - Hexokinase conformation and change by glucose), Fate of pyruvic acid

1.2. Metabolism of 2, 3 DPG as regulator of oxygen transport

1.3. Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex

1.4. Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotic hypothesis; inhibitors of electron transport chain

1.5. Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown

1.6. Pentose phosphate pathway (HMP pathway) and its significance.

1.7. Uronic acid pathway

1.8. Metabolism of Fructose and Galactose

2. Amino acid metabolism (5 hrs)

2.1. Biosynthesis and degradation of amino acids - glutamic acid, phenyl alanine,methionine, tryptophan, isoleucine, histidine, valine, Glutathione, Creatine and Creatinine

Fate of amino acids in the body

Nitrogen balance

Transamination, Decarboxylation and deamination reactions in the biological system.

Proteinuria, Hyperhomocysteinaemia, Edema and High sensitive C-reactive protein

3. Lipid metabolism (8 hrs)

3.1. Oxidation of fatty acids

3.2. Biosynthesis of fatty acids

3.3. Biosynthesis of cholesterol

4. Nucleic acid metabolism (6 hrs)

4.1. Biosynthesis and degradation of purines and pyramidines

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**FIRST SEMESTER THEORY**

**DZOL1B02T**

**BIOPHYSICS AND BIOSTATISTICS**

(90 Hours)

## Section-A-BIOPHYSICS (55 hrs)

1. Colloidal System (3 hrs)

1.1 Crystalloids and Colloids,

1.2 Properties of colloids-Adsorption, Brownian movement , Tyndall phenomena, Electosmosis, Cataphoresis, Coagulation

1.3 Forms of colloids, Suspensions and Emulsions, preparation and properties of emulsions

2. Diffusion and Osmosis (5 hrs)

2.1. Fick's laws and diffusion coefficient.

2.2. Gibb's Donnan equilibrium

2.3. Application of diffusion processes in biology: haemolysis.

2.4. Osmosis, Osmotic concentration, Osmotic pressure and osmotic gradient.

2.5. Vant Hoff's laws

2.6. Electrolytic and ionic balance in biological fluid

**3.** pH (2 hrs)

3.1. Dissociation of water

3.2. Dissociation of a weak acid

3.3. Henderson Hasselbalch equation

3.4. Electrometric determination of $p^H$

3.5. pH value calculation

3.6. Buffer Solutions-theory, buffers used in biology

4 . Bioacoustics (5 hrs)

4.1. Characteristics of sound

4.2. Physical basis of hearing

4.3. Physical organization of ear

4.5. Physical aspects of sound transmission in the ear.

4.6. Audible sound frequency

4.7. Pitch reception and theories

4.8. Infrasonic and ultrasonic sounds

4.9. Echolocation; receiving and analyzing echoes

5 . Radiation Biology (9 hrs)

5.1. Radioactivity, different types ionizing radiations and their sources

5.2. Radioactive disintegration. Decay curve, halflife - physical and biological

5.3. Biological effects of ionizing radiations – effects at macromolecular,cellular and organ system level,effects of whole body irradiation Radiation therapy

5.4. Biological applications of radioisotopes.

5.5. Radiation dosimetry- dose units and dose measurement

5.6. Radiation Detectors - GM Counter, Solid and Liquid Scintillation Counter

5.7. Incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines

5.8. Autoradiography

6.Biophysical methods

(Brief account of the following) (5 hrs)

6.1. Molecular analysis using—using UV / visible

6.2. Fluorescence,

6.3. Circular dichroism

6.4. NMR and Electron Spin Resonance (ESR) spectroscopy

6.5. Structure determination using X-ray diffraction

6.6. Analysis using light scattering.

6.7. Mass Spectrometry

6.8. Surface Plasma Resonance (SPR )

7. Electrophysiological methods (Brief) (3 hrs)

7.1. Single neuron recording

7.2. Patch clamp recording

7.3. ECG

7.4. Brain activity recording

7.5. Lesion and stimulation of brain

7.6. Pharmacological testing

7.7. PET (Positron Emission Tomography), MRI, f MRI, CAT.

8. Principles and applications of (8 hrs)

8.1. Microscopy

8.2. Resolving powers of different microscopes

8.3. Fluorescent, Interference , scanning and transmission electron microscopes

(SEM &TEM)

8.4. Different fixation and staining techniques for EM, (freeze-etch and freeze fracture methods for EM-image processing methods in microscopy)

8.5. Laser and its applications in Biology

9. Separation Techniques (10 hrs)

9.1. Chromatography (Adsorption, Partition and Ion exchange chromatography )

9.2. Column chromatography

9.3. Paper chromatographhy

9.4. Thin- layer chromatography

9.5. Gel-filtration,

9.6. Gas chromatography,

9.7. Affinity chromatography,

9.8. HPLC

9.9. Electrophoresis

9.10. Paper electrophoresis

9.11. Disc electrophoresis

PAGE, Two dimensional PAGE, Highvoltage Electrophoresis

9.12. Immunoelectrophoresis.

9.13. Isoelectric focusing.

9.14. Flow cytometry

10. Influence of gravity (3 hrs)

10.1. Human body posture in the gravitational field

10.2. Influence of G force

10.3. Force of centrifugal acceleration - importance of aviation and space travel

10.4. Effect of positive G. Force & negative G. Forces

10.5. Protection against G. Force

10.6. Influence of linear acceleration on the body

11. Nanotechnolgy (2 hrs)

11.1. Definition

11.2. Nanotechnology and its applications in the field of health care.

11.3. Roles of nanotechnology in environmental management.

**Section -B –BIOSTATISTICS** (35 hrs)

1. Introduction (2 hrs)

1.1 Biostatistics: Definition,
1.2 Characteristics of Statistics
1.3 Importance and usefulness of statistics
1.4 Limitations of Statistics

2. Data: (5 hrs)

2.1 Types of data: classification based on Source of data, Compilation, Variable, Nature

2.2 Methods of data collection and classification:-

Advantages and disadvantages of census and sampling method,

Class intervals- exclusive and inclusive method

Frequency curve (types. skewness, kurtosis, ogive)

3. Statistical Methods: Measures of central tendency and dispersal(4 hrs)

3.1. Mean, (raw data, discrete series and continuous series) Standard deviation, Standard error, degree of freedom (raw data, discrete series and continuous series)

4. Probability distributions (4 hrs)

4.1. Basic concepts and definition:

4.2. Laws of probability

4.3. Probability distribution: -

Binomial, Poisson and Normal

5. Statistical inference (problems to be discussed) (7 hrs)

5.1 Difference between parametric and non-parametric statistics;

5.2. Testing of hypothesis

5.3. Errors

5.4. Confidence interval; levels of significance, Critical region;

5.5. Normality test

5.6. t-test, chi-square test, F-test, ANOVA

5.7. Kruskal-Wallis, Mann-Whitney

6. Correlation and Regression (problems to be discussed) (7 hrs)

6.1. Types of correlation

6.2. Methods to measure correlation Scatter diagram

Karlpearson's coefficient of correlation Spearman's correlation

6.3. Types of regression analysis

6.4. Regression equations

6.5. Difference between regression and correlation analysis

7. Ecological data analysis (problems to be discussed) (6 hrs)

7.1Alpha diversity

Shannon diversity index

Simpsons Dominance index

Pielou's evenness index

Margalef species Richness

Fisher's apha

7.2 Beta diversity

Morisita Horn index

Sorenson index

Bray-Curtis similarity

**REFERENCES -**

BIOPHYSICS


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BIOSTATISTICS

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## FIRST SEMESTER THEORY

## DZOL1B03T

## SYSTEMATICS AND EVOLUTION (90 hours)

### Section A. Systematics (45 hours)

1. Definition and basic concepts in Systematics and Taxonomy (4 hrs)

1.1 historical resume of systematics

1.2Levels of Taxonomy -Alpha, beta, gamma taxonomy

1.3 Place, importance and applications of taxonomy

1.4 Goals of taxonomy

2. Classification (4 hrs)

2.1 Practice of classification- purpose of classification

2.2 Use of classification- storage of data, recovery of data

2.3 Theories of biological classification- hierarchy of categories

2.4Types of classification—evolutionary & phylogenetic classification - typological classification, phonetic classification, omnispective classification, horizontal and vertical classification

2.5 Components of classification

3. Taxonomic procedure (8 hrs)

3.1. Taxonomic collections- types of collections, value of collections

3.2. Curation- preservation of collection in field and laboratory

3.3. Recording of field data, storage of collection, labelling and cataloguing of collections

3.4. Identification- methods of identification

3.4.1. Use of keys- kinds of keys, their merits and demerits

3.5. Taxonomic descriptions: presentation of findings

3.6. Kinds of taxonomic publications

3.6.1. Taxonomic and ecological publication and their difference

4. Species concepts (7 hrs)

4.1. Species category- different species concepts: typological, Nominalistic, biological, evolutionary, recognition, ontological (theoretical) and operational (epistemological species concepts)

4.2. Taxonomic diversity within species, different kinds of species, sub species and other infra specific categories, hybrids.

5. Taxonomic characters (4 hrs)

5.1 Different kinds of taxonomic characters

5.2 Functions of taxonomic characters.

5.3 Taxonomic characters and classification

5.4 Taxonomic characters and evolution

6. Zoological nomenclature (5 hrs)

6.1 International Code of Zoological Nomenclature, development of Code of Zoological Nomenclature: its operative principles, interpretation and application of important rules in the formation of scientific names of various taxa.

6.2 Principle of priority

6.2.1 Homonymy and Synonymy

6.3 Type method and its significance

6.3.1 Different kinds of types in descriptive taxonomy

7. Newer trends in systematics (4 hrs)

7.1 Chemo and serotaxonomy

7.2 Cytotaxonomy

7.3 Numerical taxonomy

7.4 Cladistics

7.5. Molecular systematics

7.6 DNA bar coding vs traditional taxonomy

8. Ethics in taxonomy (3 hrs)

8.1 Ethics related to collections

8.1.1 Credit

8.1.2 Lending and borrowing of specimens

8.1.3 Loan of material

8.1.4 Exchange of materials

8.1.5 Collaboration and co-operation with co-workers

8.1.6 Use of language

8.2. Ethics related to taxonomic publications

8.2.1 Authorship of taxonomic papers

8.2.2 Correspondence

8.2.3 Suppression of data

8.2.4 Undesirable features of taxonomic papers

8.3 Taxonomists and user communities

9. Taxonomic impediments (4 hrs)

9.1 Impediments to build up taxonomic collections and maintenance

9.2 Shortage of man power

9.3 Lack of funding for taxonomic research

9.4 lack of training in taxonomy

9.5 Lack of Library facilities

9.6 Impediments in publishing taxonomic work

9.7 Solutions to overcome the impediments

9.7.1 International co-operation

9.7.2 Development of Taxonomic centres

9.8 Need for efficient international networking

9.9 The desired end product

**Section B. Evolution (45 hrs)**

1. Natural Selection (7 hrs)

1.1 Mechanism of natural selection - directional, disruptive and stabilizing selection

1.2. Natural selection in Islands.

1.3. Sexual selection; Intrasexual and intersexual selection-secondary sex characteristics-sexy son hypothesis-good genes hypothesis.

2. The Mechanisms (10 hrs)

2.1. Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Origin of eukaryotic cells; Evolution of unicellular eukaryotes;

2.2. Population genetics - populations, gene pool, gene frequency; Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift as factors in speciation.

2.3. speciation-allopatric- peripartric-parapatric-heteropatric- sympatric speciation;

2.4.Co-evolution; Microevolution, Macroevolution. Convergent homoplasy) -divergent-parallel evolution.

3. Tempo of evolution (8 hrs)

3.1. Gradualism Vs punctuated equilibrium.

3.2. Anagenesis Vs Cladogenesis.

4. Molecular evolution (10 hrs)

4.1. Neutral theory of molecular evolution; molecular divergence; molecular drive.

4.2. Molecular clocks- genetic equidistance- human mitochondrial molecular clock.

4.3. Phylogenetic relationships- Homology; Homologous sequences of proteins and DNA - orthologous and paralogous; parsimony analysis; nucleotide sequence analysis;.

