

**S.S.JAIN SUBODH P.G. (Autonomous) COLLEGE JAIPUR**  
(Affiliated to University of Rajasthan)



**Syllabus**

**SCHEME OF EXAMINATION AND COURSES OF STUDY**

**FACULTY OF SCIENCE**

**DEPARTMENT OF ZOOLOGY**

**M.Sc. Zoology (I, II, III and IV Semester- 2016-18)**

**Contents:**

- 1. OBJECTIVES**
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**Objectives:**

The objective of the course M.Sc. Zoology is to impart knowledge of Zoology to graduates of Biology with an emphasis on the world of animals, their evolution to the present forms over time, their habitats and food habits, and their co-existence with each other. Thus, knowledge of zoology is essential to experience the wonders of nature in the fullest. The programme enhances students to take up emerging opportunities in Life Sciences, in fields like Aqua Culture, Fisheries, Biotechnology, Medical Informatics and Environmental Management. Students are provided with requisite skills to take up research, teaching, entrepreneurship and other employment opportunities in zoology.

Department offers specialization in several major disciplines of Zoology

1. Cell & Molecular Biology
2. Environmental Toxicology
3. Entomology
4. Radiation Biology

**The main Goals and objectives of the course are:**

The Department tries to achieve the overall goals and objectives of the college and also focuses on the following special departmental objectives:

- Provide quality education in natural science
- Inculcate the spirit of resource conservation and love for nature
- Motivate students for self employment in applied branches of Zoology
- Equip the students for higher education
- Impart value based education and makes them members of civil society and provide opportunities for professional and personal development through curricular and co- curricular activities
- Conduct field studies - document biodiversity, water quality, soil profile etc. through student projects and faculty research, and Provide consultancy and organize extension activities

## **Employment Opportunities**

- Teaching
- Research Scientist in Life Science domain
- Aquaculture, Museum curators, Environmental Analysts, Zoological Parks
- E-Publishing, E-Learning, Hospital and Clinical Labs, Bio-Informatics

## **Eligibility:**

A candidate who has secured more than 55% or CGPA of 3.5 in the UGC Seven Point scale [36% or Pass marks for SC/ST/Non-creamy layer OBC/SBC] or equivalent in the Bachelor degree in Science shall be eligible for admission to First Semester of a Master of Zoology course. For candidates from outside state of Rajasthan 60% or CGPA of 4.0 in the UGC Seven Point Scale will be applicable irrespective of the category.

## **Scheme of Examination:**

1. Each theory paper carries 100 marks. The internal assessment will be 30 marks and EoSE shall carry 70 marks. The EoSE will be of 3 hours duration. There will be a practical examination of 200 marks in all Semester.
2. There will be two parts in EoSE theory paper. Part A of theory paper shall contain 10 Short Answer Questions of 14 marks, based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Candidate has to attempt seven questions out of 10 and each question will carry two marks for correct answer.
3. Parts “B” of EoSE theory paper will consist of four questions from each unit with internal choice of 14 mark each. The limit of answer will be five pages.
4. Each Laboratory EoSE will be of four hour durations and involve laboratory experiments/exercises/ Seminar presentation / Synopsis presentation/Project work or field study / Industrial Training/ consultancy training and viva-voce examination consisting of 200 Marks.
5. The aim of Project work or field study /Research laboratories/ Hospital training is to introduce students to research methodology in the subject and prepare them for pursuing research in theoretical or experimental or computational areas of the subject. The project work or Field Study is to be undertaken under guidance jointly by Head of the Department and a senior faculty or a Scientist or any other suitable person with proven research excellence in the concerned field of study. Project work or field study/ Hospital Training/ can also be taken up in an outside institution of repute Department. The guide will make continuous internal assessment of the Project work or field study / Hospital Training. EoSE for Project work or field study / Hospital Training and seminar will be held at department of the college by a board of three examiners consisting of HOD, two senior faculty of the department or expert from interdisciplinary department of the institution.
6. Supplementary/ due paper/ special examinations will be resolute as per the institutions autonomous rules.
7. Grade/CGPA/percentage/division will be decided as per the autonomous guidelines of the institution.

## 1. Proposed course for M.Sc. Zoology

### M. Sc. I Semester

0900000Max. Marks (Theory): 400

Nomenclature			External/ Theories	Internal/ Theories	Total Mini. Marks	Total Max Marks
MZO 101	Paper I	Principles of Biosystematics &Taxonomy	70	30	40	100
MZO 102	Paper II	Structure & Function of Invertebrates	70	30	40	100
MZO 103	Paper III	Biochemistry	70	30	40	100
MZO 104	Paper IV	Essentials of Cytology	70	30	40	100
MZO 151 Practical			80	60	80	200
MZO 152 Lab Work & Seminar				60		

### M. Sc. II Semester

Max. Marks (Theory): 400

Nomenclature			External / Theories	Internal / Theories	Total Mini. Marks	Total Max Marks
MZO 201	Paper I	General Physiology	70	30	40	100
MZO 202	Paper II	Environmental Biology & Ethology	70	30	40	100
MZO 203	Paper III	Molecular Biology, Biotechnology &Bioinformatics	70	30	40	100
MZO 204	Paper IV	Genetics and Molecular Evolution	70	30	40	100
MZO 251 Practical			80	60	80	200
MZO 252 Lab Work & Seminar				60		

**M. Sc. III Semester**

**Max. Marks (Theory): 400**

Nomenclature			External / Theories	Internal / Theories	Total Mini. Marks	Total Max Marks
<b>Papers :</b>						
MZO 301	Paper I	Biology of Chordates	70	30	40	100
MZO 302	Paper II	Genes & Differentiation	70	30	40	100
<b>Elective I : Environmental Toxicology</b>						
MZO303A	Paper III	Basics of Toxicology	70	30	40	100
MZO304A	Paper IV	Environmental Pollution & legal framework	70	30	40	100
<b>Elective II : Radiation Biology</b>						
MZO303B	Paper III	Fundamentals of Radiation	70	30	40	100
MZO304B	Paper IV	Biological Effects of Ionizing Radiation	70	30	40	100
<b>Elective III : Entomology</b>						
MZO303C	Paper III	Systematics and Ecology of Insects	70	30	40	100
MZO304C	Paper IV	Insect Morphology, Physiology, Embryology and Development	70	30	40	100
<b>Elective IV : Cell &amp; Molecular Biology</b>						
MZO303D	Paper III	Molecular biology of the Gene	70	30	40	100
MZO304D	Paper IV	Proteomics	70	30	40	100
MZO 451	Practical Lab Work (External) & Seminar		50	50	80	200
MZO 452	Elective Practical & Synopsis Preparation /Presentation(Internal)		50	50		

**M. Sc. IV Semester**

**Max. Marks (Theory): 400**

Nomenclature			External/ Theories	Internal / Theories	Total Mini. Marks	Total Max Marks
<b>Core Papers :</b>						
MZO 401	Paper I	Applied Zoology & Biostatistics	70	30	40	100
MZO 402	Paper II	Tools & Techniques in Biology	70	30	40	100
<b>Elective I : Environmental Toxicology</b>						
MZO 403A	Paper III	Applied Aspects of Toxicology	70	30	40	100
MZO 404A	Paper IV	Biomonitoring & Bioremediation	70	30	40	100
<b>Elective II : Radiation Biology</b>						
MZO 403B	Paper III	Principles of Radiation Protection, Legislation & International Framework	70	30	40	100
MZO 404B	Paper IV	Occupational Exposure and Radiation Safety	70	30	40	100
<b>Elective III : Entomology</b>						
MZO 403C	Paper III	Industrial, Medical & Veterinary Entomology	70	30	40	100
MZO 404C	Paper IV	Insect Toxicology and Pest Control	70	30	40	100
<b>Elective IV : Cell&amp; Molecular Biology</b>						
MZO 403D	Paper III	Cellular mechanics	70	30	40	100
MZO 404D	Paper IV	Molecular Immunology	70	30	40	100
MZO 451 Practical (External) Lab Work & Seminar			50	50	80	200
MZO452 Elective Practical (External) & Dissertation (Internal)			50	50		

**Note: Minimum number of applicants must be 10 to run the special paper.**

## **Paper I**

### **M. Sc Semester- I THEORY**

#### **MZO-I01: [Principles of Biosystematics & Taxonomy]**

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two marks

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### **UNIT I**

1. Taxonomy: Definition and basic concept of biosystematics and taxonomy.
2. History, scope and application of biosystematics.
3. Taxonomic diversity: Definition and types of various taxonomic categories, micro- and macro-taxonomy.
4. Dimensions of speciation: Species category, sub-species and other intra-species categories.
5. Kingdom of life: General outline of kingdom including Monera and Protista; Broad outline and diversity in kingdom Animalia.

#### **UNIT II**

Modern trends in taxonomy:

1. Behavioural taxonomy
2. Chemotaxonomy
3. Karyotaxonomy
4. Molecular taxonomy
5. Neo-taxonomy
6. Numerical taxonomy.

#### **UNIT III**

1. Taxonomic procedures: Collection, preservation, curating and: process of identification.
2. Taxonomic character of different kinds-Quantitative and qualitative analysis of variation.
3. Theories of biological classification: Hierarchy of categories.
4. Interpretation and application of important rules and formation of scientific names of different taxa.

#### **UNIT IV**

1. Systematic publication-Different kinds of publications
2. International code of Zoological nomenclature (ICZN) – its operative principles, interpretation and application of important rules, Zoological nomenclature, formation of scientific names of various taxa.
3. Shannon wiener index

**SUGGESTED READING:**

1. M. Koto-The. Biology of biodiversity-Springer
2. Molecular Markers, Natural History and Evolution,J.C.Avise. Chapman & hall. New York
3. E.O. Wilson-Biodiversity-Academic Press Washington.
4. G.G.-Simpson-Principle of animal taxonomy Oxford IBH PublicationCompany.
5. E-Mayer-Elements of Taxonomy
6. Bastchelet-F-Introduction to mathematics for life scientists Springer Verlag, Berling.
7. Skoal R.R. and F.J.Rohiff Biometry-Freeman, San-Francisco.
8. Snecdor, G.W. and W.G. Cochran Statistical Methods of affiliated-East-West Press, New Delhi.
9. Murry J.D. Mathematical Biology-Springer, Verlag, Berlin.
10. Principle of Animal Taxonomy; G.G Simpson. Oxford IBH Publishing Company.