5. Evolutionary trends (10 hrs)

5.1. Biochemical evolution- Collapse of Orthogenesis.

5.2. Stages in primate evolution including Homo: dry and wet nosed primates, prosimians and simians. Y-chromosomal Adam-mitochondrial Eve.

5.3. Communication, speech, language and self awareness in primates.

**References:**

**A. Systematics**


1. David, M. H, Craig Moritz and Barbara K. M. (1996) Molecular Systematics. Sinauer Associates, Inc.
2. David, M. S. (2009) DNA barcoding will frequently fail in complicated groups: an example in wild potatoes. American Journal of Botany 96(6): 1177-1189.Downloadable from www.vcru.wisc.edu/ spoonerlab/.../BarCodes%20and%20 Wild%20Potatoes.pdf
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7. Sneath P.H. A. (1973): Numerical Taxonomy: The Principles and Practice of Numerical Classification,W H Freeman & Co.


**B: Evolution**

1. Coyne, J.A. and Allen, O.H. (2004) Speciation. Sinauer Associates Inc., Massachusetts, USA.
2. David, M. H, Craig Moritz and Barbara K. M. (1996) Molecular Systematics. Sinauer Associates, Inc.
3. Douglas Futuyma (2013): Evolution, Sinauer associates Inc.
4. Gould, S. J. (1997) Ontogeny & Phylogeny, Belkrap press. Harwar University Cambridge.
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6. McHenry, H.M. (2009) "Human Evolution". in Michael Ruse & Joseph Travis. Evolution: The First Four Billion Years. Cambridge, Massachusetts: The Belknap Press of Harvard University Press. p. 265.
7. Motoo Kimura (1983) The neutral theory of molecular evolution. Cambridge University Press.
8. J. Philip Grime, Simon Pierce ( 2011) : The Evolutionary Strategies that Shape Ecosystems;; Wiley-Blackwell
9. Roderick D.M, Page and Edward, C. H. (2000) Molecular Evolution: A Phylogenetic Approach: Blackwell science.
10. Strikberger, M.W. (2005) Evolution, Jones and Bartett Publishers, London.
11. Veera Bala Rastogi ( 2014) : Organic evolution: Medtec publishers
12. Wallace Arthur (2011) Evolution: A Developmental Approach; Wiley-Blackwell

# PRACTICALS

# DZOL2B04P

# BIOCHEMISTRY

1. Actual acidity and titrable acidity of a strong and a weak acid.
2. Comparison of the buffering capacities of two buffers of same pH
3. Qualitative tests for carbohydrates
   a) Qualitative tests for monosaccharides (Glucose and fructose)
   b) Qualitative tests for disaccharides (Lactose, Maltose & Sucrose)
   c) Qualitative tests for polysaccharides (Dextrin & Starch)
   d) Identification of unknown carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose, Dextrin & Starch) by suitable tests.
4. Quantitative estimation of carbohydrates
   1.1. Estimation of blood glucose by colorimetric method (Somogy-Nelson method/ O- Toludine method)
   1.2. Estimation of total carbohydrate by phenol-sulphuric acid method
5. Qualitative tests for proteins
   a) Colour reactions with proteins (Albumin, Casein, Peptones & gelatin)
   b) Precipitation reactions with proteins (Albumin, Casein, Peptones & gelatin)
   c) Identification of unknown protein (Albumin, Casein, Peptones & gelatin)
6. Qualitative tests for non-protein nitrogenous substances (urea, uric acid and creatinine)
7. Identification of unknown carbohydrates, protein and non-protein nitrogenous substances from a given solution.
8. Quantitative estimation of proteins
   a) Estimation of proteins by Biuret method
   b) Isolation of casein from cow's milk
9. Quantitative estimation of non-protein nitrogenous substances
   a) Quantitation of blood urea by diacetyl monoxine method
   b) Determination of urine creatine by alkaline picrate method
10. Quantitative estimation of lipids
   a) Estimation of total serum cholesterol by Zak's method

b) Saponification number of oils - coconut oil & ground nut oil.

c) Iodine number of fats

**References:**


1. Plummer David, T.( latest) An introduction to practical biochemistry -Tata Mc Graw-Hill, New Delhi
2. Oser, B.L., (1965) Hawk's Physiological Biochemistry, McGraw Hill Book Co.
3. Sadasivan, S. and Manickam, A., (2005), Biochemical methods, New Age International, New Delhi.
4. Keith Wilson and John Walker (2008), Principles and techniques of Biochemistry and Molecular biology - 6th edn, Cambridge University Press
5. Jayaraman, J.(latest.) Laboratory Manual in Biochemistry, Wiley Eastern Ltd.


## DZOL2B04P

## Biophysics and Biostatistics

### Biophysics

1. pH meter and measurement of pH
2. Paper chromatography of amino acids, mixtures, identification of unknown amino acids and sugars.
3. Gel filtration chromatography (Separation of starch from glucose)
4. Thin layer chromatography of amino acids and sugars.
5. Serum electrophoresis.
6. Determination of absorption coefficient and concentration of unknown solutions by calibration curve using a coloured solution.
7. Absorption spectrum of a coloured solution (KMnO4)
8. Drawings using Camera lucida

### Biostatistics

1. Preparation of frequency table with given data
2. Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie

diagrams. (prepare same graph in Excel and keep print )

3. Graphic presentation of population distribution in the form of histogram, frequency polygon and frequency curve. (prepare same graph in Excel and keep print)
4. Computation of measures of central dispersion anthropometric data of School children. (prepare same in Excel and keep print outs and add steps for excel)
5. Simulation of binomial and poison distributions
6. Estimation of mean number of children per family(data from at least 10 families nearby campus ) (prepare same in Excel and keep print and add steps for excel)
7. Designing of an experiment for the comparison of efficacy of a few diets on different types of animals by the method of ANOVA. (prepare same in Excel and keep print and add steps for excel)
8. Regression analysis and correlation analysis of a data of heights and weight of a group of students. (prepare same in Excel and keep print outs and add steps for excel)

## DZOL2B08P- Systematics

1. Collection, Preservation and curation of specimens
2. Identification of animals (Fishes/insects/any other) up to family/ generic / species level- minimum15 specimens.
3. Preparation of dichotomous (simple bracket) keys; minimum ten sets from the identified specimens.

## DZOL2B08P- Evolution

1. Exercises in convergent evolution.
2. Exercises in divergent evolution.

**Reference**

John T (2002) Practical statistics for environmental and biological scientists john wiley and sons.

## SECOND SEMESTER M. Sc. ZOOLOGY

## DZOL2B05T

## CELL AND MOLECULAR BIOLOGY (90 Hours)

1. Genomes (5 Hrs)
   - 1.1 Genomes of prokaryotes and eukaryotes
   - 1.2 Special features of eukaryotic genomes – Unique, moderately repetitive and highly repetitive DNA sequences
   - 1.3 Reassociation kinetics of the above types of DNA
   - 1.4 Cot value and complexity of the genomes
   - 1.5 Satellite DNA and selfish DNA
   - 1.6 Organisation of human genome (brief account),human genome mapping
   - 1.7 Organelle genomes : Mitochondrial and chloroplast genomes
   - 1.8 Special features of yeast and human mitochondrial genomes

2. Replication of DNA (8 Hrs)
   - 2.1 Semiconservative and semidiscontinuous synthesis, Okazaki fragments
   - 2.2 Replicon, replication origin and terminus of E.coli and Yeast, replication fork, extrachromosomal replicons, fidelity of replication
   - 2.3 Enzymes and accessory proteins involved in replication – Helicases, Topoisomerases, Primase, SSB, DNA polymerases and DNA ligases.
   - 2.4 Priming mechanisms, Primer removal, Primosome and Replisome
   - 2.5 Replication of the ends of eukaryotic chromosome – role of telomerase
   - 2.6 Models of DNA replication – Rolling circle model and looped rolling circle model, D-loop model, θ-model
   - 2.7 Inhibitors of DNA replication – Inhibitors of nucleotide biosynthesis, DNA polymerase inhibitors, DNA template damaging agents and DNA Topoisomerase inhibitors

3. Systems that safeguard DNA (6 Hrs)
   - 3.1 Restriction enzymes : Significance, Classification and nomenclature of restriction enzymes
   - 3.2 Modification enzymes : Significance, operation of restriction and modification in bacteria
   - 3.3 DNA damages and repair
     - 3.3.1 DNA – major types of damages and their causes
     - 3.3.2 Repair mechanisms in bacteria and eukaryotes – direct reversal, mismatch repair, base excision repair, nucleotide excision repair, recombination repair, SOS response, and non homologous end joining repair

4. Transcription in prokaryotes and eukaryotes (8 Hrs)
   - 4.1 RNA polymerases of prokaryotes, eukaryotes, phages and organelles
   - 4.2 Initiation, elongation and termination of transcription

4.3 Structural organization of monocistronic and polycistronic transcription units
4.4 Promoters, enhancers, silences and insulators.
4.5 Transcription factors, activators and repressors, DNA binding domains of transcription activators
4.6 Post transcriptional modification of hnRNA – capping, poly (A) tailing, spliceosome assembly and splicing, trans splicing and RNA editing
4.7 Nucleocytoplasmic transport of the processed mRNA

5. Genetic code (5 Hrs)
   5.1 Characteristic features f the genetic code
   5.2 Degeneracy of the code, start and stop codons, wobble hypothesis, isoacceptor tRNAs
   5.3 Special features of genetic code in mitochondria, mitochondrial RNAs
   5.4 Variations in the genetic code in Mycoplasma and Tetrahymena
   5.5 Point mutations that alter the genetic code – missense, nonsense and frame shift
   5.6 Supressor mutations, suppressor genes and suppressor tRNAs
6. Ribosome : The site of protein synthesis (4 Hrs)
   6.1 Composition, topography, active centres and biogenesis of ribosome, reconstitution experiments, r-protein mutants
   6.2 Methods to study ribosome structure- Immune electron microscopy, cross linking; active centres, affinity labelling
   6.3 Organization of rRNA transcription unit, processing of pre-rRNA, role of snoRNAs
   6.4 Biogenesis; anucleolate mutants in Xenopus laevis
7. Translation in prokaryotes and eukaryotes (7 Hrs)
   7.1 Activation of amino acids and amino acylation of tRNA, amino acyl tRNA synthetases
   7.2 Process of initiation elongation and termination of translation in prokaryotes and eukaryotes; initiation, elongation and termination factors
   7.3 Translational proof-reading
   7.4 Translational inhibitors in prokaryotes and eukaryotes – role of tetracycline, streptomycin, neomycin, chloramphenicol, erythromycin, puromycin and diphtheria toxin
   7.5 Post-- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications
8. Regulation of gene expression at transcription and translation level (10 Hrs)
   8.1 Regulation of gene expression in bacteria and phages
      8.1.1 Structure and mechanism of regulation of tryptophan, arabinose and galactose operons
      8.1.2 Regulation of gene expression in phages - alternate patterns of gene expression for control of lytic and lysogenic cycle in λ phage
   8.2 Regulation of gene expression in eukaryotes
      8.2.1 Transcription regulation by chromatin remodelling

8.2.2 Effects of chromatin modification on transcription - acetylation, methylation and phosphorylation
8.2.3 Role of activators and repressors on transcription
8.2.4 Transcription regulation by the arrangement of genes in a cluster
8.2.5 Regulation of translation by alternate pathways of transcript splicing
8.2.6 Anti sense RNA strategies for regulating gene expression
8.2.7 si RNA and mi RNA in regulation, piRNAs

9. Interrupted genes (3 Hrs)
   9.1 Organisation and special features of interrupted genes
   9.2 Evolution of interrupted genes
10. Gene families (6 Hrs)
   10.1 Concept of a gene family, types of gene families
   10.2 Simple multigene family - organisation of rRNA gene in Xenopus
   10.3 Complex multigene family - organisation of histone genes in sea urchin and tRNA genes in Drosophila
   10.4 Developmentally controlled complex multigene family e.g., globin gene
   10.5 Organisation of globin genes and its expression pattern in Man
   10.6 Evolution of globin genes
   10.7 Concept of an evolutionary clock
   10.8 Pseudogenes
11. Transposons (8 Hrs)
   11.1 Definition, features and types
   11.2 Mechanism of transposition, consequences of transposon activity
   11.3 Transposons in bacteria – IS elements, Composite transposons,
   11.4 Phage Mu as a transposon
   11.5 Transposons in eukaryotes –Controlling elements in Maize, P elements in D. melanogaster,Tc1/Mariner elements
   11.6 Retroposons – Ty elements, Copia elements, LINEs, SINEs, Alu family
   11.7 Processed pseudogenes
12. Molecular mechanisms involved in recombination of DNA (5 Hrs)
   12.1 Genetic recombination – Site specific recombination , non-homologous recombination and homologous recombination
   12.2 Molecular mechanism involved in homologous recombination of DNA in eukaryotes- Holliday model: Holliday intermediate, heteroduplex DNA, gene conversion
   12.3 Role of Rec A protein in genetic recombination
13. Microbial genetics (4 Hrs)
   13.1 Structural organisation of Escherichia coli
   13.2 Methods of genetic transfer in bacteria– transformation (in Streptococcus pneumonia), conjugation and sexduction, transduction