## **Paper II**

### **MZO-I02: [Structure and Function of Invertebrates]**

#### **Duration: 3 hrs.**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two marks.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

**Max. Marks: 70**

#### **UNIT I**

##### **Body Organization**

1. Origin of Life: Unicellular and Multicellular organism
2. Type of symmetry: Body plane, Asymmetry, Radial, Biradial, Bilateral symmetry
3. Fate of Blastopore: Protostome and Deuterostome
4. Fate of Blastomere: Determinate and Indeterminate blastomeres
5. Type of Cleavage: Radial and Spiral
6. Segmentation: Pseudo, Superficial, Metameric
7. Organization of coelom: Acoelome, Pseudocoelome and coelome (Schizo and enterocoelome)

##### **Locomotion**

8. Flagella and ciliary movement in protozoa
9. Hydrostatic movement in coelenterate, annelida and echinodermata

#### **UNIT II**

##### **Nutrition and digestion**

10. Patterns of Feeding and digestion in lower metazoa,
11. Filter feeding in Polychaeta, Mollusca and Echinodermata

##### **Respiration**

12. Organs of respiration – Gills, lungs and trachea
13. Mechanism of respiration
14. Respiratory pigments

#### **UNIT III**

##### **Excretion**

15. Organs of excretion: Coelomoducts, Nephridia and Malpighian tubules, Organ of Bojanus & Green gland
16. Mechanism of excretion
17. Excretion and osmoregulation

##### **Nervous system**

18. Primitive Nervous system: Coelenterata and Echinodermata
19. Advanced Nervous system- Annelida, Arthropoda (Crustacean and insecta) and Mollusca (Cephalopoda)

## **UNIT IV**

### **Reproduction**

20. Regeneration, Asexual (Paramecium, obelia)
21. sexual reproduction { Annelida, arthropoda, mollusca)

### **Invertebrate larvae**

22. Larval forms of free living invertebrates
23. Larval forms of parasites
24. Significance of larval forms

### **Minor Phyla**

25. Organization, General Character and significance (Ctenophora, Rhyncocoela, Entoprocta, Rotifera, Bryozoa, Phoronida)

### **SUGGESTED READING:**

1. The Invertebrates. Vol.1. Protozoa through Ctenophora, Hyman, L.H. McGraw Hill Co., New York
2. Invertebrate Structure and Function. Barrington, E.J.W. Thomas Nelson and Sons Ltd.London.
3. Evolution of Metazon life cycle, Jagerstain, G. Academic Press, New York & London.
4. The Invertebrates. Vol.2. Hyman, L.H. McGraw Hill Co., New York.
5. The Invertebrates. Vol.8. Hyman, L.H. McGraw Hill Co., New York. and London
6. Invertebrate Zoology Barnes, RD. W.B.Saunders Co., Philadelphia
7. A Biology of higher Invertebrates, Russel-Hunter, WD. McMillan Co. Ltd., London
8. The Invertebrates smaller colomate groups, Vol.5. Hyman, L.H. McGraw Hill Co., New York.
9. Animal Parasitism. Cad. C.P.Prentice Hall Inc., New Jersey.
10. Student Text Book of Zoology. Vol.I.II and III. Sedgwick.A. Central Book Depot, Allahabad.
11. Text book of Zoology. Parker, T.J., Haswell. W.A.Macmillan Co., London.

## MZO-I03: [Biochemistry]

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry two marks.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT-I: PROTEIN

1. General properties and classification of proteins
2. Amino acid structure and classification
3. Structure of protein-Primary, Secondary, Tertiary and Quaternary
4. Ramachandran plots
5. Globular and fibrous protein
6. Protein sequencing

#### PROTEIN METABOLISM

7. Amino acid degradation: Deamination reaction- Oxidative and non oxidative, transamination and transdeamination, Decarboxylation,
8. Ornithine cycle of urea formation ,
9. Fate of carbon skeleton of amino acids

### UNIT II: CARBOHYDRATES: STRUCTURE AND BIOLOGICAL IMPORTANCE OF-

1. Monosaccharides
2. Oligosaccharides
3. Polysaccharides (storage and structural polysaccharides, glycosaminoglycans)
4. Glycoconjugates (glycoproteins and proteoglycans)
5. Carbohydrates metabolism: Enzyme reaction, regulation and importance of Glycolysis, Citric acid cycle. Pentose phosphate pathway, glycogenolysis, glycogenesis, gluconeogenesis.

### UNIT III: LIPIDS

1. Fatty acids: structure, nomenclature, acyl glycerols, wax, phospholipids, sphingolipids, glycolipids, lipoproteins
2. Terpenoids and sterols: structure, properties and functions
3. Functions of lipids
4. Signal transducing molecule
5. Lipid metabolism: fatty acid oxidation, fatty acid biosynthesis, biosynthesis of triglycerides

### UNIT-IV: VITAMINS

1. Classification, structure, occurrence and functions of fat soluble vitamins
2. Classification, structure, occurrence and biological functions of water soluble vitamins
3. Phenolics and alkaloids; structure, biological properties and functions

#### ENZYMES

4. Classification and nomenclature of enzymes

5. Mechanism of enzyme action
6. Enzyme kinetics
7. Isoenzymes and co-enzymes
8. Inhibition of enzyme
9. Allosteric Regulation Of Enzymes
10. Enzymes as biosensor Inborn error of metabolism

**SUGGESTED READING:**

1. Voet, D. and J.G. Voet. Biochemistry John Wiley & Sons.
2. Freifelder, D. Physical Biochemistry W.H. Freeman & Co.
3. Segal, I.H. Biochemical calculations John Wiley and Sons
4. Creighton, T.E. Protein Structure and Molecular Properties W.H. Freeman & Co.
5. Freifelder, D. Essentials of Molecular Biology
6. Wilson, K. and K.H. Goulding A Biologists Guide to Principals and Techniques of Practical Biochemistry
7. Cooper, T.G. Tools of Biochemistry
8. Hawk, Practical Physiological Chemistry
9. Garret, R.H. and C.M. Grisham. Biochemistry. Saunders college Publishers.

## **Paper IV**

### **MZO-I04: [Essentials of Cytology]**

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two marks.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### **UNIT I: IMPORTANCE OF CELL & CELL THEORY**

1. Structure of prokaryotic and eukaryotic cells along with differences
2. Molecular composition and arrangement functional consequences of Biomembrane
3. Transport across cell membrane: diffusion, active transport and pumps
4. Co-transport by symporters or antiporters

#### **UNIT II: CYTOSKELETON**

1. Microfilaments, intermediate filaments and microtubules structure and dynamics
2. Intracellular transport, role of kinenin and dynein
3. Cell-Cell junction: Tight junction, Gap Junction, Plasmodesmata

#### **UNIT III: SIGNAL TRANSDUCTION, PROTEIN TRAFFICKING AND SORTING**

1. Introduction
2. Cell surface receptors
3. Second messenger system
4. MAP kinase pathways
5. Signaling from plasma membrane to nucleus
6. Protein synthesis on free and bound polysomes
7. Uptake into ER
8. Membrane proteins, Golgi sorting, Post translational modifications

#### **UNIT IV: CELL CYCLE**

1. Events in cell cycle
2. Mitosis and Meosis
3. Cyclin and cyclin dependent kinases and their regulation
4. Chromosome remodelling

## **SUGGESTED READING:**

1. Cell and Molecular Biology; De Robertis and De Robertis; Saunders College
2. Cell Biology; Powar, C.B.; Himalaya Publications.
3. Molecular Biology of the gene; Watson J.D; Benzamin/ Cummings
4. Molecular Biology of the Gene. I.D Watson, N.H. Hopkins, J.W. Roberts, J.A. Steiz and AM Weiner The Benjamin/Cummings Pub. Co., Inc., California.
5. Molecular Cell Biology, J. Darnell H.Lodish and D. Baltimore Scientific American Books, Inc., USA.
6. Molecular Biology of the cell. B.Alberts, D.D.Bray, J.Lewis, M.Rafif, K. Roberts and J.D.Watson. Garland Publishing inc., New York.
7. Gene IV, Benjamin Lewin. Oxford University Press, UK.
8. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A.Meyers (Ed.), VCH Publishers, Inc., New York.
9. Molecular Cloning: A Laboratory Manual, J.Sambrook, E.F.Fristsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
10. Introduction to Practical Molecular Biology, P.D.Dabre, John Wiley& Sons Ltd. New York.
11. Molecular Biology Lab Fax, T.A.Brown (Ed.), Bios Scientific Publishers Ltd., Oxford.
  
- 12 Cell Biology: Grellar Karp, International student versions

## PRACTICALS

### PAPER I [Principles of Biosystematics & Taxonomy]

- Identification, Classification and study of the animals from major invertebrate groups (Protozoa to Hemichordate including minor phyla) using museum specimens, slides, modals or charts.

#### 1. Specimens:

**Protozoa-** Gregarines, Monocytes, Euplotes, Dominion, Noctiluca, Radiolarian, Opalina

**Porifera-** Sectional view of sycon (T.S., L.S.), Grantia (T.S.)

**Cnidaria-** Slides of Obelia polyp and medusa, Pennaria, Aurelia Tentaculocytes

**Helminthes-** Slides of Temnocephala Museum Specimens of Ascaris lumbricoides, Taenia Solium, Planaria

**Annelida-** Slides of Ozonbranches, Glossophonia. Museum Specimens of Eunice, chloehava. Polynoe, Terebella. Eurythoe.

**Arthropoda-** Slides of Cyclops, Daphina, section of Peripatus, museum specimens of Balanus Lepas, Palinurus, Uca, Pycna, Hippa, Gongylus, Belostoma. Limulus, Squilla, Eupagurus.

**Mollusca-** Museum Specimens of Dolabella, Pteria, Nerita, Sanguinolaria, Chicoreus, Ficus, Lambis, Tridacna, Onchidium, Oliva, Murex, Turritella, Bulla, Cardium, Arca.

**Echinodermata-** Museum Specimen of Linkia, echinodiscus, Holothuria, Antedon.

**Minor phyla-** slides of Bugula, Plumatalla, Cristatella, Pectinella, Museum Specimen of Phoronis, Dendrostoma.

**Larvae-** Planula, Redia, Cercaria, metacercaria, Trochopore, Nauplius, Zoea, Mysis, Phyllosoma, Trilobite larvae of limulus, Antilon, Veliger, Bipinnaria, Ophio and Echinopluteus, Auricularia, tornaria

2. Composition assessment of taxonomic diversity in a habitat. (Grassland, arid land, wet land etc.)
3. Use of taxonomic keys to identify at least 6-10 orders of insects (upto order level only).
4. Visit river/pond/ sea

### Paper II (Structure and function of Invertebrates)

1. Virtual dissection of invertebrates using computer software  
OR
2. Dissection: Nervous System, Leech, crab, Scorpion, Mytilus, Sepia, Aplysia, Sea Urchin, Holothuria, Star Fish.
3. Mounting: Hydra, Obelia, Sertularia, Complanaria, Tubularia, Miracidium larvae, cercaria, Radia Larvae, Cyclops, Daphnia, Zoea, Megalopa Mysis planktons

### **PAPER III [BIOCHEMISTRY]**

1. Identification of protein, carbohydrate and lipid in various tissues/food materials
2. Identification of different kinds of mono-di and polysaccharides in biological /food materials.
3. Verification of Beer-Lambert's Law using any colour solution
4. Determination of absorption maxima of a coloured solution
5. Plotting of standard curve
6. Quantative estimation of the following in various tissues :-
  - A.Carbohydrates: Glycogen, glucose and ascorbic acid.
  - B.Proteins: Total proteins
  - C.Lipids: Total lipid, Phospholipids and cholesterol.
  - D.Nucleic acid: DNA and RNA
  - E.Enzymes: Acid and alkaline phosphates
7. Paper chromatography: unidimensional chromatography using amino acids from purified samples and biological materials.
8. PAGE electrophoresis, determination of serum protein through PAGElectrophoresis
9. Determination of pH of different solutions

### **PAPER IV [ESSENTIALS OF CYTOLOGY]**

1. Preparation of different cell types: Liver Hepatocytes , Adipocytes, Spleen cells
2. Study of Polytene chromosomes in salivary glands of Chironomus larva/Drosophila
3. Light microscopic examination and preparation of tissue sections.
4. Study of mitotic and meiotic chromosomes from permanent prepared slides.
5. Preparation of slides for mitotic study.
6. Preparation of slides for meiotic study in the testis of grasshopper.
7. Preparation of multipolar nerve cell from the spinal cord of a mammal.
8. Barr body preparation in buccal epithelial cells.