13.3 Brief note on mapping genes by interrupted mating (in bacteria)

14. Cell cycle (4 Hrs)

14.1 Cell cycles in vivo

14.2 Control of cell cycle – role of protein kinases, check points, kinase inhibitors and cellular responses

15. Molecular Biology of cancer (7 Hrs)

15.1 Characteristics of transformed cells

15.2 Gene mutations in cancer and genetic rearrangements in progenitor cells

15.3 Oncogenes, proto oncogenes and tumor suppressor genes

15.4 Virus induced cancer

15.5 Cancer and the cell cycle

15.6 Cancer and apoptosis

15.7 Interactions of cancer cells with normal cells

15.8 New therapeutic interventions in cancer – Immunotherapy and gene therapy

15.9 Impairment of signalling mechanism in tumrigenesis : Role of oncogenes and oncoproteins, NIDDM and cancer

15.10 Cancer as a disease of development: Context dependent tumors, Cancer stem cells and the epithelial-mesenchymal transition, cancer and epigenetic gene regulation, developmental therapies for cancer (Brief account)

**REFERENCES**


1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. (2002). Molecular Biology of the Cell. Garland, NY
2. Brown T. A. (2000). Essential Molecular Biology. II Ed. Oxford OUP.
3. Brown T. A. (2006). Genomes 3. Garland Science, New York.
4. Clark, David P. (2005). Molecular Biology. Ameterdam, Elsevier.
5. Jones & Bartlett l Learning (2013)GENES XI 5 wall street Barlington, MA 01803978-443-5000
6. Karp, G. (2013). Cell and Molecular Biology.(7th Edition) John Wiley, New York
7. Karp, G. (2002). Cell and Molecular Biology. John Wiley, New York
8. Klinemith, L. J. and Kish, V. M. (1995). Principles of Cell and Molecular Biology. 2nd Ed. Harper Collins College Publishers.
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12. Malcinski, G. M. and Freifelder, D. (1998). Essentials of Molecular Biology. 3rd Ed. Jones and Bartlett Publishers.
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14. Nelson D. L. Cox, M. M. and Lehninger, A. L. (2007). Principles of Biochemistry, IV Ed. Freeman and Co, NY.
15. Panno, Joseph (2005). Gene Therapy. Facts on file. New York.
16. Scott F Gilbert (2014). Developmental Biology. Xth edition. Sinauer Associates
17. Sinden, Richard R. (2006). DNA structure and function. California, Academic press.
18. Snustad, D. P. and Simmons, M. J. (2000). Principles of Genetics. 2nd Ed. John Wiley & Sons Inc.
19. Synder, L. and Champness, W. (1997). Molecular Genetics of Bateria. ASM Press Washington DC.
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21. Strachan, T. and Read, A. P. (2003). Human Molecular Genetics, III ed, John-Wiley & Sons NY.

**SECOND SEMESTER M.Sc ZOOLOGY**

## DZOL2B06T

### ECOLOGY AND ETHOLOGY

**(90 Hours)**

**Part-A-ECOLOGY** (65 hrs)

1. Natural history of Indian subcontinent (3 hrs)

    1.1 Major habitat types of the subcontinent

    1.2 Geographic origins and migrations of species

    1.3 Seasonality of the subcontinent

2. Habitat and niche (3 hrs)

    2.1 Concept of habitat and niche

    2.2 Niche width and overlap

    2.3 Fundamental and realized niche

    2.4 Resource partitioning

    2.5 Character displacement

3. Ecosystem (9 hrs)

    3.1 Structure and function

    3.2 Ecosystem energetic

    3.3 Primary production

    3.4 Energy flow models

    3.5 Mineral cycling (CNP)

    3.6 Trophic levels, Food chain, food web and secondary production

    3.7 Decomposers and detritivores

4. Population Ecology (7 hrs)

4.1 Characteristics of a population

4.2 Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations

4.3 Sampling methods in the study of behaviour, habitat characterization

4.4 Ground and remote sensing methods

4.5 Population growth curves, Life tables, survivorship curves, population regulation, Life history strategies, r and k selection, Demes and dispersal, interdemic extinctions, age structure of populations

4.6 Growth and regulation of human population

5. Species interaction (6 hrs)

5.1. Types of interactions, interspecific competition

5.2. Herbivory, Carnivory, Pollination, Symbiosis;-mutualism, commensalisms and proto co- operation

6. Community Ecology (7 hrs)

6.1. Nature of communities

6.2. Characteristics of a biotic community

6.3. Species diversity and its measurements, Alpha diversity: Simpson's Diversity Index -Shannon index -Fisher's Alpha - Rarefaction; Beta diversity -Sorensen's similarity index-Whittaker's measure; Gamma diversity

6.4. Latitudinal gradients in diversity

6.5. Edges and ecotones.

7. Ecological succession (4 hrs)

7.1. Types, mechanisms

7.2. Changes involved in succession

7.3. Concept of climax

8. Biogeography (6 hrs)

8.1. Major terrestrial biomes:

(a) Tropical rain Forest (b) Grassland (c) Desert (d) Chaparral

(e) Temperate deciduous Forest (f) Temperate boreal forest (g) Tundra

(h) Savanna

9. Theory of island biogeography (4 hrs)

9.1. Theory - Influencing factors -

9.2 Applications in conservation biology- species-area relationship -single large or several small (SLOSS) - development of habitat corridors

10. Biogeographical zones of India (4 hrs)

(a) Trans Himalayan zone; (b) Himalayan zone; (c) Desert zone;

(d) Semiarid zone; (e) Western Ghats zone; (f) Deccan plateau zone;

(g) Gangetic plain zone; (h) North east zone. (i) Coastal zone; (j) Islands present near the shore line.

11. Applied Ecology (8 hrs)

11.1. Carbon credit, Carbon trading, Blue Carbon

11.2 Green building technology and its ecological importance.

11.3 Discuss the benefits and disadvantages of the idea of (brief)

a. Inter linking of major rivers of India,

b. Sethusamudram ship canal project.

C. Biodiversity with special reference to India-status monitoring and documentation, major drivers of biodiversity change .

12. Conservation Biology

12.1. Principles of conservation

12.2. Major approaches to management,

12.3. Indian case studies on conservation & management strategy (concepts of project tiger, Biosphere reserves).

**Part B. ETHOLOGY (25 hrs)**

1. Introduction (3 hrs)

1.1 Ethology as different from the other schools studying animal behaviour like behaviourism.

1.2 Behaviour as a reaction to stimuli - sign stimuli, social releasers, Ethograms, super normal stimuli, stimulus filtering.

2. Motivating factors (3 hrs)

2.1 General factors in motivation; Studies of motivation in guppies;

2.2 mating systems-parental investment and reproductive success

3. Conflict behaviour- stress-displacement activities- Ritualization. (2 hrs)

4. Instinctive behaviour & reflex action, neural basis of sleep and arousal-

5. Learning. Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks (3 hrs)

5. Adaptiveness of behaviour (3 hrs)

JP Scott's categories of behaviour.

6. External stimulus - circadian rhythms (3 hrs)

6.1- Proximate and Ultimate factors

6.2-Types of orientation-reafference theory of Von Holst & Mittel Steadt.

6.3-Navigation & migration

7. Parental care -Mating systems, Parental investment and Reproductive success; Development of behavior; Social communication; Social dominance; Use of space and territoriality; domestication and behavioural changes; Social behaviour of termites & Primates; (4 hrs)

8. Evolution and advaptiveness of behaviour-Altruism, Kin selection, inclusive fitness, selfish gene theory, cultural transmission of behaviour

(4 hrs)

**REFERENCES**

ECOLOGY


1. Ahluwalia and sunitha malhorta-Environmental Science-Ane Books Pvt.Ltd
2. Allan Beebi and Anne Maria Brennan-2006- First Ecology-Ecological principles and environmental issues-Oxford university press
3. Archbold, O. W. Ecology of World Vegetation. New York, NY: Chapman and Hall, 1995.
4. Begon,Harper,Townsend- Ecology-Individuals,Populations,and communities-Blackwell Science,Second edition
5. Brewer Richard-The Science of Ecology-Saunders college publishing
6. Chapman J.L and Reiss.M.J- Ecology principles and applications-Cambridge law price editions
7. Charles J .Krebs- Ecology.The experimental analysis of distribution and abundance
8. David Quammen. 1997. The Song of the Dodo: Island Biogeography in an Age of Extinctions. Scribner. ISBN 0-684-82712-3
9. Dick Neal- Introduction to population Biology- Cambridge University Press
10. Eugene P.Odum- Fundamentals of Ecology- W.B.Saunders Company
11. MacArthur, R. H. and Wilson, E. O. 1967. The Theory of Island

Biogeography. Princeton, N.J.: Princeton University Press.

12. Magurran, A. E. 2004. Measuring biological diversity. Oxford: Blackwell Publishing. ISBN 0- 632-05633-9
13. May and Mc Lean- Theoretical Ecology principles and applications-Oxford university press
14. Whittaker, Robert H. Communities and Ecosystems New York: MacMillan Publishing Company, Inc., 1975.

**ETHOLOGY**

1. Chris Barnard (2003) : Animal Behaviour: Mechanism, Development, Function and Evolution, Publisher: Pearson Education.
2. David McFarland (1999) : Animal Behaviour: Psychobiology, Ethology and Evolution, 3rd Edition. Publisher: Pearson Education.
3. David Mcfarland (2006) A Dictionary of Animal Behaviour. Publisher: Oxford University Press.
4. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
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7. Manning, A. (1967) An Introduction to Animal Behaviour. Edward Arnold Pub., London.
8. Manning, A. and Dwakins, M.S. (1995) An Introduction to Animal Behaviour. Cambridge Univ. Press, Lond.
9. Scott, J.P. (1972) Animal Behaviour. Publisher: Univ of Chicago

**SECOND SEMESTER M. Sc. ZOOLOGY(CSS)**

## DZOL2B07T

**DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY**

**(90 Hours)**

Part- A - DEVELOPMENTAL BIOLOGY

1. Introduction: Basic concepts of development (6 hrs)

1.1 Potency

1.2 Commitment

1.3 Specification - autonomous, conditional, syncytial

1.4 Determination

1.5. Morphogenetic gradients

1.6 Imprinting

1.7 Mutants and transgenics in analysis of development

1.8 The stem cell concept-Stem cell vocabulary, Stem cell potency, Progenitor cells, Adult stem cells, Stem cell niches, Mesenchymal stem cells, Multipotent adult stem cells, Pluripotent Embryonic stem cells, Stem cell therapy.