**Semester- II**  
**THEORY**

**Paper I**

**MZO-202: [General Physiology]**

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry two marks.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

**UNIT-I**

**DIGESTIVE SYSTEM**

1. Nature of food-stuff
2. Various types of digestive enzymes and their action in alimentary canal
3. Absorption and assimilation of food
4. Nervous and hormonal control of digestion
5. Energy balance

**RESPIRATORY SYSTEM**

1. Respiratory organs respiratory pigment -Haemoglobin
2. Mechanism of breathing
3. Physiology of respiration, control of breathing
4. Aerodynamics and BMR

**CIRCULATORY SYSTEM**

1. Composition and function of blood
2. Haemopoiesis, blood clotting
3. Blood volume, blood volume regulation
4. Anatomy of heart structure
5. Myogenic heart, ECG — its principle and significance, cardiac cycle
6. Heartbeat, blood pressure and blood groups

**UNIT-II**

**EXCRETORY SYSTEM**

1. Physiology of excretion
2. Functional architecture of kidney and nephron
3. Nitrogenous end products, formation of urine and its hormonal control
4. Role of kidney in osmoregulation, urine concentration

5. Waste elimination, micturition
6. Electrolyte balance, acid-base balance

### **MUSCULAR SYSTEM**

1. Types and properties of muscles
2. Functional architecture of skeletal muscles
3. Biophysical and biochemical events during muscular activity

### **NERVOUS SYSTEM**

1. Functional architecture of neurons
2. Origin and propagation of nerve impulse through axon
3. Action potential, synaptic transmission
4. Reflex arc and reflex action
5. Gross neuroanatomy of the brain and spinal cord
6. Central and peripheral nervous system
7. Neural control of muscle tone and posture

### **UNIT-III**

#### **SENSE ORGANS**

1. Structural architecture and functioning of eyes and ears
2. Tactile response

#### **THERMOREGULATION AND COLD TOLERANCE**

1. Heat balance and exchange, endotherms vs ectotherms
2. Counter-current heat exchanger
3. Torpor, hibernation and aestivation
4. Adaptations to extreme climate
5. Comfort zone, body temperature- physical, chemical and neural regulation

#### **STRESS**

1. Basic concepts of environmental stress and strain
2. Homeostasis, physiological response to body exercise
3. Meditation, yoga and their effects

### **UNIT-IV**

#### **ENDOCRINOLOGY**

1. Endocrine glands in vertebrates, hormones and related diseases

Reproduction:

2. Reproductive cycle
3. Reproductive processes (implantation, parturition and lactation), neuroendocrine regulators in mammals .

## **PRACTICALS**

1. Photometric determination of haemoglobin in blood sample.
  2. Determination of MCV, MCH, MCHC and colour index of the given sample of blood.
  3. Demonstration of the blood clotting time and erythrocyte sedimentation rate,
  4. Determination of the urea in urine
  5. Determination of the glucose in urine.
  6. Study of digestive enzymes in different parts of the alimentary canal.
  7. Study of histological slides of endocrine glands
  8. Study of estruses smear
  9. Study of location of endocrine glands
  10. Measurement of human blood pressure
  11. Demonstration of haemolysis and crenation
  12. Demonstration of Kymograph is recording of the frog heart beat and the study of the effect of electrical stimulation hot and cold, drugs, etc.
  13. Kymographic recording of muscles twitch , summation of twitches, chronic contractions, tetanus, fatigue and stair-case phenomenon from the sciatic nerve gastronomies muscle preparation of frog.\*
  14. Study of spinal and convulsive reflexes in frog\*
- \*In case, frogs become available students may be asked to perform the various exercises. Otherwise following CAL exercise may be included (please see E-pharm programme).
15. The effect of  $K^+$ ,  $Ca^{++}$ , ACh and Epinephrine on the isolated heart of frog and conclude your data with the graphic representation.
  16. The effect of various doses of ACh and Nor-epinephrine on Blood pressure, Heart Rate and Respiratory Rate of the dog;
  17. The effects of Atropine, Epinephrine, Ephedrine and Eserine on Rabbit's eyes and other such exercise can be framed from the E-Pharm software.

## Paper II

### MZO-201: [Environmental Biology & Ethology]

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two marks.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### UNIT I: ECOLOGY

1. Ecological law of minimum and law of tolerance
2. Ecological niches, overlapping of niches, ecotone
3. Energy flow, food chain, food web and trophic levels, ecological pyramids
4. Nutrient cycles in nature -carbon, nitrogen, phosphorus and water.
5. Ecozones of India -habitat and fauna
6. Population ecology: Characteristics of a population, Population growth curves, population regulation, Life history strategies (r and k selection)
7. Environmental Pollution - air, water, soil, noise and radiation (electromagnetic and ionizing)carbon foot print

#### UNIT II: BIODIVERSITY

1. Species diversity, ecosystem diversity, genetic diversity and molecular Diversity Alpha, Beta and Gamma Diversity
2. Biodiversity indices. Measuring -species richness, species evenness Simpson's diversity Index and Shannon's diversity index
3. Biodiversity act of India and Biodiversity hot spots in India ( with special reference to Western Ghats and North east), UNESCO heritage sites (Kaziranga National Park)
4. Ecological communities: (succession, zonation, environment, biota and adaptations)  
Terrestrial  
Fresh water  
Marine and estuarine
5. Climatic Changes -El Nino and La Nina, Earthquakes and Tsunami
6. Brief Knowledge of EIA
7. Elementary knowledge of : Wildlife acts and schedules, CITIES, TRAFFIC, WWF, Ramser convention, IUCN, ZSI, ZAI, ENVIS, IGCMC, Project Tiger, Biosphere reserves, world heritagesites and hot spots, Hop spots,

#### UNIT III: ETHOLOGY

1. Scientists and their works: Konrad Lorenz, Niko Tinbergen, Karl Von Frisch, Skinner BF and Harlow Harry, Richard .Dakins, EO Wilson, Desmond Morris.
2. Concepts of Ethology (SS, FAP, ASE, IRM), Flush Toilet model; genes and behaviour; evolution of behaviour.
3. Learning introduction and definition, types of learning, Habituation, trial and error, conditioning, cognition and imprinting. Short and long term memory, neural mechanism of learning.
4. Methods of studying brain and behaviour: Neuroanatomical, neurophysiological and neurochemical.
5. Mammalian brain and behaviour, Limbic system and hypothalamus.

#### **UNIT-IV: SOCIAL BEHAVIOUR**

1. Properties and advantages of social grouping, social group of monkeys.
2. Sociobiology-Darwinian fitness, individual fitness, kin selection, group selection. Co-operation, reciprocation altruism ,reciprocal altruism, proximate and ultimate causations, Orientation
3. Territorial behaviours: home range, territory, core area
4. Aggressive behavior
5. Feeding and sexual strategies in animals.
6. Courtship and mating behaviour in animals
7. Communication in animals: auditory, tactile, visual and chemical.

#### **SUGGESTED READING:**

1. Ecology, Individuals. Populations and Communities. Begon. M., J.I., Harper and C.R. Townsend, Blackwell Science. Oxford U,
2. Ecological concepts. Cherrett, J.M. Blackwell Sci. Publi. Oxford U.K.
3. Population biology. Elseth. B.D. and K.M.Baumgartner. Van Nostrand Co., New York
4. Fundamentals of ecological modeling. Jorgenson. SE. Elsevier. New "
5. Animal behaviour: A synthesis of ethology and comparative psychology. Hinde. R.A. McGraw-Hill. New York.
6. Behavioural ecology. Krebs J.R. and N.B. Davis: Blackwell. Oxford. U.K.
7. Sociology: The new synthesis. Wilson. E.O. Harbard Univ. Press. Cambridge. Mass.USA
8. A New Ecology - Systems Perspective Sven Erik Jørgensen, Brian Fath, Simone Bastianoni, Joao Marques, Felix Muller, S. Nors Nielsen, Bernard Patten, Enzo Tiezzi and Robert Ulanowicz Elsevier May 2007
9. Alcock, John. Animal behaviour—an evolutionary approach. (Sinauer Associates). 547 pages.
10. Barnard, C.J. Animal behaviour. (Croom Helm, London). 340 pages.
11. Barnett,S. A. . Modern Ethology.
12. Chauvin, Remy . Ethology: The biological study of Animal Behavior. (InternationalUniv. Press). 245 pages.
13. Colgan, Patric W. Quantitative Ethology. (John. Wiley & Sons). 364 pages.
14. Immelman, C. Introduction to Ethology.
15. Manning, Aubrey. An Introduction to animal behaviour. (Edward Arnold Publ., London). 208 pages.
16. Manning, Aubrey. An introduction to animal behaviour. (Addison-Wesley Publ.Co.). 294 pages. 42
17. McFarland, David. Animal behaviour: Psychology, Ethology & Evolution. (ELBS Publ.).
18. Slater, P.J.B. Essentials of animal behaviour. (Cambridge Univ. Press). 233 pages.
19. Wallace,Robert A. The ecology and evolution of animal behavior. (Goodyear Publ. Co. Inc.). 284 pages.

## **Paper III**

### **MZO-203: [Molecular Biology, Biotechnology & Bioinformatics]**

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two marks.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### **UNIT- I: DNA REPLICATION**

1. Structure of DNA
2. Prokaryotic & eukaryotic DNA replication
3. Mechanics of DNA replication
4. Enzymes and accessory proteins involved in DNA replication

#### **TRANSCRIPTION**

5. Structure of RNA
6. Prokaryotic and Eukaryotic transcription
7. RNA polymerases, General and specific transcription factors

#### **POST TRANSCRIPTIONAL MODIFICATION IN RNA**

8. 5' cap formation
9. Transcription termination
10. 3' end processing and polyadenylation ,Splicing

#### **UNITII: TRANSLATION**

1. Genetic code
2. Prokaryotic and eukaryotic translation
3. Mechanisms of Translation
4. Regulation of Translation
5. Co and post translational modifications of protein

#### **RECOMBINATION AND REPAIR**

6. Holiday junction, Gene targeting, Gene disruption
7. FLP/ FRT and Cre/lox recombination
8. Rec A and other recombinases

#### **UNIT III: MOLECULAR MAPPING OF GENOME**

1. Genetic and physical maps
2. Southern and fluorescence in situ hybridization for genome analysis
3. Molecular markers in genome analysis: RFLP,RAPD and AFLP analysis

## **TRANSGENIC ANIMALS AND KNOCKOUTS**

4. Production
5. Applications
6. Embryonic stem cells
7. Care and breeding of experimental animals including bioethics

## **ASSISTED REPRODUCTION TECHNOLOGIES**

9. Embryo sexing and cloning
10. Screening for genetic disorders
11. ICSI, GIFT etc.
12. Cloning of animals by nuclear transfer

## **UNIT IV: BIOINFORMATICS**

1. Bioinformatics - Biological /Specialized Database - Servers for Bioinformatics (NCBI, EBI, Genoment)
2. Sequence analysis techniques - Genomics - Proteomics.
3. Practical aspects of multiple sequence alignment
4. Phylogenetic analysis
5. Predictive methods using Nucleotide sequences of Mice and Men: Navigating public physical mapping

## **SUGGESTED READING:**

1. Molecular Biology of the gene; Watson J.D.; Benzamin/ Cummings.
2. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson, Garland publishing. Inc., New York, 1994.
3. Molecular Cell biology (2nd Edition) J. Darnell, H. Lodish and D.Baltimore, Scientific American Books,USA,1994.
4. Cell & Molecular Biology, (8th edition), E D P Roberties& E M F Roberties, Lippincott Williams & Wilkins, 2005
5. The cell, (5th edition), R C Swanson and P C Webster , Prentice hall of India Pvt. Ltd., 1990
6. Cell and Molecular Biology, (3rd edition), P Sheeler and D E Bianchi, John Wiley & Sons, Inc, 1987
7. Cell and Molecular Biology: Concepts and Experiments, (4th edition), G Karp, John Wiley & sons, Inc., 2005
8. The cell. A Molecular Approach, (4th edition), G H Cooper and R E Hausman, ASM Press, 2007
9. Gene VII, Indian eds. Lewin, B. Oxford university press, Bombay.
10. Essential Bioinformatics, Jin Xiong, John Wiley and Sons. 2006.
11. Introduction to Bioinformatics, A Teresa and D P Smith, Prentice Hall, 1999.
12. Bioinformatics, A practical Guide to the Analysis of Genes and Proteins, (2nd edition), A D Baxevanis, and B F Ouellette, John Wiley and Sons, 2002.
13. Instant notes, Bioinformatics, Westhead, Parish, and Twyman, (1st edition), Bios Scientific Publishers Ltd., 2003.

## **Paper IV**

### **MZO-204: [Genetics and Molecular Evolution]**

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry ~~two~~ marks.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### **UNIT- I: MENDELIAN INHERITANCE**

1. Modern Mendelism and non Mendelian pattern of inheritance.
2. Patterns of gene inheritance, multiple alleles, linkage and crossing over, inheritance of sex and autosomal genes, cytoplasmic inheritance.
3. Conjugation, transformation & transduction in bacteria and their use in preparation of genetics maps.
4. Recombination frequency, genetics in animal breeding (inbreeding and out breeding) heterosis, expressivity, penetrance.

#### **UNIT II: HUMAN GENETICS**

1. Pedigree analysis, karyotype analysis, Lyon Hypothesis,
2. Genetics of ABO system, Rh disease and inheritance, sickle hemoglobin and inheritance, Thalasseмииs,
3. Human Genome Project, DNA finger printing
4. Genetic disorders- Patau, Edward's, Chriduchat syndrome, Philadelphia Chromosome.

#### **UNIT III: Population Genetics:**

1. Hardy-Weinberg law of genetic equilibrium
2. Natural selection, Mutation, Genetic drift, Migration, Meiotic drive
3. Analysis of quantitative traits quantitative traits and natural selection,
4. Genotype-environment interactions
5. Inbreeding depression and heterosis,
6. Puncheated Equibrilium and gradualism
7. Heritability

#### **UNIT IV: MOLECULAR EVOLUTION**

1. Gene Evolution, Multigene families, molecular drive, Micro-and Macro-evolution, convergent-divergent evolution
2. Molecular phylogenetics: Phylogenetic trees, Phylogenetic inference-Distance methods, parsimony methods, maximum likelihood method, Molecular clocks.

**SUGGESTED READING:**

- a. Genetics- Eldon J Gardner
- b. Molecular Genetics Part I and II – H. Herbert Taylor
- c. Principles of Genetics- 3<sup>rd</sup> Edition, E.J. Gardner
- d. Gene Structure and Expression- J.D.Hawkin, Cambridge University Press
- e. Heredity- A.F.Shull, 4<sup>th</sup> Edition, McGraw hill Book Company, London
- f. Genetics- Strick Berger
- g. Genes V – Benjamin Lewin, Oxford University Press, New York.
- h. Evolutionary genetics, John Maynard Smith, Oxford University Press, NewYork, 1998
- i. Genes and Evolution, A.P. Jha, Mc Graw Hill Publishers, New Delhi, 1993
- j. Molecular Cell Biology 5<sup>th</sup> Edition, Lodish et al., 2004, W.H. Freeman and Company, New York.
- k. The World of the Cell Becker, Klein smith and Hardin, 5<sup>th</sup> Edition, 2004, Pearson Education Pvt. Ltd.

## **PRACTICALS**

### **GENERAL PHYSIOLOGY**

1. Demonstration of the use and operation of oscilloscope for recording neuroelectric activity and electrocardiogram.
2. Photometric determination of haemoglobin in blood sample.
3. Determination of RBC, WBC, MCV, MCH, MCHC and colour Index of the given sample of blood.
4. Demonstration of the blood clotting time, erythrocyte sedimentation rate, haemolysis and crenation.
5. Determination of the urea in urine
6. Determination of the glucose in urine.
7. Study of digestive enzymes in different parts of the alimentary canal.

### **ENVIRONMENTAL BIOLOGY & ETHOLOGY**

1. Estimation of alkalinity, acidity, dissolved oxygen, chloridePh in water, nitrogen, phosphorous
2. Microbial analysis in soil
3. A visit to a sanctuary/National Park. (Preparation of Report)
4. Learning by trial and error in animals using maze and jumping box
5. Study of movement of fish in aquarium
6. Study of courtship in birds
7. Food preference in tribolium
8. Pheromones in earthworms
9. Study of imprinting in chicks

### **MOLECULAR BIOLOGY, BIOTECHNOLOGY & BIOINFORMATICS**

1. Squash and smear preparations of testis of cockroach / grasshopper aceto-orecin and Fuelgen staining of these preparations.
2. Study of mitosis in onion root tip and meiosis in testes of insect or mammal.
3. Study of giant chromosomes in the salivary gland of Chironomus larva or Drosophila
4. Vital and supravital staining (with Neutral red and Janus green (B) of cells of the testis of an insects or mammal to study the mitochondria.
5. Preparation of multipopular nerve cell from the spinal cord of a mammal.
6. Study of prepared microscope slides, including those showing various cell types, mitosis, meiosis and giant chromosomes.
7. Study of PCR
8. Extraction of Genomic DNA
9. Restriction digestion of  $\gamma$  DNA

## **BIOINFORMATICS**

1. Study of the tools used in bioinformatics.
2. Retrieve the sequence for the database.
3. Genome sequencing techniques.
4. Methods of sequence alignment.
5. Nucleotide and protein Sequence databases.
6. Gene bank flat file format.
7. Data mining in proteomics.

## Semester III

### Paper I

#### MZO-301: [Biology of Chordates]

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### Unit I

- outline classification of chordates.
- Evolutionary Times scale ,Evolutionary Significance of Chordates and protochordates
- Origin, evolution and adaptive radiation of chordates
- Origin, evolution and general characters Agnatha : Ostrachoderms and cyclostomes
- The early Gnathostomes (Placoderms)

#### Unit II

- A general account of the Elasmobranchii, Holocephali, Dipnoi and Crosspterygii.
- Adaptive radiation in bony fishes
- Origin, evolution and adaptive radiation of Amphibia
- Origin, evolution of Reptiles : Seymouria and cotylosaurai
- Skull of reptiles
- Sense organs in reptiles

#### Unit III

- Origin, evolution of Birds
- Origin of Flight : Flight adaptation
- Flightless birds
- Modification of beak, feet and palate in birds

#### UNIT IV

- Origin of Mammals : Primitive mammals(Protheria & Metatheria)
- Evolution of viviparity and oviparity
- Evolution and significance of exothermy and endothermy
- General account of adapative radiations in Eutherian mammnals
- Evolution of Primates

## **SUGGESTED READING:**

1. The Biology of Hemichordata and Protochordata. Barrington, E.J.W. Olter and Boyd. Edinhourgh.
2. Structure and Habit in vertebrate evolution - carter, G.S.Sedgwick and Jackson. London
3. Comparative anatomy of vertebrates. Kent. C.G.
4. Chordate morphology. Malcom Jollie. East-West Press Pvt.Ltd., New Delhi.
5. Analysis of vertebrate structure. Milton Hilderhrand. John Wiley and Sons., Inc, New York
6. Text Book of Zoology, Sedgwick, A.A. Students Vol.II.
7. Vertebrate Body. Romer A.S. W.B. Saunders Co., Philadelphia.
8. Life of vertebrate, Young. J.Z. The Oxford University Press. London.
9. Life of mammals, Young. J.Z. The Oxford University Press. London.
10. Evolution of the vertebrates, Colbert. E.H. John Wiley and Sons Inc., New York.
11. Vertebrate Paleontology. Romer. A.S.University of Chicago Press, Chicago.
12. Chordata structure and function. Waterman. A.J.Macmillan Co. New York.
13. Vertebrate evolution. Joysey.K.A. and T.S.Kemp. Oliver and Boyd. Edinbourgh.
14. The Phylogeny of vertebrate. Lovtrup.S.JohnWiley and Sons. London
15. The biology of the Amphibia. Kingsley Noble G.Dover Publications. New York

## Paper II

### MZO-302 [Genes & Differentiation]

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT I

Principles of developmental biology:

Potency, commitment, specification, induction and competence.

Determination and differentiation; morphogenetic gradients; cell fate and cell lineages, Early vertebrate development:

Cleavage types

Gastrulation, Cell movement and formation of germ layer (fruit fly, frog, chick and mouse)

Cell to cell interaction and cell signaling during early morphogenetic development in early embryo, gastrulation neuralation and primordial organ

Origin and fate of neural crest cells

### Unit II

Body axes

Genetics of axis specifications in Drosophila

I

Establishment of body axes in mammals and birds

Tetrapod limb development

Homeobox concept in different phylogenetic groups

Hormones as mediators of development

### UNIT III

Environmental regulation and animal development:

Environmental cues and effects

Malformations and disruptions.

Changing evolution through development modularity

Developmental constraints

Creating new cell types-basic evolutionary mysteries.

Biology of sex determination:

Chromosomal determination in *Drosophila* and mammals

Testis determination genes

Ovarian development

Secondary sex determination in mammals.

Environmental sex determination

#### UNIT IV

Totipotency and Pluripotency

Embryonic stem cells, stem cells niches.

Genomic equivalence and the cytoplasmic determinants

Renewal by stem cells-epidermis, connective tissue, skeletal muscle and Hemopoietic Stem cells:

Blood cell formation

Bone marrow transplants

Stem cell disorders

Gene therapy

Genetic errors of human development

#### **SUGGESTED READING:**

1. An Introduction to Embryology: Balinsky, B.I. : W.B. Saunders, Delhi.
2. Development Biology. Berrill, N.J. McGraw Hill book Co. New York.
3. Modern Embryology: Bodemer, C.W. : Holt Rinehart and Winston, Inc. New York, Chicago.
4. Developmental biology: Scott. F. Gilbert.