2. Gametogenesis, fertilization and early development (10 hrs)

2.1 Production of gametes- Spermatogenesis and Oogenesis, Ultrastructure of gamates

2.2 Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals)

2.3 Zygote formation-

2.3.1. Encounter of sperm and egg

2.3.2. Capacitation

2.3.3. Acrosome reaction

2.3.4. Activation of Ovum

2.3.5 Amphimixis

2.3.6. Prevention of Polyspermy (Fast block and Slow block)

2.4 Cleavage and blastula formation

2.5 Gastrulation and formation of germ layers in amphibia

2.6 Embryonic fields

3. Embryogenesis and Organogenesis (10 hrs)

3.1 Axis formation in amphibians - The Phenomenon of the Organizer- Nieuwkoop center., primary embryonic induction, mechanism of axis formation

3.2 Anterior posterior patterning in Amphibians - Hox code hypothesis

3.3 Anterior posterior patterning in Drosophila – anterior forming genes (bicoid,

hunchback), posterior forming genes (nanos, caudal), terminal forming gene (torso), segmentation genes- gap genes, pair rule genes, segmentation polarity genes, homeotic selector genes, realistor genes

3.4 Dorso- ventral patterning in Drosophila- dorsal protein gradient

3.5 Limb development in chick- Formation of the Limb Bud, Generating the Proximal-Distal Axis of the Limb, Specification of the Anterior-Posterior Limb Axis, Generation of the Dorsal-Ventral Axis

3.6 Insect wings and legs formation

3.7 Vulva formation in Caenorhabditis elegans

4. Cell to cell communication in Development (7 hrs)

4.1 Cell adhesion- Differential cell affinity, The thermodynamic model of cell interactions

4.2 Cadherins and cell adhesions

4.3 Cell migration (brief)

4.4 Cell signaling –Induction and competence, Reciprocal induction, Epithelial - mesenchymal interactions

4.5 Paracrine factors

Signal transduction cascades (Fibroblast growth factors and the RTK pathway, The JAK-STAT pathway, The Hedgehog family, The Wnt family, The TGFβ super family, cell death pathways )

5. Differential Gene Expression in Development (8 hrs)

5.1 Evidence for genomic equivalence

5.2 Differential gene transcription-Promoters and Enhancers,DNA methylation. Transcription factors, Silencers and Insulators.

5.3Differential RNA processing- X chromosome inactivation- dosage compensation,

5.4 Control of gene expression at the level of translation-Differential mRNA longevity, selective inhibition of mRNA translation, Selective activation of mRNA translation, micro RNAs, Control of RNA expression by cytoplasmic localization.

5.5 Post translational regulation of gene expression.

5.6 Models of cell differentiation- hematopeiesis, myogenesis, differentiation of

neural crest cells.

5.7 Reversibility of patterns of gene activity- cell fusion, transdifferentiation.

6. Sex Determination (3 hrs)

6.1 Chrosomal sex determination, The Mammalian pattern, Primary sex determination in Mammals, The ovary pathway- Wnt 4 and R-spondin 1, The testis pathway, Secondary sex determination in Mammals

6.2 Hormonal regulation of the sexual phenotype

6.3 The genetic analysis of the secondary sex determination.

6.4 Environmental sex determination- Temperature dependent sex determination in Reptiles, Location dependent sex determination.

6. Metamorphosis, Regeneration and Aging (8 hrs)

6.1 Metamorphosis in Amphibians and Insects and their hormonal control

6.2 Types of regeneration - Super, Hetero, Epimorphic, Morphallactic and Compensatory regeneration, Histological process during regeneration

6.3 Ageing – The biology of senescence, cellular and extra cellular aging, Genes and aging, DNA repair enzymes, Aging and the insulin signaling cascade, The mTOR pathway, Chromatin modification, Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed aging .

7. Environmental regulation of animal development (4 hrs)

7.1 Environmental regulation of normal development - types of polyphenism

7.2 Environmental disruptions of normal development (Teratogenesis) Teratogenic agents - Alcohol, retinoic acid, Bisphenol A(BPA), heavy metals, pathogen, Testicular Dysgenesis Syndrome, DES as an endocrine disruptor, Endocrine disruptors as obesogens

8.Developmental Mechanisms of Evolutionary change-

Heterotopy, Heterochrony, Heterometry, Heterotypy. ( Brief) (2 hrs)

**References - Developmental biology**

1. Balinsky, B. I. An introduction to Embryology.
2. Berril, N. J. Developmental biology.
3. Deuchar, E. M. Cellular interactions in animal development.
4. Gilbert, S. F. Developmental Biology. Sinauer Associates, 10th edition
5. Hodge, R. Developmental Biology: From a Cell to an Organism.
6. Hopper, A. S. & N. H. Hart. Foundation of animal development.
7. Lash, J & J. R. Whittaker. Concepts of development.
8. Muller, W. A. Developmental biology. Springer.
9. Snustad, D. P., J. M. Simmons & J. B. Jenkins. Principles of Genetics. Wolpert, L. Principles of Development. Oxford university press, 2nd edition

**Part B Endocrinology (35 hrs)**

1. Endocrine glands and their Hormones (Brief account) (5 hrs)
    - 1.1. Hormone secreting organs and tissues -skin, liver, kidney, heart.
    - 1.2. General classes of chemical messengers- Peptide, thyroid, steroid hormones, neurotransmitters and pheromones
    - 1.3. Synthesis and delivery of hormones- storage, secretion and transportation
    - 1.4. Physical characteristics of hormones - latency, post-secretary modification and half- life
    - 1.5. Physiological roles of hormones.
    - 1.6. Control of hormone secretion.
2. General mechanisms of Hormonal action (4 hrs)
    - 2.1. Cell signalling
    - 2.2. Receptors and transducers;
        - 2.2.1. types of receptors- g protein coupled receptors, steroid receptors and nitric oxide receptors,
        - 2.2.2. Regulation of receptor number, receptor activation
    - 2.3. Second messengers of hormone action- cAMP, cGMP, inositol triphosphate, diacylglycerol ,
    - 2.4. Receptor signal transduction
    - 2.5. Eicosanoids and hormone action
3. Anatomy of endocrine glands; structure, physiological functions, and control of secretion of their hormones and pathophysiology. (13 hrs)
    - 3.1. Hypothalamus

3.2. Hypophysis

3.3. Thyroid

3.4. Parathyroid

3.5. Adrenal

3.6. Pancreas

4. Hormones and male reproductive physiology (7 hrs)

4.1. Synthesis, chemistry, and metabolism of androgens

4.2. Endocrine control of testicular function

4.3. Physiological roles of androgens and estrogens

4.4. Pathophysiology

5. Hormones and female reproductive physiology (3 hrs)

5.1. Synthesis, chemistry, and metabolism of Ovarian steroid hormones

5.2. Physiological roles of Ovarian steroid hormones

5.3. Hormonal regulation of female monthly rhythm

5.4. Hormonal factors in pregnancy, parturition and lactation

6. Neurohormones (3 hrs)

6.1. Gases as neural messengers

6.2. Endorphins- physiological roles, mechanism of action and pathophysiology

6.3. Brain hormones and behaviour

6.4. Neuroendocrine pathophysiology

**References - Endocrinology**


1. Bentley, P. J. Comparative vertebrate endocrinology
2. Bern, H. A. Text book of comparative endocrinology
3. Bolander, F. F. 2006. Molecular endocrinology, Academic press, New Delhi.
4. Ganong, W. F. 2005. Review of medical physiology, Mc Graw Hill, New Delhi.
5. Hadley, M. E. 2000. Endocrinology, Pearson education, Inc., New Delhi.
6. Harris, G. W. 1995. Neural control of the pituitary gland, Edward Arnold, London.
7. Hazelwood, R. 1990. The endocrine pancreas, EnglewoodCliffs, Prentice Hall, NJ.
8. Horrbin, D. F. Essentials of Biochemistry, endocrinology and nutrition.
9. Prakash Lohr. Hormones and human health
10. Nelson R. J. Introduction to behavioural endocrinology
11. Norris D. O. 2005. Vertebrate endocrinology.
12. Vinzen, G. Et al, 1992. Adrenal cortical steroid hormones, EnglewoodCliffs, Prentice Hall, NJ.

## SECOND SEMESTER PRACTICALS

## DZOL2B09P

### Cell and Molecular Biology, Developmental Biology & Endocrinology

1. Cell fractionation and isolation of mitochondria, nucleus and nucleolus
2. Isolation of DNA from liver/spleen/thymus
3. Isolation of bacterial plasmids
4. Isolation of RNA from yeast
5. Estimation of DNA by diphenyl amine method/UV absorption
6. Estimation of RNA by orcinol method/UV absorption
7. Estimation of protein by Lowry's method
8. Maintenance of E.coli culture (suspension and surface cultures) and quantitative evaluation of a given sample of culture by dilution and plating.
9. Preparation of salivary gland polytene chromosome from Drosophila larva
10. Study of meiotic stages using grass hopper testes.
11. Preparation of chromosome spread using mice/rat/guinea pig bone marrow.
12. Analysis of metaphase chromosomes from rat/mouse bone marrow or any other suitable material by means of G banding.
13. Preparation of human karyotype from photographs of chromosome spreads – Normal and abnormal
14. Preparation of restriction fragments and their separation by electrophoresis
15. Transformation of E. coli with plasmids

### Part 2 - Developmental Biology & Endocrinology

1. Induced ovulation in fish.
2. Identification of different developmental stages of frog - Egg, blastula, gastrula, neurula, tadpole external gill and internal gill.
3. Vital staining of chick embryo.

4. Preparation of temporary/permanent whole mounts of chick embryo of the following stages to study the extent of development of the circulatory and nervous system in detail in 20, 24, 33, 48 & 72 hours of incubation.
5. Tracing the development of stained parts. Candling, identification of blastoderm, window preparation - staining using stained agar strips and following the development.
6. Preparation of stained temporary/permanent mounts of larvae.
7. Experimental analysis of insect development - Drosophila.
8. Regeneration studies in frog tadpole tail.
9. Demonstration of sperm of rat/calotes/frog.
10. Morphological and histological studies of different types of placenta in mammals.
11. Hormones in Amphibian metamorphosis - Thyroxine/Iodine solution.
12. Culture of early chick embryo in vitro.
13. Study of invertebrate/vertebrate larval forms (minimum 7).
14. Observation of the mid-sagittal sections and cross sections of the chick embryo through head/ heart region of 24, 48 & 56 hours of incubation.

**Reference for Practicals**


1. Adamstone, E. B. & Waldo Shumway (1954). 3 Ed. A Laboratory Manual of Vertebrate Embryology. John Wiley & Sons, Inc.
2. Roberts Rugh (1961). Laboratory Manual of Vertebrate Embryology. Indian Ed., Allied Pacific Pvt. Ltd.
3. Browden, L. W., Erikson, C. A., & Jeffery, R. W. (1991). Developmental Biology. 3 Ed., Saunders College Publi., Philadelphia.
4. Zarrow, M. X., Yochim, J. M., Mc Carthy, T. L. & Sanborn, R. C. (19964). Experimental Endocrinology: A source book of basic Techniques. Academic Press, New York.
5. Thomas, J. A. (1996). Endocrine methods. Academic press, New York.
6. Humason, G. L. (1962). Animal Tissue techniques. W. H. Freeman & Co.


## SECOND SEMESTER PRACTICALS

## DZOL2B08P

## ECOLOGY AND ETHOLOGY

**Part A Ecology**

1. Identification, qualitative and quantitative estimation of marine plankton
2. Estimation of BOD in polluted water sample.
3. Estimation of COD in water sample
4. Estimation of salinity, phosphates, chlorides and silicates and nitrates in water samples
5. Separation and identification of soil arthropods using Berlese funnel.
6. Determination of moisture content of soil sample.
7. Determination of water holding capacity of soil sample.
8. Testing the transparency of water using Secchi disc
9. Determination of primary productivity in pond water using light and dark bottle.
10. Study of termitorium / ant colony
11. Principle and application of the following instruments-GPS, Thermo hygrometer, Altimeter, Air samplers, soil samplers, Berlese funnel, Lux meter, anemometer, Rain gauge, Plankton net, Plankton counting chamber, Weather balloon, Secchi disc etc ( at least six items)
12. FIELD STUDY-A study tour of at least five days duration (need not be at a stretch) to observe the ecology and behaviour of animals should be under taken. The places of visit include inter tidal region, fresh water bodies, lakes, rivers, hill streams ,wetlands, mangroves, forests grasslands, drinking water treatment plants, and sewage treatment plants.

    A report of the field study is to be included in the practical record to be submitted at the time of examination.

**Part B Ethology**

1. Studying and reporting the behaviour and ecology of animals in selected fields (Social spider/Jungle babbler/white headed babbler or Bonnet Macaques)
2. Study of circadian rhythm
3. Chemo reception and behaviour in flies -finding the tarsal threshold for sugar
4. Behavioural reaction to moisture and light using isopods.

**References**


1. NC Aerry 2010- A manual of environmental analysis . Ane books private limited.
2. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour.

John Wiley and Sons, Lond.

3. Manning, A. (1967) An Introduction to Animal Behaviour. Edward Arnold Pub., London.

## THIRD SEMESTER

## DZOL3B010T

## PHYSIOLOGY

## (90 Hours)

1. Nutrition: (12 hrs)

1.1. Constituents of normal diet and their daily requirements

1.2. Physiological calorie value of food stuffs

1.3. Antioxidant nutrients

1.4. Digestion of carbohydrate, protein & lipids- Brief note on the role of salivary glands, liver, pancreas and intestinal glands in digestion

1.5. Absorption of carbohydrates, lipids, amino acids, water, electrolytes, vitamins and minerals in GIT

1.6. Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation

1.7. The role of hormones and neurotransmitters in the control of gastrointestinal motility

1.8. Energy balance and obesity-causes and consequences

1.9. BMR and its significance (Ref. 4)

2. Excretory system (12 hrs)

2.1 Introduction: Brief description of different types of excretory organs in different animal groups

2.2 Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus - structure, parts and function

2.3 Urine formation (glomerular filtration, tubular reabsorption and tubular secretion)

2.4 Regulation of water balance -Mechanism of concentration of urine - Counter current system (counter current multiplier and counter current exchanger)

2.5 Renal regulation of acid base balance

2.6 Composition (normal & abnormal) and characteristics of urine

2.7 Physiology of micturition

2.8 Renal clearance - definition, concept and significance; clearance value of urea, creatinine, phosphate, potassium, chloride and sodium

3. Respiratory system: (13 hrs)

3.1 Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia)

3.2 Physiological anatomy and histology of respiratory passage and lungs

3.3 Mechanism of pulmonary ventilation (inspiration & expiration) -

3.4 Alveolar ventilation, dead space and its effect on alveolar ventilation

3.5 Role of surfactant in alveolar expansion

3.6Pulmonary volumes and capacities - definition & normal values (tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, functional residual capacity, inspiratory capacity, vital capacity, total lung capacity)

3.7 Exchange of gases

3.8Transport of gases

3.8.1 Transport of oxygen and carbon dioxide

3.8.2 Oxygen dissociation curve - factors affecting binding of oxygen to haemoglobin ($PO_2$, $PCO_2$ ,CO, pH, body temperature, diphosphoglyceric acid level, faetal haemoglobin and also myoglobin) 3.9 Neural and chemical regulation of respiration

4. Nervous system (18 hrs)

4.1 Introduction: Basic details of neurons and action potential

4.2 Gross neuroanatomy of the brain (histology & neural pathway not expected unless otherwise specified)

4.2.1. Cerebral cortex- Motor cortex: mention functional areas (including specialized areas) and their motor functions

4.2.2. Cerebral cortex- Association areas, their sub areas and their functions; Wernicke's area and its intellectual function

4.2.3. Memory - definition, types of memory (positive and negative memory), brief note on the mechanism of short term, intermediate long term and long term memory, consolidation of memory

4.2.4. Brain stem - List the components (medulla, pons, mesencephalon, reticular and vestibular nuclei) and functions

4.2.5. Cerebellum- mention parts and functions

4.2.6. Basal ganglia - mention components and functions

4.2.7. Limbic system; structure and functions (emotion and motivation)

4.3. Gross neuroanatomy of the spinal cord

4.3.1. Spinal cord - structural organization

4.3.2. Reflex action - reflex arc, muscle spindle, Golgi tendon organ

4.3.3. Types of reflexes- monosynaptic reflex (e.g., Muscle stretch reflex, negative stretch reflex), polysynaptic reflex (e.g., withdrawal reflex)

4.4. Diseased states of brain - brief description of epilepsy, depression, schizophrenia, Alzheimer's disease, Senile dementia & Parkinson's disease

5. Special senses (13 hrs)

5. 1 Vision

5.1.1 Structure of eyeball

5.1.2 Fluid systems of the eye

5.1.3 Layers of Retina and photoreceptors (rods & cones)

5.1.4 Brief notes on the neuronal cell types and neural circuitary of the retina and visual pathways from retina to visual cortex

5.1.5 Image formation

5.1.5.1. Formation of image on the retina

5.1.5.2. A brief general account of electrophysiology of vision

5.1.5.3. Photochemistry of vision & colour vision

5.2. Taste:

5.2.1. Primary sensations of taste (agents and site of sensation)

5.2.2. Taste buds (location, structure, receptors and nerve supply)

5.2.3. Physiology of taste (receptor stimulation, generation of nerve impulse by taste buds and its transmission to CNS)

5.3. Smell:

5.3.1. Olfactory membrane and receptor cells

5.3.2. Physiology of olfaction (stimulation of olfactory cells and transmission

of smell signals to CNS)

6. Tactile response: (brief note) (4 hrs)
   - 6.1.1. Mechanoreceptors and their stimulation
   - 6.1.2. Pain receptors and their stimulation
   - 6.1.3. Thermal receptors and their stimulation

7. Cardiovascular system (8 hrs)
   - 7.1. Introduction: Brief description of vertebrate hearts
   - 7.2. Structural organization of myogenic heart (in human beings)
   - 7.3. Physiological anatomy of cardiac muscle - specialized tissue
   - 7.4. Heart as a pump
   - 7.5. Cardiac cycle
   - 7.6. ECG - Principle and application
   - 7.7. Neural and chemical regulation of heart function
   - 7.8. Blood volume and blood pressure
   - 7.9. Physiological anatomy of coronary blood flow, coronary blood flow and its control
   - 7.10. Ischemic heart disease - mention causes and example

8. Lymphatic system (5 hrs)
   - 8.1. Lymph channels of the body
   - 8.2. Composition and formation of lymph
   - 8.3. Functions of lymph and lymphatic system including role of in controlling interstitial fluid protein concentration, interstitial fluid volume and interstitial fluid pressure

9. Environmental physiology
   - 9.1. Thermoregulation
     - 9.1.1. Comfort zone, normal body temperatures (oral, skin & core), heat production &heat loss, factors affecting body temperature, lethal temperature
     - 9.1.2. Temperature regulating mechanisms (hot & cold), mention the role of hypothalamus, thyroid and adrenal glands
     - 9.1.3. Acclimatization

**REFERENCES**

1. Arthur C.Guyton & John E. Hall (2003): Textbook of Medical Physiology, Saunders

(An imprint of Elsevier).

2. William F.Ganong (1999): Review of Medical Physiology, Lange Medical Publications (Appleton & Lange).
3. Jain A.K. (2009): Text Book of Physiology (Vol. I & II), Avichal Publishing Company, New Delhi.
4. Deb, A.C. (2002): Fundamentals of Biochemistry (2002): New Central Book Agency (P) LTD, India.
5. Prosser & Brown, Comparative Animal Physiology
6. William S. Hoar, Comparative Animal Physiology
7. Kunt-Schmidt-Nielsen: Animal Physiology, Adaptation and Environment.
8. Jensen D. (1976): Principles of Physiology, Appleton Century Crafts, N.Y.
9. Lonco, G.N. (1993): Physiological Animal Ecology. Longman Scientific and Techhnical, Essex.
10. Caer BL-Haw's Physiological chemistry, 14th Edn. Tata McGraw Hill Pub. Co. New Delhi.
11. Shepherd, G.M: Neurobiology-Principles of Neural Science, E. Kandel & P. Schwartz.
12. Campbell et al. (1984): Clinical Physiology, 5th Edn. Blackwall Scientific Publications, Oxford.
13. Pragnelli, C.V & Farhi, L.E. (1989): Physiological function of special Environment-Springer verlag, N.Y.
14. Davie IV & Lewid S.M.- Practical Haematology, 6th Edn. Churchill, Livingstone, Edinburgh.

**THIRD SEMESTER**

## DZOL3B011T

### IMMUNOLOGY & CYTOGENETICS

**(90 Hours)**

A. Immunology (67 hrs)

1.Introduction (9 hrs)

1.1. Innate and adaptive immunity, types and attribute of adaptive immunity

1.2. Cells and organs (primary, secondary and tertiary) of the immune system

1.3. Antigens, Antigenecity, immunogenecity and Haptens, Adjuvants

1.4. Factors influencing immunogenicity

2. Antibodies (8 hrs)

2.1. Structure, Different Classes and functions of Antibody Molecules

2.2. Generation of Antibody diversity

2.2.1. Organisation of immunoglobulin gene

2.2.2. Light chain (V-J-C) and Heavy chain (V-D-J-C) rearrangement.

2.2.3. Mechanism of rearrangement

2.2.4. Class switching

2.3. Monoclonal antibodies-Hybridoma Technology and Applications

2.4. Antibody Engineering

3. Antigen-Antibody Interactions (8 hrs)

3.1. Strength of Antigen Antibody Interactions

3.2. Cross reactivity, precipitation reactions, agglutination reactions, agglutination inhibition reactions.

3.3. Immunotechniques -Detection of molecules using ELISA, RIA, Western Blot, Immunoprecipitaion, immunoelectrophoresis, Immunodiffusion reaction (Mancini and Ouchterlony method), Immunofluorence, Flowcytometry (FACS).

4. Generation of B Cell & T cell response (10 hrs)

4.1. Humoral & Cell mediated response- Primary and secondary response, Generation of CTLs, NK cell mediated cytotoxicity, ADCC

4.2. B & T cell receptors (αβ, ϒδ) and $CD_3$ Complex

4.3. Properties of B cell & T cell Epitopes

4.4. Activation and differentiation of B and T cells

5. Immune effector Mechanisms (12 hrs)

5.1. Cytokines & Antagonists, Properties and function, therapeutic applications.

5.2. Compliment System

5.2.1. Components

5.2.2. Compliment activation and regulations(classical,alternate and lectin pathways, MAC formation)

5.2.3. Functions

5.3 Toll -like receptors

5.4. Inflammation

5.4.1.Acute and chronic inflammation.

5.4.2. Neutrophil and lymphocyte extravasation

5.4.3. Mediators of inflammation

5.5. Hypersensitivity reactions

5.5.1. Type I, II and III hypersensitivity reactions

5.5.2. Delayed type hypersensitivity

6. Major Histocompatability Complex ( MHC) (6 hrs)

6.1. General organisation and inheritance of MHC

11.MHC genes & molecules

12. Cellular distribution of MHC molecules

13. Antigen processing and presentation -Endogenous and Cytosolic pathways. Presentation of non peptide bacterial antigens.

7. Immune system in Health and Diseases (12 hrs)

7.1. Immune responses during bacterial (Tuberculosis) parasitic (malaria) and viral (HIV) infections.

7.2. Autoimmune diseases

7.2.1. Organ specific (Hashimotos thyroiditis, Autoimmune anaemia, Good Patures syndrome, Insulin dependent diabetes mellitus; Graves disease; Myasthenia gravis)

7.2.2. Systemic autoimmune disease (SLE, Multiple sclerosis, Rheumatoid arthritis)

7.2.3. Treatment of autoimmune disease.

7.3. Primary Immunodeficiency diseases (Bruton's disease, Di-george Syndrome &Severe combined immunodeficiency (SCID)

7.4. Secondary immunodeficiency Diseases (AIDS). Origin, means of infection, course of infection, structure and types of HIV, Acute infection, seroconversion, Window period, Chronic latent phase- Lymph adenopathy, Crisis phase, viral

multiplication, mutation, diagnosis, antiretroviral therapy and AIDS vaccine.

7.5. Vaccines-

7.5.1. Passive immunisation

7.5.2. Active immunisation (herd immunity)

7.5.2.1. Whole organism vaccine- Attenuated and Inactivated vaccine- advantages and disadvantages.

7.5.2.2. Purified macromolecule Recombinant Vector, DNA vaccines, synthetic peptide vaccines and multivalent vaccines

8. Transplantation immunology (4 hrs)

8.1. Immunologic basis of graft rejection

8.2. General and specific immunosuppressive therapy

8.3. Transplantation antigens

**References:**


1. Adul K Abbas and Andrew H Lichtman (2003).Cellular and Molecular Immunity (fifth edition).Elsevier Science,USA.
2. Carpenter. Immunology and Serology
3. Das Gupta, Modern Immunology
4. Godkar, P.B. (1998): A Text Book of Medical Laboratory Technology, Bhalani Bhalani Publishing House Mumbai
5. Hay & Hudson -Practical Immunology.
6. Janis Kuby (1997): Immunology. WH Freeman,New York
7. Joshi. K. R and Osamo N.O (1994). Immunology.Agro Bios Publishers,Jodhpurr
8. Peter Parham (2004).The immune System (2nd Edition), Garlands, New York
9. Roit, Essentials of Immunology.
10. Shetty. N (1993) Immunology Wiley Eastern Ltd, New Delhi
11. Weir-Hand book of Experimental Immunology(Volume 1,2&3).