## PRACTICALS

### Paper I [Biology of Chordates]

#### ANATOMY

Cranial Nerves of Wallago attu or any other locally abundant fish

Neural Complex of Herdmania

Accessory respiratory organs of Heteropneustes fossilis

Labyrinthine organs of Anabas testudinus

Museum specimens:

Herdmania and Amphioxus, Petromyzon, Myxine. 1 Pisces: Rhinobatus, Pristis, Trygon, Chimaera, Polydon, Acipenser, Amia, Lepidosteus, Protopterus, Lepidosiren, Neoceratodus, Noroptentis, Exocoetus, Echeneis, Pleuronectes, Clarias, Mestacembelus, Diodon, Tetrado, Ostracion, Lophis, Syngnathus, Hippocampus, Anguilla, L

Amphibia: Ichthyophis, Necturus, Proleus, Ambystoma, Axolotl larva, Salamander, Siren, Alytes, Hyla, Rhacophorus,

Reptilia:

Testudo, Chelone, Sphegnodon, Calotes, Hemidactylus, Phrynosoma, Draco, Varanus, Chameleon, Cobra, Hydrophis, rattle Snake, Viper, Pit Viper, Krail, Eryx, Gavialis.

Aves: Archaeopteryx, Taylor Bird, Indian Keel, Jungle

fowl, Pavo, Columba, Psittacula, Woodpecker, Bubo (hoopoe),

Mammals: Ornithorhynchus, Echidna, Macropus, Hedgehog, Manis, Loris, Bat, Mongoose, Hystrix, Otter

Microscopic Slides:

Lower Chordates: Herdmania tadpole larva, Amphioxus - T.S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Arnmocoete • Larva whole mount.

Pisces : Placoid scale, Cycloid scale, Ctenoid scale.

Amphibia: V.S. skin of Frog, T.S. passing through stomach, duodenum, intestine, liver, pancreas, Jung, kidney, testes, ovary, spinal cord, bone. V.S of Lizads.

Aves: V.S. skin of bird, contour feather, down feat

Mammalian tissues: Blood smear, Simple cuboidal epithelium, Simple columnar epithelium,

Simple squamous epithelium, Adipose tissue, Reticular Tissue

## Comparative Osteology:

I

Comparative account of axial and appendicular skeletons of Frog, Varanus,

Fox and Rabbit (both articulated and Disarticulated).

Skull of Reptiles (Anapsida and Diapsida).

Palate in Birds.

Skull and lower jaw of carnivore mammal & herbivore mammal.

Collection of various types of feathers. j

With reference of whole mount and museum specimen animal types may be substituted with diagram and photograph, models etc

It should be ensured that animal used in practical exercise should not come under wildlife protection act 1975

## Paper II [Genes & Differentiation]

### Practicals

1. To Study lifecycle of *Drosophila*

2. Identification of male and female *Drosophila*

3. Identification of wild and mutant forms of *Drosophila*

4. To Embryonic stem cells, stem cells niches. \

5. Genomic equivalence and the cytoplasmic determinants

6. Renewal by stem cells- epidermis, connective tissue & skeletal muscle Hemopoietic Stem cells:

7. Sex comb of *Drosophila*

8. To prepare permanent slide of W.M. of *Drosophila*

9. To make squash preparation of salivary gland chromosome from 3rd instar larva of *Drosophila*

10. Mono hybrid and dihybrid inheritance in *Drosophila*

11. Simple problems based on Mendelism

12. Demonstration of sex chromatin

13. Embryology of Frog (slides & preserved materials)

14. Embryology of Chick.

15. Blastoderm moulding of chick embryo

16. To study development of chick embryo through window preparation

## Core Elective I

### MZO-303A [Basics of Toxicology]

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### UNIT-I

- **Introduction to Toxicology**
  - I) Historical overview & scope of toxicology
  - II) Classification of Toxic agents
  - III) Spectrum of Undesired effects
- Chemical Interaction
  - Additive, Synergistics, Potentiation & Antagonism
- Dose Response & Dose Response curves

#### UNIT II

- **Measuring of Animal Toxicity**
  - Animal Toxicity Test: Acute, Subacute, Chronic (carcinogenesis, Mutagenesis, Teratogenesis) & Reproductive Toxicology
- **Mechanism of Toxicology**
  - I) Absorption & Distribution
  - II) Metabolism of Toxicants
  - III) Reaction Metabolites
  - IV) Elimination

#### UNIT III

- **Biotransformation of Xenobiotics**
  - Phase I Enzyme Reaction –,
    - Oxidation - Cytochrome P-450- Dependent Monooxygenase system, Flavin containing Monooxygenase, Nonmicrosomal Reaction, Cooxidation during Prostaglandin Biosynthesis.
  - Reduction
  - Hydrolysis
    - Phase II Enzyme Reaction-  
Glucuronidation, Sulfation, Methylation, Acetylation, Amino acid conjugation, Glutathion conjugation & Phosphorylation

Phase I Enzymes (Hydrolysis, Reduction, Oxidation  
Phase II Enzyme Reactions (Glucuronidation, Sulfation, Methylation, Acetylation, Amino-  
acid conjugation Glutathione Conjugation, Phosphorylation)

#### **UNIT IV**

##### **Target organ Toxicity**

- **Hepatotoxicity:** Susceptibility of the Liver , Types of Liver injury, Biochemical mechanism, Example of Hepatotoxicants.
- **Nephrotoxicity:** Susceptibility of Kidney, Renal physiology &function  
Example of Nephrotoxicants.
- **Pulmonary toxicity:** Susceptibility of the Lung, Types of toxic response, Example of Lung toxicants.
- **Nervous system:** Nervous system structure & function ,Vulnerability of Nervous System , Neurotoxicity, Example of Neurotoxicants.
- **Reproductive toxicity:** Reproductive processes(Development ,Male and Female Reproduction , Example of Reproductive Toxicants.

## **SUGGESTED READING:**

1. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
2. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
3. Casserett and Doull's Toxicology: The basic source of Poisons. (VI Edition)
4. Gleick, H.P. 1993. Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press.
5. Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment
6. Smith, Keith (1996) Environmental Hazards- Assessing risk and reducing disaster, 2nd Edition, London & New York.
7. Wisnr B., Adams, J. (Ed.) (2002) WHO Environmental Health in Emergencies and Disaster- A practical guide, World Health Organisations.
8. Conner, David (1994) Managing the environment with rapid Industrialisation- Lessons from the East Asian Experience, OECD, Paris.
9. Khanna, GopeshNath (1990) Environment Problems and the United Nations, Ashish Publishing House, New Delhi.
10. Sharma P.D., Environmental Biology and Toxicology, Meerut: Rastogi Publications
11. Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment
12. Sharma, B.K. Environmental Chemistry. Meerut publication
13. Pandey, Shukla, Trivedi, Fundamentals of Toxicology. New Central book agency

## **MZO-303 B [Fundamentals of Radiation]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

## **UNIT-I**

### **Atomic structure**

- Mass Number and atomic mass
- Isotopes, isomers, isobars
- Subatomic particles
- Excitation and ionization
- Nuclear forces and nuclear structure

## **Types of Radiation**

- A) Nuclear Radiation
- B) X-Ray Types, characteristics and Applications alpha, beta and Gamma rays and Characteristics

## **Radioactivity**

- Natural, Artificial and Half life
- Background Radiation
- Units of Radiation

## **Unit II**

### **LET and RBE**

### **Radiation Dosimetry**

### **Detection and Measurement of Radiation**

- G.M. Counter
- Scintillation Counter (Liquid and solid)
- Proportional counter
- Gamma Ray Spectrophotometer

## **UNIT III**

### **Radiation chemistry**

- Radiolysis of water.
- Formation of oxygen reactive species
- Oxygen effect
- Direct & indirect effects

### **Radiation Monitors**

- Film Badge
- Pocket dosimeter
- Thermo luminescence Dosimeter
- Area Monitoring

## **Unit IV**

### **Radioactive contamination and decontamination**

- Sources of contamination
- Control of contamination
- Contamination monitoring
- Decontamination

### **Radioactive waste management**

- Types of radioactive waste
- Discharge of radioactive waste
- Management of nuclear waste
- Safety and regulatory accept bodies

## **SUGGESTED READING:**

- Andrews, H.L.: Radiation Biophysics. Prentice-Hall Engel-Wood Cliffs. New Jersey. 1974 or

Later Edition.

- Avena, V : Ionizing Radiation and Life.. Mosby, S1. Lonis. 1971 or Later Edition.
- Baverstock, K. of Staltar, J. Low Dose Radiation Biological Bases of Risk Assessment. Taylor of Francis, 1989.
- Broil. AB Low level Radiation Effects. A fact Book : Society of Nuclear Medicine, USA, 1982.
- Bulokav EB. ,V Naiitel and J.B. Reitan.: Radiobiological Consequences of Nuclear Accidents- Contamination Radioecology, Radiobiology and Health.
- Chase, GD. and Robinowitz, J.L. Radioisotope Methodology. Burgess Publishing Co.

Minneapolis, Minn, USA. 3<sup>rd</sup> Edition, 1967 or Later.

- Coggle. J.E. : Biological Effects of Radiation. Taylor and francis Ltd., London, 1988 or Later Edition.
- Dalrymple, G.V, Ganldev, M.E., Kollmorgen, G.M. and Vogel, H.J.. Medical Radiation Biology. Saunders. Philadelphia, 1973 or Later Edition.
- Duncan, R.C., Knapp., R.G., and Miller III, M.C., : Introductory Biostatistics for the Health Sciences. John Wiley and Sons. Inc., New York, 1977 or Later Editon.
- Fobrikant. J.I. : Radiobiology. Year book med., Chicago, 1972 or Later Edition.
- G.B. gendes, H. Metives and J. Stathes. : Biological Assessment of occu pational Exposure to Actinides. Nuclear Tech. Pub. Kent, 1989.
- Gesben, G. , C.M. Menaene and H. Smilts.: Environment and Human Risks of Tritium. Nuclear Tech. Pub. Kent, 1986.

### **Paper III**

#### **MZO-303 C [Systematics and Ecology of Insects]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT-I**

Historical review of insect classification .basis of insect classification.

Phylogeny of Arthropoda and Hexopoda .Introduction to primitive insects.

Detailed classification of important and selected super families and families of the following orders- Orthoptera, Isoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera.

### **UNIT-II**

Social life in Isoptera and Hymenoptera. Life cycle of locusts and aphids.

Origin and evolution of insects with special reference to fossil insects. Causes of success of insects.

### **UNIT-III**

Ecology of insects-

- (a) Effect of physical factors.
- (b) Intra and inter specific relations. (Biotic factors)
- (c) Insect plant interaction.

### **UNIT-IV**

Population ecology: Population dynamics, size, fluctuation, biogeography, community ecology, species interaction, community structure, diversity.

Biochemical adaptations to environmental stress (metamorphosis, diapause, polymorphisms, swarms, outbreaks and migration).