## B. **Cytogenetics (23 hrs)**

1. Cellular communication (7 hrs)

1.1 Regulation of hematopoiesis

1.2 General principles of cell communication

1.3 Cell-cell interactions – cell adhesion and roles of different a dhesion molecules

1.4 Extracellular matrix: Basal membrane and Laminin, Collagen, Proteoglycan, Fibronectin

1.5 Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.

1.6 Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

2. Cell signaling (10 hrs)

2.1 Signal transduction

2.2 Concept of cell-signaling

2.3 Signaling through cell surface receptors: G protein linked receptors; signaling via cAMP, PKA, IP3, $Ca^{2+}$/calmodulin, PKC, Ca-MK, Enzyme linked receptors, Receptor tyrosine kinase (RTK), signaling of growth factors, Tyrosine kinase associated receptors, JAK-STAT signaling pathway, Receptor protein tyrosine phosphatase (PTP), Receptor serine/threonine kinase, Receptor guanyl cyclase, cGMP, PKG, Histidine kinase associated receptors

2.4 Receptor desensitization

2.5 Signaling by nitric oxide, carbon monoxide

2.6 Signaling network

3. Apoptosis and its significance (6 hrs)

3.1 Necrosis; Programmed and induced cell death

3.2 Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis

3.3 Regulation of apoptosis - Extracellular and Intracellular

3.4 Apoptosis in Caenorhabditis elegans, Drosophila, mammals and bacterial population

3.5 Mechanism of cell death

3.6 Genes involved in apoptosis

**Reference**


1. Becker, W. M., Reece, J. B. and Poenie, M. F. (1999; 2000). The World of the Cell, 4th edition, Benjamin/Cummings Publishing Co.
2. Benjamin Lewin (2008). Genes IX. Jones & Bartlett Learning Publishers, New York.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter(2002). Molecular Biology of the Cell. 4th Edition, Garland Science, New York.
4. De Robertis, E. D. P. and De Robertis, Jr. E. M. F. (1996). Cell and Molecular Biology,Eighth Edition, B.I. Waverly Pvt Ltd, New Delhi.

5. Karp, G. (2002). Cell and Molecular Biology. John Wiley, New York.
6. Kleinsmith, L. J. and Kish, V. M. (1995). Principles of Cell and Molecular Biology (SecondEdition). Harper Collins College Publishers, New York.
7. Peter Snustad, D. and Michael J. Simmons (2000). Principles of Genetics. 2nd Ed. John Wiley& Sons Inc.
8. Purves W. K., Orians G. H. and Heller H. C. (1995). Life: The Science of Biology, 4th Edition. Sinauer Associates, Sunderland.
9. Robert H. Tamarin (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Education Pvt Ltd, New Delhi.
10. Sheeler, Philip and Donald, E. Bianchi. (1987) Cell and Molecular Biology. III Ed. John Wiley.
11. Watson J. D., Hopkins N. H., Roberts, J. W., Steits, J. A. and Weiner, A. M. (1987). Molecular Biology of the Gene 4th Edition. The Benjamin Cumming Publishing Company. Menlo Park, California.

## THIRD SEMESTER

## DZOL3B012T

## MICROBIOLOGY & BIOTECHNOLOGY

**(90 hours)**

## Part-A-MICROBIOLOGY (45 Hours)

1. Introduction- (3 Hrs)
    1.1 History and scope of microbiology
    1.2 Spontaneous generation concept
    1.3 Recognition of the role of microbes in diseases
    1.4 Composition of the microbial world
    1.5 Turning points in microbial research
    1.6 Microorganisms and the evolution of the earth
    1.7 Modern age of micro biology
2. Microbial Taxonomy and Phylogeny (4 Hrs)
    2.1. Major characteristics (classic and molecular)
    2.2. Numerical taxonomy
    2.3. Taxonomic ranks
    2.4. Phylogenetic studies
    2.5. Phenetic classification
    2.6. Bergey's Manuel (mention major groups)
3. Bacterial cell structure and function (6 hrs)
    3.2. Plasma membrane and internal system - Cytometrix, inclusions, ribosomes,nucleoid
    3.3. Bacterial cell wall Peptidoglycan - structure-
    3.4. Gram positive and gram negative cell wall- Mechanism of gram staining
    3.5. Components external to cell wall; pili and fimbriae, capsule and slime layers,Flagella and motility

4. Microbial nutrition (3 hrs)
    4.1. Nutritional requirements,
    4.2. Nutritional types (Auto, Hetero, Chemo, Phototrophs & obligate parasites)
    4.3. Culture media and types of media-
    4.4. Mixed microbial population, pure cultures and pure culture techniques
5. Microbial growth (5 hrs)
    5.1. Growth curve -synchronous growth

5.2. Continuous culture

5.3. Factors influencing microbial growth

5.4. Measurement of growth

5.5. Measurement of cell numbers- Petroff, Hassuer counting Chamber, Spread plate and pour plate techniques

5.6. Measurement of cell mass-Turbidity and microbial mass measurements

6. Utilization of energy (4 hrs)

6.1. Biosynthetic process-peptidoglycan synthesis, amino acid synthesis

6.2. Non synthetic processes -Bacterial motility and transport of nutrients

7. Viruses (4 hrs)

7.1. General structural properties

7.2. Types: DNA viruses, RNA viruses, and enveloped viruses

7.3. Virus-host interactions- lytic cycle and lysogenic cycle.

8. Microbial diseases (4 hrs)

8.1. Human diseases caused by bacteria- Strepto ccoccal diseases, Typhoid, Cholera, tetanus, Leprosy, tuberculosis and Pneumonia.

8.2. Human diseases caused by viruses- AIDS, Small pox, Rabies, Measles, Swine Flu, Bird flu, SARS

8.3. Fungal diseases- Candidiasis

9. Control of microorganisms (5 hrs)

9.1. Disinfectants; A - physical- Heat, filtration and radiation

B-Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.

9.2. Antibiotics- Penicillin's, Cephalosporins, Chloramphenicol, Tetracyclines

9.3. Microbial drug resistance

10. Microbial fermentation (4 hrs)

10.1. Lactic fermentation Homolactic and heterolactic fermenters, Mention dairy products ,cheese, Yogurt, kefir etc

10.2. Alcoholic fermentation-Alcoholic beverages

11. Environmental microbiology (3 hrs)

11.1. Aquatic microbes

11.2. Microbiological analysis of drinking water

11.3. Waste water- microbial characteristics and treatment

11.4. Microbial Bioremediation, Biofertilizers, and Bioinsecticides

11.5. Biogas plants.

**Part-B-BIOTECHNOLOGY** **(45 Hrs)**

1. Introduction (1 hr)

Definition, branches, scope and importance

2. Genetic engineering (4 hrs)

2.1. Cloning vectors –

2.1.1. Properties of a good cloning vector

2.1.2. Types - plasmids (pBR322, pBR 327, pUC); phages (lambda phage, M13); cosmids, Phagemids, viruses, BAC, YAC and MAC.

2.2. Shuttle vectors and expression vectors

2.3. Enzymes for r DNA technology- Restriction enzymes and ligases

3. Different steps involved in in vivo cloning (3hrs)

3.1. Construction of chimeric DNA (Blunt end ligation, cohesive end ligation,homopolymer tailing, use of linkers)

3.2. Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization

3.3. Amplification – Multiplication, Expression and integration of the DNA insert in host genome

4. Molecular probes (2 hrs)

4.1. Production

4.2. Labelling

4.3. Applications

5. Genomic and cDNA library (4 hrs)

5.1. Construction

5.2. Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity.(Refer unit 4-Molecular Biotechnology by Glick and Pasternak-ASM press)

5.3. Blotting techniques- Southern blot, Northern blot, Western blot, Dot blot and Slot blot, FISH and GISH, Chromosome walking

6. Polymerase Chain Reaction (2 hrs)

6.1. Basic PCR – raw materials and steps involved

6.2. Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and Real Time PCR

6.3. Applications of PCR in Biotechnology and genetic engineering

7. Molecular markers (brief notes) (3 hrs)

7.1. RFLP

7.2. AFLP

7.3. RAPD

7.4. Minisatellites (VNTR)

7.5. Microsatellites (SSR)

7.6. SNPs

8. Isolation, sequencing and synthesis of genes (3 hrs)

8.1. Isolation (for specific proteins and tissue specific proteins)

8.2. DNA sequencing – Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide synthetic method

8.3. Synthesis of gene-Chemical synthesis of tRNA gene, Synthesis of gene from mRNA, Gene synthesis machines

9. Transfection methods and transgenic animals (3 hrs)

9.1. Definition, Methods - Electroporation, DNA micro injection, Calcium phosphate precipitation, Dextran mediated transfer, shot gun method, virus mediated, lipofection method, engineered embryonic stem cell method

9.2. Transgenic animals for human welfare

10. Biotechnology - Animal and human health care (3 hrs)

10.1. Vaccines

10.2. Disease diagnosis

10.3. Gene therapy

10.4. Transplantation of bone marrow, artificial skin,

10.5. Antenatal diagnosis

10.6. DNA finger printing

10.7. Forensic medicine

11. In vitro fertilization (2 hrs)

11.1. In vitro fertilization and embryo transfer in human

11.2. In vitro fertilization and embryo transfer in live stock

12. Animal cell and tissue culture (3 hrs)

12.1. Culture media – natural and artificial

12.2. Culture methods – primary explantation techniques, various methods of cell and tissue culture

12.3. Tissue and organ culture

13. Gene Silencing techniques (2 hrs)

13.1. Antisence RNA

13.2. RNAi

13.3. Gene knockouts

14. Cloning- (2 hrs)

14.1. Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning) –

14.2. Advantages and disadvantages of cloning

15. Environmental biotechnology (3 hrs)

15.1. Pollution control – cleaner technologies, toxic site reclamation, removal of oil spill, reducing of pesticides and fertilizers, biosensors, biomonitoring.

15.2. Restoration of degraded lands - reforestation using micro propagation, development of stress tolerant plants

16. Intellectual property rights (2 hr)

16.1. Intellectual property protection,

16.2. Patents, copy right, trade secrets, trademarks

16.3. GATT and TRIPS, patenting of biological materials,

16.4. International co-operation, obligation with patent applications, implications of patenting-current issues

17. The ethical and social implications - (2 hrs)

17.1. Ethics of Genetic engineering - Social impacts - Human safety-Virus resistant plants-Animals and ethics-

17.2. Release of GEOs-Use of herbicide resistant plants-Human genome alterations by biotechnology

17.3. Social acceptance of biotechnology-Transgenic crops - Social acceptance of medical biotechnology- Acceptance of GM crops for food and pharmaceutical production, Social acceptance of Industrial biotechnology

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**Part- B- Biotechnology**

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2. Bernard R. Glick & Jack J. Pasternak-Molecular Biotechnology-Principles and applications of recombinant DNA- ASM press Washington D.C.
3. Charles Hardin (2008): Cloning, Gene expression, and Protein purification-Experimental procedures and process rationale - Oxford University Press.
4. Chatterji, A.K. -Introduction to environmental biotechnology-Prentice Hall of India
5. Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge University press.
6. Dominic, W.C. Wong-The ABCs of gene cloning-Springer international edition
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11. Wilson & Walker (2008): Principles and techniques of Biochemistry and Molecular biology- Cambridge low price editions.

**Part- Microbiology**

12. Gandhi-Microbiology and Immunology notes and cases-Blackwell publishing
13. Hans G. Schlegel (2008): General Microbiology-Cambridge low price editions
14. Kanika Sharma-Manual of microbiology tools and techniques-Ane's student edition-Ane books Pvt. Ltd
15. Monica Cheesbrough - District laboratory practice in tropical countries, Part I and II - Cambridge low price editions
16. Mansi- Fermentation,Microbiology and Biotechnology-Taylor and Francis
17. Pelczar, M.J, Reid, R.D. & Chan, E.C.S-Microbiology-TMH edition
18. Prescot, Harley and Klein- Microbiolgy, IVth ed. McGraw-Hill
19. Rao, A.S.-Introduction to microbiology-Prentice Hall of India.
20. Tortora, Funke and Case - Microbiology : An Introduction Eight edition- pearson education, Veerbala Rastogi-Fundamentals of Molecular biology-Ane books
21. Wise-Bioinstrumentation and Biosensors-Taylor and Francis.

# THIRD SEMESTER PRACTICAL

## DZOL4B13P

### PHYSIOLOGY, IMMUNOLOGY, MICROBIOLOGY, BIOTECHNOLOGY AND MICROTECHNIQUES

## DZOL4B13P

### PHYSIOLOGY

1. Kymograph: working principle and applications
2. Effect of different substrate concentration, pH and temperature on human salivary amylase activity. Colorimetric method, plot graphs.
3. Qualitative demonstration of digestive enzymes in cockroach - amylases, lipases, proteases, invertases and controls.
4. Digestion in a vertebrate and calculation of peptic value.
5. Influence of temperature and pH on the ciliary activity in fresh water mussel/mytilus using silver foil. Plot graphs
6. Determination of respiratory quotient - estimation of $O_2$ consumption by an aquatic animal.
7. Determination of the rate of salt loss and gain in an aquatic animal (fish or crab).
8. Estimation of urea and ammonia in human Urine. Titrimetric method.
9. Rate of glucose - absorption - calculation of Cori coefficient
10. Estimation of haemoglobin of Fish/Man - Sahli's method.
11. Blood volume determination by dye dilution method (Vertebrate)
12. Blood: clotting time, bleeding time, rouleaux formation, preparation of haemin crystals.
13. Enumeration of RBCs in human blood.
14. Determination of lactic acid in muscle tissue.
15. Differential count of human WBCs
16. Haematocrit and ESR of human blood.
17. WBC total count

**References**


1. Oser B. L., Hawk's Physiological chemistry, McGraw Hill Book Company
2. Hill R.W., Wyse G.A. (1989), Animal Physiology 2nd edition. Harper Collins Publishers

3. Schmidt-Nielsen, K. (1997), Animal Physiology, adaptation and environment, Cambridge university Press
4. G. K. Pal and Pravati Pal (2001) Text Book of Practical Physiology. Orient Longman

## DZOL4B13P

## IMMUNOLOGY

1. Study of cells of immune system.
2. Histology of organs of immune system.
3. Bleeding of animals and preparation of serum.
4. Seperation of lymphocytes.
5. Demonstration of agglutination reaction.
6. Immuno Electrophoresis.
7. Demonstration of ELISA technique.
8. Production of antibodies.
9. Preparation of antiserum.
10. Titration of antiserum

## DZOL4B13P

### MICROBIOLOGY

1. Selective isolation and enumeration of bacteria.
2. Bacterial staining technique
    a. Simple staining of bacteria.
    b. Negative staining
    c. Hanging drop technique.
    d. Gram staining.
    e. Endospore staining.
3. Turbidity test for contamination of milk.
4. Phosphate activity of milk.
5. Microbial filters and their application.
6. Preperation of media and sterilization.eg: Nutrient agar, mac conkey agar,
7. Sterilization by wet and dry heat, disinfection.

8. Cultivation of yeast and molds
9. Isolation of pure colonies of bacteria.
10. Growth curve of yeast - monitoring progress of microbial culture.
11. Bacteriological analysis of water e.g., fecal pollutants.
12. Anaerobic culturing.
13. Antibiotic sensitivity test.

## DZOL4B13P

## BIOTECHNOLOGY

1. Isolation of plasmid DNA.
2. Isolation of total RNA from tissues
3. Separation of DNA by electrophoresis.
4. Bacterial transformation.
5. PCR
6. Cell immobilization.

## DZOL4B13P

### MICROTECHNIQUE AND HISTOCHEMISTRY

1. Preparation of stained and unstained whole -mounts.
2. Identification of the various tissues of animals in serial sections prepared using Nuclear and cytoplasmic stains.
3. Processing a few types of tissues for the histochemical staining-Staining of serial Sections to show the presence of
    a) Carbohydrates by PAS method
    b) Proteins by Mercury Bromophenol Blue method
    c) Lipids by Sudan Black B method
    d) DNA by Feulgen Technique.

Submission:

| | |
|---|---|
| Stained/unstained Whole mounts | - 4 numbers |
| Double stained serial histology slides | - 4 numbers |
| Histochemical slides | - 2 numbers |

**References:**

1. Ausubel, F.M., Brebt R, Kingston, R.E., Moore, D. D., Seidman, J. G., Smith, J.A. and Struht, K. (2002): Short protocols in Molecular Biology. John Wiley & Sons, Inc.
2. Sambrook, J. and Russel, D.W. (2001): Molecular cloning: A laboratory Manual. CSHL Press, New York.

## FOURTH SEMESTER

## DZOL4E01T

## Environmental Biology I: Man, Environment & Natural Resources

(90 Hrs)

1. Weather and climate: (15 hrs)

1.1. Atmosphere- structure and composition; Local winds: Sea and land breezes; Polar easterlies, Westerlies; Trade winds; Jet streams

1.2. Indian and African Monsoon;

1.3. Inversions: temperature or thermal inversions- causes -consequences - subsidence inversion;

1.4. Clouds and their formation

Cloud categories: low, middle, and high clouds: Cirrus (Ci), Cirrocumulus (Cc), and Cirrostratus (Cs), Altocumulus (Ac), Altostratus (As), and Nimbostratus (Ns), Cumulus (Cu), Stratocumulus (Sc), Stratus (St), and Cumulonimbus (Cb).

2. Element and factors of climate: (15 hrs)

2.1. External factors: solar radiation- Plate tectonics-Milankovitch Theory - Orbital eccentricity - obliquity- axial precession.

2.2. Internal factors: earth's orography- oceanic and continental influence- Deforestation- surface albedo- snow and ice- Volcanic activity- Dust particles- Greenhouse gas concentrations- Atmosphere- ocean heat exchange-Atmospheric Carbon Dioxide Variations- human influences

2.3. Global climate changes - causes and consequences.

2.4. Physical evidence for climatic change - Historical and archaeological evidence- Glaciers - Vegetation -Ice cores -Dendroclimatology- Pollen analysis-Sea level change

3. Human population (10 hrs)

3.1 Exponential growth - geometric growth or geometric decay- Malthusian growth model

3.2 Population momentum age structure - population pyramid, age structure diagram Types of population pyramid - Young and aging populations - youth bulge

3.3 Current trends in global population with reference to developed and developing countries

3.4 Population explosion -Baby boom - History of population growth Projections of population growth, Demographic transition Carrying capacity - Human population in India

4. Ecosystem (25 hrs)

4.1 Ecosystems-a) types, natural & artificial, agroecosystems, City ecosystems and Spacecraft ecosystems

4.2 Functions of Ecosystems

4.3 Ecological energetics - Fixation and utilization of energy

4.3.1 Primary production, factors affecting & measurements of primary production

4.3.2 Eclogical efficiencies- ratios within and between trophic levels,

4.3.3 Lindmann's work, Single channel, Y shaped and universal energy flow models

4.3.4 Place of man in the food chain, Human expropriation of primary production, Nutrient cycling, selection, diversity, decomposition and stability.

4.4 Development of ecosystems, Types and factors controlling, changes in the trends of ecological attributes,

4.5 Relevance of ecosystem development concept to human ecology and evolution of ecosystems

4.6 Human impact on ecosystems, Human settlements, Human cultural evolution, Environmental crisis,

4.7 Environmental protection and sustainable development, Creating sustainable cities suburbs and towns,

4.8 Meeting human needs while protecting the environment.

5. Resources of the Earth - Renewable & Non renewable (25 hrs)

5.1 Natural resources-Renewable and nonrenewable natural resources.

5.2 Depletion of natural resources and its effects.

5.3 Culture fisheries, briefly mention the common species and culture methods

5.4 Aquaculture. economically important crustaceans, mussels, oysters, clams and sea

weeds.(Brief)

5.5 Fishery resources of Kerala with special reference to fresh water ornamental species.

5.6 Marine products - Food value of fish, Fish meal, fish body oil, Fish liver oil, Fish maw and other products.

5.7 Forest products -major and minor products of both plant and animal origin,

5.8 Economically important insects and their products-Honey, Lac and Silk.

5.9 Plantation, crops, and their products and uses (Tea, coffee, Rubber, Coconut, Cashew nut, Cardamom)

5.10 Mineral resources with special reference to India. Their over exploitation and environmental problems citing case studies from India.

5.11 Water as a resource -Characteristics of water. Major water compartments. Hydrological cycle. Water management and conservation - Rain water harvesting techniques. Surface and ground water resources of Kerala

5.12 Energy resources

5.13 Conventional energy sources (coal, Oil and natural gas and oil shale)

5.14 Non conventional energy sources -solar energy, wind energy, geothermal energy, hydropower, biomass, biogas, Tidal energy, Energy from waste, Hydrogen, and Nuclear energy.

5.15Energy crisis

**References:**


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10. Emlen, J.M Population biology. The co- evolution of population dynamics and behaviour- M c Millan publishing company New York, London.
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13. Irewarth Horn, An introduction to climate- Mac Graw-Hill
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22. Puri et al.- Forest Ecology- Oxford university press
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24. Raymond Dasman- Environmental Conservation- John Wiley
25. Sagrayia, K. P. - Forest and Forestry- National Book Trust, New Delhi
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28. UN population estimates and projections, database query, August2009". Esa.un.org. 2009-03-11. http://esa.un.org/unpp/.

## FOURTH SEMESTER

## DZOL4E02T

## Environmental Biology II: Environmental Pollution

## (90 Hours)

### 1: AIR POLLUTION (35 hrs)

1.1 Primary air pollutants: occurrence, sources and sinks of the following pollutants: (a) compounds of carbon, (b) compounds of sulphur, (c) compounds of nitrogen, (d) gaseous halogens, (e) ozone, (f) mercury, (g) particulate matter

1.2 Sampling of air using sampling train and orifice flow meter

1.3 Method of sampling and monitoring of the following gaseous air pollutants (Two methods for each pollutant)

(a) Oxides of Carbon, Hydrocarbons

(b) $SO_2$, $H_2S$, Mercaptans

(c) Oxides of Nitrogen, Ammonia

(d) Ozone

1.4 Sampling and sizing of particulate matter.

Sample collection - settlement, filtration, particle count, evaluation by optical microscopy, particle size analysis - projected diameter and statistical diameter (Ferete's diameter and Martin's diameter).

1.5 Interaction of air pollutants in the atmosphere

Secondary pollutants, photochemical-smog, Acid rain, green house effect, Ozone depletion.

1.6 Effect of air pollution:

(a) On materials, buildings, metals etc.

(b) On vegetation

(c) On weather and atmospheric conditions

(d)On human health- a brief survey of major air pollution episodes.

1.7 Air pollution- abatement technology, basic principles of design and working of:

(a) Bag filters (b) Inertial collection- cyclones

(c) Electrostatic precipitators (d) Scrubbers

(e)Adsorption (f) Device for controlling automobile emissions

1.8 Noise pollution-sources, effects and abatement

1.9 Air Act.

1.10 Air Quality Standards

**2: WATER POLLUTION (40 hrs)**

2.1. Organic pollution: (a) Origin and sources of Organic pollutants, Biodegradable and non-biodegradable- Domestic, Agricultural and Industrial sources.

(b) Biochemical oxygen demand (BOD) - Kinetics of BOD tests- rate constant and its importance- Method of estimation

(c) Chemical Oxygen Demand (COD) - Importance and method of estimation

(d) Effects of organic pollution on aquatic systems, saprobicity system and indicator species Importance in pollution assessment

2.2. Eutrophication- natural and cultural sources and effects.

2.3. Biocides: Classification and types of Biocides- Fungicides, Pyrethroids and pesticides.

Effects of Biocides, Biological magnification Toxic effects on non target organisms- hazards to man.