### **SUGGESTED READING:**

1. The Insect: Structure and function by R.F. Chapman
2. Comparative Insect physiology, Biochemistry and Pharmacology .Vol :1-13.  
Edited by G.A. Kerkut and L.I. Gilbert.
3. Entomophagous Insect by Clausen
4. Entomology by Gilbert
5. Principles of Insect Physiology by Wigglesworth.
6. Fundamentals of Entomology by Elzinga
7. Hand book of economic Entomology for South India by Ayyar.
8. Insect cytogenetics by R.E.F.Symposium.
9. Insects and plants by Sting, Lawton and southwood.
10. Insect and hygiene by Busvine.
11. Insect Physiology by Wigglesworth.
12. Insect morphology by Mat Calf and Flint
13. Applied Agricultural Entomology by Dr. Lalit Kumar Jha

### **MZ0303D [Molecular biology of the Gene]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

## **UNIT I**

### **DNA**

- Equivalence rule
- Primary & secondary structure
- Unusual secondary structure (Slipped and cruciform structure; triple helix DNA; Tetraplex) and G-quadruplex.
- Types (A,B, &Z DNA) and flexibility
- Forces stabilizing the structure: Denaturation and renaturation; base pairing; hydrophobic interactions and Ionic interactions
- Packing of DNA: Nucleosome, solenoid & scaffold

## **UNIT II**

### **DNA replication**

- Prokaryotic and Eukaryotic replication
- Mechanism of DNA replication including end replication
- Enzyme and accessory proteins involved in DNA replication
- Drugs that effect replication

### **DNA repair**

- Direct Reversal of DNA Damage
- Excision Repair
- DNA Synthesis
- Recombinational Repair

## **UNIT III**

### **DNA binding proteins and gene expression**

- DNA binding domains
- Homeodomain proteins
- Zinc finger proteins
- Winged-helix (Forked helix) proteins.
- Leucine zipper proteins
- Helix loop-helix proteins

### **Role of Topoisomerase enzyme**

## UNIT IV

### Regulation of Gene expression

- Operon concept
- Catabolic repression
- Positive and negative regulation
- Inducers and corepressors
- Regulation by attenuation: *his* and *trp* operons

### ESSENTIAL READINGS:

1. Molecular Biology of the gene; Watson J.D.; Benzamin/ Cummings.
2. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson, Garland publishing. Inc., New York, 1994.
3. Molecular Cell biology (2nd Edition) J. Darnell, H. Lodish and D.Baltimore, Scientific American Books,USA,1994.
4. Cell & Molecular Biology, (8th edition), E D P Roberties & E M F Roberties, Lippincott Williams & Wilkins, 2005
5. The cell, (5th edition), R C Swanson and P C Webster , Prentice hall of India Pvt. Ltd., 1990
6. Cell and Molecular Biology, (3rd edition), P Sheeler and D E Bianchi, John Wiley & Sons, Inc, 1987
7. Cell and Molecular Biology: Concepts and Experiments, (4th edition), G Karp, John Wiley & sons, Inc., 2005
8. The cell. A Molecular Approach, (4th edition), G H Cooper and R E Hausman, ASM Press, 2007
9. Gene VII, Indian eds. Lewin, B. Oxford university press, Bombay

### Elective II

#### MZO-304 A [Environmental Pollution & Legal frame work]

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

**Air Pollution:** Atmospheric composition and stratification Sources, Species of pollutants, classification – criteria and specific pollutants. Effects of air pollution on plants, human health, materials and ecosystems. Synergistic effects of air pollutants. Air pollutant dispersion, Plume behavior, Temperature inversion, Lapse Rate and Stability, Wind Rose.

## UNIT-II

**Water Pollution:** Sources, species and water quality parameters. Organic and inorganic pollutants, sewage, leachates, eutrophication, heavy metals. Transport of pollutants in aquatic ecosystems. Bioaccumulation, Biomagnification. Bioindicators. Characteristics of domestic, industrial and agricultural wastes, their effects on receiving water bodies, Waterborne diseases. Thermal Pollution: Sources, Effects of pollution on human and animals.

## UNIT-III

**Noise Pollution:** Sources, sound pressure level, decibels, intensity, duration, pitch, noise-spectra-octave bands, noise-monitoring-sound level meter, frequency weighting net-works, equivalent continuous noise level and other noise indices. Effects of noise pollution on human and animals. Permissible standards.

**Thermal, Radiation and Space Pollution:** Sources, Effects of pollution on human and animals.

## UNIT IV

**Acts, Rules and Regulations:** Acts, rules and amendments thereof - Wildlife (Protection) Act 1972, Water (Prevention and Control of Pollution) Act 1974; Forest Conservation Act 1980, Environment (Protection) Act 1986. Air (Prevention and Control of Pollution) Act 1981; Bio-Medical Waste (Management & Handling) Rules, 1998; Tran boundary Movement Rules, 2008. Hazardous waste handling Rule, NGT

## SUGGESTED READING:

1. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
2. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
3. Casserett and Doull's Toxicology: The basic source of Poisons. (VI Edition)
4. Gleick, H.P. 1993. Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press.
5. Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment
6. Smith, Keith (1996) Environmental Hazards- Assessing risk and reducing disaster, 2nd Edition, London & New York.
7. Wisnr B., Adams, J. (Ed.) (2002) WHO Environmental Health in Emergencies and Disaster- A practical guide, World Health Organisations.
8. Conner, David (1994) Managing the environment with rapid Industrialisation- Lessons from the East Asian Experience, OECD, Paris.
9. Khanna, GopeshNath (1990) Environment Problems and the United Nations, Ashish Publishing House, New Delhi.
10. Sharma P.D., Environmental Biology and Toxicology, Meerut: Rastogi Publications
11. Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment
12. Sharma, B.K. Environmental Chemistry. Meerut publication
13. Pandey, Shukla, Trivedi, Fundamentals of Toxicology. New Central book agency

## **MZO-304B [Biological Effects of Ionizing Radiation]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **Unit I**

#### **Effects of radiation at the molecular and the cellular level**

##### **Basic radiation chemistry**

Breakage of chemical bonds by excitation ionization; biologically important elements; direct and indirect effects of radiation: generation of free radicals, interaction with DNA; interaction with proteins and lipids DNA repair

#### **Effects of radiation on cells**

; point mutations, chromosome breaks, mitosis; mitotic dysfunction, cell death; consequences of cell death; consequences of cell damage, DNA repair; cell sensitivity; radiosensitizers and protectors; chromosome aberrations as biological indicator of dose

### **Unit II Deterministic**

#### **effects**

##### **Effects of whole body irradiation**

General dose-response curve; threshold; severity; acute radiation syndrome; haematopoietic system; gastrointestinal tract; central nervous system

##### **Effects of partial body irradiation**

Skin (erythema, ulceration, effect of radiation type and radiation quality); thyroid, lung, eye lens; gonads; threshold doses; effect of fractionation and dose rate; case histories (accidental exposures)

### **UNIT III**

#### **Stochastic somatic effects**

##### **Stochastic effects**

Cancer induction and development; sources of data: atomic bomb survivors, dial painters, medical exposures, miners, animal data

Dose-response relationship; absolute and relative risk models; dose and dose rate effectiveness factors; ICRP risk factors, fatal and non-fatal cancers

## **Stochastic hereditary effects**

Stochastic effects

Elementary genetics; natural mutations; production of gametes and damage to chromosomes (examples); gene mutations; sources of data: man and animals; concept of doubling dose; UNSCEAR and ICRP approach; ICRP risk assumptions: subsequent generations and severity

## **Unit IV**

### **Effects on the embryo and foetus**

Radiation effects

Sensitivity at different stages of development; brain development and retardation; induction of leukaemia and cancers

## **Epidemiological studies and issues**

Epidemiological studies

Statistical requirements, current types of studies; association and confounding factors, power and precision; prospects and pitfalls

## **SUGGESTED READING:**

- Andrews, H.L.: Radiation Biophysics. Prentice-Hall Engel-Wood Cliffs. New Jersey. 1974 or Later Edition.
- Avena, V : Ionizing Radiation and Life.. Mosby, S1. Lonis. 1971 or Later Edition.
- Baverstock, K. of Staltar, J. Low Dose Radiation Biological Bases of Risk Assessment. Taylor of Francis, 1989.
- Broil. AB Low level Radiation Effects. A fact Book : Society of Nuclear Medicine, USA, 1982.
- Bulokav EB. ,V Naiitel and J.B. Reitan.: Radiobiological Consequences of Nuclear Accidents-Contamination Radioecology, Radiobiology and Health.
- Chase, GD. and Robinowitz, J.L. Radioisotope Methodology. Burgess Publishing Co. Minneapolis, Minn, USA. 3<sup>rd</sup> Edition, 1967 or Later.
- Coggle. J.E. : Biological Effects of Radiation. Taylor and francis Ltd., London, 1988 or Later Edition.
- Dalrymple, G.V, Ganldev, M.E., Kollmorgen, G.M. and Vogel, H.J.. Medical Radiation Biology. Saunders. Philadelphia, 1973 or Later Edition.
- Duncan, R.C., Knapp., R.G., and Miller III, M.C., : Introductory Biostatistics for the Health Sciences. John Wiley and Sons. Inc., New York, 1977 or Later Editon.
- Fobrikant. J.I. : Radiobiology. Year book med., Chicago, 1972 or Later Edition.
- G.B. gendes, H. Metives and J. Stathes. : Biological Assessment of occu pational Exposure to Actinides. Nuclear Tech. Pub. Kent, 1989.
- Gesben, G. , C.M. Menaene and H. Smilts.: Environment and Human Risks of Tritium. Nuclear Tech. Pub. Kent, 1986.

## **MZO-304C [Insect Morphology, Physiology, Embryology and Development]**

**Duration: 3 hrs**

**Max. Marks:70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT-I**

General organization of insect body,

- Integument
- Head: sutures and area of cranium, tentorium, Gnathal appendages.
- Thorax: Legs and their modifications, wings and wing coupling.

### **UNIT-II**

Digestive system

- Alimentary canal and its modifications
- Physiology of digestion.

Physiology of circulatory system

Excretory system and its modifications

Respiratory system and its modifications, adaptations for aquatic respiration.

### **UNIT-III**

Nervous system and its modifications.

- Morphology and physiology of neuroendocrine system.
- Sense organs: Mechanoreceptors, Chemoreceptor.
- Auditory organs, light producing organ, sound producing organ, visual organ (Compound eye and ocelli).

Muscular system and distribution of muscles.

### **UNIT-IV**

Reproductive system. Morphology and physiology of male and female, reproductive system, its associated ducts and glands and external genitalia.

Embryology: - Structure of egg, embryonic and post embryonic development, Types of larvae, pupae and metamorphosis.