2.4. Heavy metals sources and effects of the following in the ecosystem and human population

(a)Mercury - Inorganic and Organic mercury compounds - Bioconversion of inorganic and organic mercury

(b) Cadmium - itai - itai disease

(c) Lead - Plumbism

(d) Lesser metals - copper, zinc, selenium, chromium, molybdenum, beryllium and thallium.

2.5. Thermal pollution-sources, effects- cooling towers as control measures.

2.6. Oil spills-sources effects and control.

2.7. Hazards of Radioactive materials in the environment Biological effects of ionising radiations, Nuclear waste disposal.

2.8. Carcinogens in the environment

(a) Polycyclic aromatic hydrocarbons (b) Nitrosamines (c) Inorganic carcinogens Asbestos, Metal dust (d) Carcinogens in food: Artificial sweeteners, disodium benzoate and other additives.

2.9. Water pollution abatement technology:

1 Primary, secondary and tertiary treatment systems (b) Principles of design and operation of (1) screens (2) Grit chambers (3) Sedimentation tanks (4)

Oxidation ponds and (5) algal pond.

2.10. Design and operation of biological treatment systems: (1) Aerated lagoons (2) Activated sludge process (3) Trickling filters (4) sludge digest.

2.11.Sewage and sewage treatment: composition, bacteriology of sewage treatment, stabilisation-properties of sewage, categories of sewage, use of effluents in irrigation

2.12. Water Act,and Water quality standards.

**3. TERRESTRIAL POLLUTION (15 hrs)**

3.1 Solid waste- garbage, rubbish, ashes, debris, street litter, agricultural waste, mining waste, industrial waste, e-waste etc.

3.2 Problems of solid waste disposal, consequences of solid pollution-Love canal episode as an example.

3.3 Solid waste disposal methods: Sanitary land fill, plasma gasification, deep well injection, incineration

3.4 ,Generation of biogas from biodegradable organic wastes

3.5 Recycling of solid wastes

**References:**


1. Ahluwalia & Sunita Malhotra (2009): Environmental Science-Ane books Pvt.Ltd
2. Ananthakrishnan T.N.- Bioresource Ecology- Oxford and IBH
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5. Cunningham & Cunningham (2003): Principles of Environmental Science:, Tata McGraw Hill
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20. Smith & Smith- Minamata-Holt, Rinchart & Winston.
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## FOURTH SEMESTER

## DZOL4E03T

## ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-III - ENVIRONMENTAL CONSERVATION

(90 Hours)

1. Habitat Conservation (25 hrs)

1.1. Forest Ecology

1.1.1. Major vegetation types - dry and moist deciduous, semi evergreen, evergreen, and montane evergreen forests

1.1.2. Tropical rain forests; geography, climate; precipitation; features of plants- leaves, root, bark.

1.1.3. Shola forests (Cloud forests) ; global distribution; fog precipitation; cloud stripping; water shed function; fauna; vegetation.

1.1.4. Montane shola grass land matrix

1..1..5. Mangroves

1.2. Deforestation and its consequences

1.2.1. Need for scientific management and conservation of forests 1.2.2- Social forestry and agro forestry

1.3. Habitat destruction, Fragmentation and Degradation causes and consequences

1.4. Wetlands and waterfowl conservation

1 Ramsar convention aims and objectives, Ramsar sites in Kerala

2 Coastal zone management

1 Special features of CRZ

2 Coastal Zone Management plan and its objectives

1 Categorization of the Coastal Zone; 'Setback line': Coastal Zone Management

3 Indicative list of ecologically sensitive areas (ESA)

1.5 Coral reefs: list of major coral reefs; conservation problems

1.6 Ocean acidification; Ocean Warming and Coral Bleaching;

1.7 Coral tourism; water pollution; sedimentation; coral mining;

2. Biodiversity conservation (40 hrs)

2.1. The richness of biodiversity

2.2The importance of biodiversity (Direct and indirect values)

2.3 Reasons for high species diversity in the tropics.

2.4. Biodiversity of India

2.5. The threatened biodiversity with special reference to critically endangered vertebrates from India.

2.6. Loss of biological diversity and Causes of extinction.

2.7. Endemism

2.8. Keystone species and Keystone resources-

2.9 Exotic species introductions, invasive species, disease and over exploitations

2.10. Global hotspots - hotspots in India,- Western ghats and Sreelanka, Indo Burma, and Eastern Himalayas.

2.11. Unesco world heritage site- sites of ecological importance of India.

2.12. Biological control and Integrated Pest Management.

2.13. Organic farming and its importance

3 Strategies of conservation

1 3.1 Concept of minimum viable area and minimum viable population

3.2National Parks, aims and objectives -Briefly mention the important national parks in India with special reference to Kerala (Eravikulam, Silent valley, Mathikettan chola, Anamudi chola and Pambadum chola National parks from Kerala)

3.3 Sanctuaries-Major sanctuaries in India and mention the sanctuaries in Kerala.

3.4 Biosphere Reserves -Their aims and objectives, briefly mention them-with special reference to Kerala

3.4.1.1 Conservation strategies at the global level-Role of World conservation union, CITES, WWF, TRAFFIC, Ramsar Convention, UNFCCC (Kyoto Protocol), Convention on Biological Diversity (CBD), Conservation International (CI) ,

Operation Wallacea, REDD.

3.4.2 IUCN categories of threatened animals and red data book.

3.4.3 Wildlife management in India; Role of Government and non governmental agencies. Briefly mention wildlife protection act 1972 and its amendments and schedules

3.4.4 Endangered species -strategies of conservation with special reference to India - Project Tiger, Project Elephant, Project hangul, Operation Rhino. Crocodile breeding project, Project Sangai, Gir lion project, Himalayan Musk deer project.

3.4.5 Ex situ conservation -Zoo, Aquarium, Seed bank, Gene bank, Pollen bank

3.5 In situ conservation.- National parks, sanctuaries, Biosphere reserves, Community reserves and other protected areas. Traditional Ecological Knowledge (TEK)-

3.6.1 Introduction and need for its conservation

3.6.2 Economic benefits

3.6.3 Social implications-sacred groves, sacred landscape, sacred species

3.6.4 TEK and sustainable development.

4. Environmental Impact (25 hrs)

4.1. Aims and uses of preparing Environmental Impact Statement (EIS)

4.2. Aims and objectives of Environmental Impact Assessment (EIA),

4.3. Environmental management systems-ISO-14000 standards

4.4. Cost benefit analysis of environmental protection incorporating, environmental costs and benefits of designing projects.

4.5. Development and displacement of rural communities, ethical and socio - economic problems, Disappearing culture and traditions, Impact on environment. Urban environment and new problems.

4.6. Ecotourism - Importance of Ecotourism, visitor impact, visitor management, control and safety rules - threats to local culture, ecolodges. Economic &Ecological effects of ecotourism

4.7. Restoration of ecology and degraded rural landscape- Illustrate with case studies from India.

4.8. Environmental protection movements - Global, national, and local, historical, present social pressure group agencies like green, and Chipco

movement, Narmada Bachao.

4.9. Marine debris, Great pacific ocean/Indian ocean garbage patches; Asbestos and healh hazards;

**References:**


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16. Odum H. T. System ecology, an Introduction- John Wilsy & Sons, New York
17. Owen O. S. Natural resources conservation, An Ecological Approach- Mac Millan.
18. Ramakrishnan, P.S.-Ecology and sustainable development-National book trust India
19. Primack- Essentials of Conservation Biology fifth edition-Sinauer associates
20. Puri et al.- Forest Ecology- Oxford university press
21. Raymond Dasman- Environmental Conservation- John Wiley
22. Sagrayia, K.P. - Forest and Forestry- National Book Trust, New Delhi
23. Smith R.I. Elements of ecology- Harper and Row publishers, New York.
24. Turk and Turk-Environmental Science- Saunders College Publishing

**FOURTH SEMESTER PRACTICALS**

## DZOL4E04P

## ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY -I

WATER POLLUTION

(Practical classes to be conducted during Fourth semester)

Waste water characterization - determination of the following parameters in waste water samples

1. Turbidity - Nephlo meter or Secchi disc method
2. Odour
3. Dissolved solids - gravimetric method
4. Suspended methods - gravimetric method
5. Dissolved oxygen (modified Winkler method)
6. Biochemical oxygen demand - Dilution method
7. Chemical oxygen demand - Dichromate digestion
8. Ammonia nitrogen - Indophenol blue method
9. Nitrite nitrogen - Azo dye method
10. Nitrate nitrogen -Phenol disulphonic acid method
11. Sulphate
12. Inorganic phosphates - APHA method
13. Hardness EDTA titration Method
14. Residual chlorine
15. Species diversity indices and indicator species
16. Primary production
    a) Light and dark bottle method b) b) Chlorophyll method.

**References:**


1. Greenberg et.al-Methods for the examination of water and waste water-APHA publishers Washington D.C.
2. Indian standard methods for measurement of air pollution-ISI - New Delhi
3. Indian standard method of sampling and test for industrial effluents Part III-ISI New Delhi
4. Michael -Ecological methods for field and Lab investigations-Tata Mc Graw-Hill
5. NC Aery-Manual of Environmental Analysis- Ane Books Pvt.Ltd
6. Sawyer & Mc Carty-Chemistry for environmental engineering -Mc Graw Hill Publishers
7. Trivedi & Goel-Practical methods in Ecology and Environmental Sciences-Environmental publications Karad

## PRACTICALS

## DZOL4E05P

## ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY – II

AIR POLLUTION, RADIATION BIOLOGY AND HEAVY METALS

### A. AIR POLLUTION

Air samplers - Simple, Handy and High volume air samplers.

Monitoring of the following pollutants in ambient and polluted air:

1. Dust fall
2. Suspended particulate matter
3. Sulphation rate using lead peroxide candle.
4. Sulphur dioxide
5. Nitrogen dioxide
6. Ammonia
7. Study on the effect of $SO_2$ on vegetation

### B. RADIATION BIOLOGY

1. Demonstration of UV induced lipid peroxidation in tissue homogenates
2. Effect of Vitamin E on UV induced lipid peroxidation

### C. HEAVY METALS

Estimation of the following metals in effluent and sediment samples

1 1. Copper-Biquinoline method

1 2. Zinc- Zincon method

2 3. Chromium (Hexavalent) - Diphenylcarbazide method

**References:**


1. Aery, N.C.-Manual of Environmental Analysis- Ane Books Pvt.Ltd
2. Greenberg et al-Methods for the examination of water and waste water-APHA publishers Washington D.C.
3. Indian standard methods for measurement of air pollution-ISI - New Delhi
4. Indian standard method of sampling and test for industrial effluents Part III-ISI New Delhi
5. Michael -Ecological methods for field and Lab investigations-Tata Mc Graw-Hill
6. Sawyer & Mc Carty-Chemistry for environmental engineering -Mc Graw Hill Publisher

## DZOL4E05P

### ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-III

SOIL & SEDIMENT ANALYSIS

A. Soil and Sediment Analysis

1. Collection and Preservation
2. Redox potential.
3. Alkalinity.
4. $P^H$
5. Exchangeable calcium and magnesium
6. Sodium and potassium.
7. Available phosphorous.
8. Ammonia Nitrogen
9. Chlorides
10. Organic Matter -Walkley Black Method
11. Sulphates

B. Environmental Microbiology

12. Standard plate count of soil and water samples
13. MPN of total coliforms
14. MPN of faecal coliforms

C. Bioassay Studies and Insecticides

15. Fish/Daphnia bioassay test to find out the toxicity of heavy metals/pesticides
16. Calculation of LC50 or TLm
17. Determination of the concentration of the following insecticides in water:
    a) DDT
    b) Methyl parathion
18. Inhibition of acetylcholine esterase by organophosphates/ carbamate insecticides (demonstration only)

**References:**


1. Aery, A.C.-Manual of Environmental Analysis- Ane Books Pvt. Ltd
2. Greenberg et.al-Methods for the examination of water and waste water-APHA publishers Washington D.C.
3. Indian standard methods for measurement of air pollution-ISI - New Delhi
4. Indian standard method of sampling and test for industrial effluents Part III-ISI New Delhi

5. Michael -Ecological methods for field and Lab investigations-Tata Mc Graw- Hill
6. Sawyer & Mc Carty-Chemistry for environmental engineering -Mc Graw HillPublishers
7. Trivedi & Goel-Practical methods in Ecology and Environmental Sciences- Environmental publications Karad.