## **SUGGESTED READING:**

1. The Insect: Structure and function by R.F. Chapman
2. Comparative Insect physiology, Biochemistry and Pharmacology .Vol :1-13.  
Edited by G.A. Kerkut and L.I. Gilbert.
3. Entomophagous Insect by Clausen
4. Entomology bu Gilbert
5. Principles of Insect Physiology by Wigglesworth.
6. Fundamentals of Entomology by Elzinga
7. Hand book of economic Entomology for South India by Ayyar.
8. Insect cytogenetics by R.E.F.Symposium.
9. Insects and plants by Sting, Lawton and southwood.
10. Insect and hygiene by Busvine.
11. Insect Physiology by Wigglesworth.
12. Insect morphology by Mat Calf and Flint
13. Applied Agricultural Entomology by Dr. Lalit Kumar Jha

## **MZO304D [Proteomics]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT I**

#### **RNA and Transcription**

- Types and structural features (mRNA, tRNA and rRNA)
- Prokaryotic transcription
- Eukaryotic transcription
- Regulatory elements and mechanism of transcription regulation
- Transcription termination – attenuation and antitermination
- Drugs inhibiting transcription

### **UNIT II**

#### **Post-transcriptional modification in RNA**

- 5'- Cap formation
- End processing and polyadenylation
- Splicing and editing
- Nuclear export of mRNA
- RNA stability
- Inhibitors of RNA synthesis

## UNIT III

### Translation

- Genetic code
- Prokaryotic and eukaryotic translation
- Regulation of translation
- Inhibitors of protein synthesis
- Post translational modifications

## UNIT IV

### Protein Sorting and Transport: The endoplasmic reticulum

- The Endoplasmic Reticulum and Protein Secretion
- Targeting Proteins to the Endoplasmic Reticulum
- Insertion of Proteins into the ER Membrane
- Protein Folding and Processing in the ER
- Quality Control in the ER
- The Smooth ER and Lipid Synthesis
- Export of Proteins and Lipids from the ER

Bioinformatics: Definition, Scope, Basic concepts in bioinformatics, importance and role of bioinformatics in life sciences , Bioinformatics databases- introduction, types of databases

Nucleotide sequence databases, Elementary idea of protein databases BLASTA, FASTA, PHYLOGENY TREE Analysis

### ESSENTIAL READINGS:

1. Molecular Biology of the gene; Watson J.D.; Benzamin/ Cummings.
2. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson, Garland publishing. Inc., New York, 1994.
3. Molecular Cell biology (2nd Edition) J. Darnell, H. Lodish and D.Baltimore, Scientific American Books,USA,1994.
4. Cell & Molecular Biology, (8th edition), E D P Roberties & E M F Roberties, Lippincott Williams & Wilkins, 2005
5. The cell, (5th edition), R C Swanson and P C Webster , Prentice hall of India Pvt. Ltd., 1990
6. Cell and Molecular Biology, (3rd edition), P Sheeler and D E Bianchi, John Wiley & Sons, Inc, 1987
7. Cell and Molecular Biology: Concepts and Experiments, (4th edition), G Karp, John Wiley & sons, Inc., 2005

8. The cell. A Molecular Approach, (4th edition), G H Cooper and R E Hausman, ASM Press, 2007
9. Gene VII, Indian eds. Lewin, B. Oxford university press, Bombay

## **Practicals of Special papers**

### **Toxicology**

1. Determination of alkalinity and acidity of soil and water
2. Determination of dissolved oxygen in water
3. Determination of chloride in water
4. pH estimation of water
5. Estimation of nitrogen and phosphorus in water sample
6. Determination of Total Dissolved Solids in Waste Water Sample
7. Determination of Chemical Oxygen Demand in Waste Water Sample
8. Analysis of Total Hardness of Waste Water Sample
9. Analysis of Waste Water/Sludge for Heavy Metals
10. Determination of LC /LD 50 Assay
11. Case Study

### **Radiation Biology**

1. Knowledge and use of the various instruments. Geiger-Muller counter, Scintillation counters, Survey meter, Single-channel gamma spectrometer, Cobalt camera.
2. Finding out the operating voltage of the G-M tube.
3. Calculation of Inverse Square Law
4. Determination of the resolving time of the G-M tube.
5. Absorption of beta and gamma rays
6. Determination of Backscattering factors
7. Histopathological, histochemical and biochemical studies of various tissues after external irradiation.

### **Entomology**

#### **Anatomy**

- Cockroach – Endocrine complex, Nervous System, Alimentary Canal
- Grass hopper - Nervous System, Reproductive System, Alimentary Canal
- White grub- Nervous System

### **Permanent mounting**

#### **Mouth Parts**

- Biting & Chewing (Cockroach)
- Piercing & sucking – (Mosquito)
- Siphoning – (Butterfly)
- Tympanum & Spiracle (Grasshopper)

- Antennae, wings and legs of Mosquito, butterfly, grasshopper, cockroach
- Whole mounts of insects (Lice, ants, termite, bedbug, mosquito etc.)

### **Insect rearing**

- Tribolium
- Rhizopertha
- Heliothis armigera
- Corcyra
- Callosobruchus sps

### **Study of prepared slides**

- Whole mount of insects
- Legs
- Mouth Parts
- Wings
- Histology of insect
- Antennae

### **Study of selected insects**

- Study of selected insects as museum specimens.
- Identification of selected insect and their identification with the help of taxonomic key

### **Microtomy**

**Field trips for insect's collection and preservation (eggs, larva, pupae & adult)**

### **Spotting**

- Insect specimen with Morphological adaptation
- Whole mount insects slide
- Histology slide
- Specialized body parts

### **Cell & molecular biology**

Operation of microscope:

- Experiments on phase contrast
- Use of fluorescence microscope: Detection of nucleic acid by acridine orange/ ethidium bromide.

1. Techniques:

- Separation of protein by Agarose gel electrophoresis
- Separation of DNA by Agarose gel electrophoresis
- Separation of proteins and on SDS-PAGE and
- Commet assay
- DNA Ladder assay
- Restriction digestion assay
- Westurn blotting
- Experiment on PCR

2. Chromosomal Techniques:

- Preparation of salivary gland chromosome from Drosophila/Chironomous larva and stain with acetocarmine/acteo-orcein/fulgen
- Preparation of mammalian chromosome from bone marrow or testis and stain with Giemsa stain

3. Preparation of biological tissues and sectioning

- Paraffin wax histology by microtome
- Fresh- frozen by cryostate

4. Retrieval of protein of interest , analysis and homology using BLAST FASTA, Use of various protein biological databases like EMBL swissport etc.

## SEMESTER IV

### MZO-401 [Applied Zoology & Biostatistics]

**Duration: 3 hrs.**

**Max Marks 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### UNIT I

- Economic importance of Protozoa: Beneficial and Harmful protozoa
- Economic importance of Helminthes: Beneficial and harmful Helminthes
- Economic importance of Arthropods: Beneficial and Harmful mites and ticks, crustaceous, spiders, insects.
- Insects a pollinators, ornamental insects, as food.
- Lac insect, Honey bees, Silk worm and industries related to them.
- Harmful insects:- insect pest: crop pest, storage pests, pests of fruit and vegetables, pest of medical and veterinary importance and their management.

#### UNIT II

- Pisciculture and products of fishing industry
- Prawn fisheries.
- Economic importance of mollusca: Pearl culture.
- Poultry keeping and Duck poultry.
- Dairy farming and Piggery.
- Leather industry, wool industry, (Fur and Fur Industry).

### **UNIT III**

#### Introduction to Biostatistics

- Definitions of biostatistics
- Statistical symbols
- Scope & Applications of biostatistics
- Collection, organization and representation of data

#### Measures of Variability

Mean deviation

Standard deviation

Variance and coefficient of variation

#### Correlation and Regression

- Types of correlation
- Methods of studying correlation
- Regression analysis
- Uses of regression analysis

### **UNIT IV**

#### Tests of Significance

- Significance of difference in means
- Standard error of mean
- Student's t-test
- F-test

#### Chi-square test

- Testing goodness of Fit
- Chi-square distribution and characteristics
- Applications of Chi-square test
- Yate's correction

#### Analysis of Variance

- One-way classification
- Two-way classification

### **SUGGESTED READING:**

1. Manning An introduction to behaviour Edward. Arnold.London
2. Animal behaviour,R.A. Publication McGraw Hill Co.New York.
3. Animal Societies and Evolution : Scientific American Publications
4. Animal behaviour : Mac Farland D. Publications.ELBS
5. Animal behaviour :Werlace, R.A. Publ. Goodyear Publishin Co lne.

6. Grizimek'sencyclopaedia of Ethology.
7. Hand book of Ehological method Laharen.Publ.Garland STPM Press
8. Animal behaviour- ReenaMathur, Rastogi Publications Meerut
9. Biostatistics: A Foundation for Analysis in Health Sciences, (6th edition), W W Daniel, John Wiley and Sons Inc., 1995.
10. Statistical Methods in Biology, N T J Bailey, Cambridge University Press, 1995.
11. Statistics for Biologist, R C Campbell, Cambridge University Press, 1989.
12. Fundamentals of Biostatistics, Khan, Publishing Corporation, 1999
13. Practical statistics for Experimental Biologists, A C Swardlaw, John Wiley and sons Inc., 1985

## **MZO-402[Tools & Techniques in Biology]**

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT I**

Principle and application of :-

- Light microscopy and micrometry
- Phase contrast microscopy
- Interference microscopy
- Polarized microscopy
- Fluorescence microscopy
- Confocal scanning microscopy
- Electron Microscopy
  - Transmission electron microscopy
  - Scanning electron microscopy
- Confocal microscopy

### **UNIT II:**

Principle and application of :-

- Ultracentrifugation :Differential and density gradient
- Electrophoresis: Agarose,PAGE, isoelectro-focussing points and capillary electrophoresis
- Chromatography:Paper,TLC,GLC,HPLC,ion-exchange and affinity chromatography
- Freeze techniques:Freeze –drying,Freeze substitution,Freeze fracture and freeze itching
- X-ray diffraction
- Lamberts – Beer’s Law and Colorimetry,
- Spectrophotometry:fluorescence,UV,NMR,, ESR, ORD,CD, Atomic absorption
- Flow Cytometry/fluorescence activated cell sorter

### **UNIT III:**

Principle and application of radiation techniques in biology

- Radiation Dosimetry
- Radioisotopes and half life of isotopes
- Tracer techniques in biology
- Auotoradiography
- Cerenkov Radiation
- Geiger Muller counter
- Scintillation Counter

### **UNIT IV**

Principles and technique of:-

- Nucleic acid hybridization and cot curves
- Sequencing of nucleic acids
- Blotting techniques(southern, northern and western)
- Polymerase chain reaction
- Screening of genomic and complementary DNA libraries
- Hybridoma technology
- Embryo sexing
- Assisted reproductive technologies
- Cell culture techniques:-culture media, primary and secondary culture,cell line,transformation,techniques (in brief)Cell proliferation measurements, Cell viability test

### **SUGGESTED READING:**

1. Cell and Molecular Biology, (3rd edition), P Sheeler and D E Bianchi, John Wiley & Sons, Inc, 1987
2. Cell and Molecular Biology: Concepts and Experiments, (4th edition), G Karp, John Wiley & sons, Inc., 2005.
3. Introduction to Instrumental analysis; Robert Braun:, Mc –Graw hill,
4. Essentials of Biophysics, P Narayanan, New Age Int. Pub. New Delhi. 2000
5. Fundamental Laboratory Approaches for Biochemistry and Biotechnology, A J Ninfa., D P Ballou, Fitzgerald science press, Inc., 1998
6. Principles and Practice of Bioanalysis, R F Venn, Taylor and Francis, 2003
7. Principles and Techniques of Biochemistry and Molecular Biology ,(6th edition), K Wilson and J Walker (editor), Cambridge University Press, 2007
8. Bioinstrumentation, J G Webster, John Wiley & Sons Inc. 2004
9. Methods in Modern Biophysics, B Notting, Springer Verlag Berlin Heidelberg New York, 2003
10. Protein Purification Principles and Practice, (3rd edition), R K Scopes, Spring International, 2004
11. Spectroscopy for the Biological Sciences, G G Hames, John Wiley & Sons Inc. 2005

## **PRACTICALS**

### **Paper I [Applied Zoology & Biostatistics]**

#### **Applied Zoology**

- General introduction to stains, preservations and fixatives.
- Museum specimens
  - Protozoa- Selected species of economic importance
  - Plathelminthes- Selected species of economic impotence
  - Arthropoda- Mites, Ticks, Spiders, Insects
- Permanent preparations- Whole mounts, various body parts/Appendages
- Visit to fish industry/Poultry farm/ Dairy/ Leather industry etc.

#### **Biostatistics**

Preparation of frequency tables, histograms, frequency curves, ogives and pie diagrams.

- Calculation of standard deviation and coefficient of variation.

- Estimation of significance between samples using Student's t-test, F-test and Chi-square test.
- Plotting of regression lines, calculation of correlation and regression analysis .
- Analysis of variance (One-way & Two –way classification).

## **Paper II [Tools & Techniques in Biology]**

1. Microscopy – Light microscopy: principles, parts & function
2. Micrometry- principle and measurement of microscopic objects: Low power and high power.
3. Camera Lucida drawing with magnification and scale
4. Principle and working of phase contrast microscope
5. Principle & operation of Centrifuge
6. Study of principle of Chromatography and separation of amino acids mixture By ascending Paper
7. Chromatography
8. TLC separation of Amino acids from purified samples and biological materials
9. Principle & operation of Colorimeter
10. Principle & operation of Spectrophotometer
11. Chromosome banding, FISH, chromosome painting
12. SDS PAGE/ Agarose Gel Electrophoresis
13. Visit to tissue culture lab

## **Core Elective III**

### **MZO-403 A [Applied Aspects of Toxicology]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT I**

#### **Food Toxicology**

- Nature and complexicity of food
- Safety standards for food, food ingredients and contaminants
- (Food, drug & cosmetics Act, food and colour additives, GRAS (generally recognized as safe)
- Tolerance setting for substances in food (Pesticide residues, drugs used in food producing animals, unavoidable contaminants (heavy metals, chlorinated organics, Nitrosamine, food-borne molds & mycotoxins)
- Microbiologic Agents Substances produced by cooking

### **Unit II**

#### **Forensic / Analytic Toxicology**

- Analytical role in general toxicology
- Analytical role in Forensic Toxicology
- Toxicological investigation of a poison death
- Criminal poisoning of the living

### **UNIT III**

#### **Occupational Toxicology**

- Workplace, exposures, and standards (Nature of the work force, Determinants of dose occupational exposure limits)
- Occupational diseases (Silicosis, Asbestosis, Psittacosis, Fluorosis & Others)
- Toxicological Evaluation of Occupational agents

### **UNIT IV**

#### **Regulatory Toxicology**

- Programs for regulating chemical hazards (Food & Drug Administration, EPA, Occupational Safety and Health Administrations)
- Regulatory Control over Toxicity
- Animal Welfare Requirement
- Wild Life Toxicology

#### **Risk Assessment**

- Hazard Identifications (Assessing Toxicity of Chemicals)
- Risk Characterization
- Risk Perception & comparative Analysis of Risk
- Environmental Impact Assessment

### **SUGGESTED READING:**

1. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
2. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
3. Casserett and Doull's Toxicology: The basic source of Poisons. (VI Edition)
4. Gleick, H.P. 1993. Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press.
5. Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment
6. Smith, Keith (1996) Environmental Hazards- Assessing risk and reducing disaster, 2nd Edition, London & New York.
7. Wisnr B., Adams, J. (Ed.) (2002) WHO Environmental Health in Emergencies and Disaster- A practical guide, World Health Organisations.
8. Conner, David (1994) Managing the environment with rapid Industrialisation- Lessons from the East Asian Experience, OECD, Paris.
9. Khanna, GopeshNath (1990) Environment Problems and the United Nations, Ashish Publishing House, New Delhi.
10. Sharma P.D., Environmental Biology and Toxicology, Meerut: Rastogi Publications
11. Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment
12. Sharma, B.K. Environmental Chemistry. Meerut publication
13. Pandey, Shukla, Trivedi, Fundamentals of Toxicology. New Central book agency

## **MZO-403 B [Principles of Radiation Protection, Legislation & International Framework]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT-I**

#### **Conceptual framework**

- The ICRP (International Commission on Radiological Protection) Basic Framework (types of exposure, control of radiation sources); brief review of quantities, including collective dose
- The System of Radiological Protection in proposed and continuing practices:
- Justification of a practice; optimization of protection with examples; individual dose limits
- Potential exposures; dose and risk constraints
- System of protection for intervention
- Assessment of the effectiveness of the system of protection

### **UNIT II**

#### **Radiation protection programme**

Prior radiological evaluation and safety assessment; scope and structure of the radiation protection programme; responsibility and commitment of registrant, licensees and employers; responsibility of workers and others at the workplace; radiation protection organization; special administrative arrangements; infrastructure; role of the radiation protection officer; role of the qualified expert; lines of communication (internal, between employers, with regulatory authority); safety culture; quality assurance; emergency preparedness

#### **The role of international organizations in radiation protection**

- International Atomic Energy Agency (IAEA): Statutory functions; establishment and implementation of safety standards, legally binding instruments: Conventions
- International Commission on Radiological Protection (ICRP)
- International Commission on Radiation Units and Measurements (ICRU)
- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
- International Labour Organisation (ILO)
- World Health Organization (WHO)
- Food and Agriculture Organization of the United Nations (FAO)
- OECD Nuclear Energy Agency (OECD/NEA)
- Pan American Health Organization (PAHO)

### **UNIT III**

## **The development of safety and regulatory aspects**

- Safety and regulatory of staff at all levels
- Priority to safety : policies, procedures; responsibilities; the lines of authority for making decisions; organizational arrangements; communication lines
- Safety indicators and case studies

### **UNIT IV**

- Legislation - Radiation Safety Act 1975 –
- Radiation Safety (General) Regulations 1983
- Hazardous Waste Management and Handling Rules / Biomedical Rules / Solid Waste Management Rules
- Atomic Energy Act (AEA) 1962 and rules,
- Guidelines of nuclear diagnostic

### **SUGGESTED READING:**

Granien, R., Applied Radiobiology of Radiation Protection. Prentice Hall, 1990.

• Grosel, D.S. and Hop Zvood, L.E. Biological Effects of Radiations. Academic Press, New York, 2nd Edition, 1979 or Later Edition.

• Hall. E.1. Radiobiology for the Radiologist. 3d Edition, Harper and Row, 1990 or Later edition.

• Hall. E.1.: Radiation and Life. Pergamon Press, Oxford, U.K. 2<sup>nd</sup> Edition, 1987.

• Hendec. w.R.: Health Effects of Low Level Radiation. Prentice Hall. 1984.

• Huilgol. N.G. et al.: Low level Radiation and Living State. Naraza Publishing House, Community Center Panchsheel Park, New Delhi, 1993.

• Kiefer J. Biological Radiation effects. Springer-Venlag, Berlin, 1989.

• Kriegel, H. ef of. Developmental Effects of Prenatal Irradiation. VCH, . 1982.

• Lawrence c.w. Cellular Radiobiology. Arnold, London, 1971 or Later Edition.

Pant, G.S. and Basu, AK. Biological Aspects of Human Irradiation Eds. Himalaya Publishing House, Delhi, 1992.

• Pizzarello D. J. and Witcofsli Lea R.L. and Febiger: Basic Radiation Biology. Philadelphia, 1970 or Later.

• Prasad, K.N., Human Radiation Biology. CRC Press, inc. Cleveland, Ohio, USA, 1984.

• Rajan O. Advanced Medical Radiation Dosimetry. Prentice-Hall of India Pyt. Ltd., New Delhi, 1992.

• Riklin, E. ed. Frontiers of Radiation Biology. VCH, 1990.

• Scheres, E. ,c. Streffer, K.R. Trott.: Radiation Exposure and Occupational Risks Eds. Berlin, 1990.

• Seiwan J. Elements of Radiobiology, Thomas, C.C. 1983.

• Steve Forshie: Essentials of Radiation Biology and Protection, Publisher: Delmar Cengage Learning.

• Upton, A.C. Radiation Carcinogenesis. Ehseviees, 1986.

## **MZO403 C [Industrial, Medical & Veterinary Entomology]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT-I**

#### **Industrial Entomology**

Types and life history of honey bees used in Apiculture.

- Bee keeping Management & prospects.

Life history and cropping of lac insect

- Lac – Utility and scope of lac industry.

Types of silk worm, life history and rearing of silk worms

- Silk worm pathology & insect Pest management
- Mulberry and Non mulberry Silk production.

### **UNIT-II**

#### **Medical Entomology**

- Study of following insects as vectors of human diseases regarding their classification up to family, appearance, habit, brief life history, distribution, diseases caused and control measures :- Mosquito(Anopheles & aedes) , flea, housefly.

### **UNIT-III**

#### **Forensic Entomology**

- Forensic entomology with special reference to man and wild life.
- Beneficial insects (silk worm, honey bee, lac insect and industries related to them).

### **UNIT-IV**

#### **Veterinary Entomology**

- Study of following insects as pests of domestic animals with general reference of their classification up to family, habit, brief life history, damage, diseases caused and control measures :- Horse fly, cattle blood sucking fly, Flesh fly, Poultry louse .

### **SUGGESTED READING:**

1. A text book of Applied Entomology, vol.2 - K. P. Srivastava, 1996.

2. Elements of Entomology- Rajendra singh.
3. A text book of Forest Entomology – T.V. Sathe, 2009.
4. Sericulture and Pest Management – T.V. Sathe and A.D. Jadhav, 2001.
5. Sericultural crop protection – T.V Sathe, 1998.
6. Agricultural Pests of India and South East Asia – A.S. Atwal, 1993.
7. Crickets and Household pests – T.V. Sathe and M.R. Awate, 2009.
8. Beekeeping in the tropics – G.S. Smit, 1960.

9. Beekeeping in India, ICAR, New Delhi, S. Singh, 1975.
10. A handbook of practical Sericulture, CSB, Ullal and Narsimhanna, 1981.
11. Lac culture in India farm information unit, DEMOFA, New Delhi, S. Krishnaswami,
12. A text book of applied entomology- K. P. Srivastava.
13. Elements of entomology- Rajendra singh

### **MZO 403D [Cellular mechanics]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT I**

#### **Cell Death and Cell Renewal**

- Programmed Cell Death
- The Events of Apoptosis
- Caspases: The Executioners of Apoptosis
- Central Regulators of Apoptosis: The & I-2 Family
- Signaling Pathways that Regulate Apoptosis

### **UNIT II**

#### **Cancer**

- Types of Cancer
- The Development of Cancer
- Causes of Cancer
- Properties of Cancer Cells
- Transformation of Cells in Culture

#### **Oncogenes**

- Retroviral Oncogenes
- Proto-Oncogenes
- Oncogenes in Human Cancer
- Tumor Suppressor Genes

### **UNIT III**

#### **Aging: The biology of senescence**

- Maximum life span and life expectancy
- Causes of aging
  - (a) General wear and tear and genetic instability
  - (b) Free radicals, oxidative damage and antioxidants
  - (c) Telomerase and aging

#### **UNIT IV**

##### **Stem Cells and the Maintenance of Adult Tissues**

- Proliferation of Differentiated Cells
- Stem Cells
- Medical Applications of Adult Stem Cells

##### **Embryonic Stem Cells and Therapeutic Cloning**

- Embryonic Stem Cells
- Somatic Cell Nuclear Transfer

#### **ESSENTIAL READINGS:**

1. Cell and Molecular Biology; De Robertis and De Robertis; Saunders College
2. Cell Biology; Powar, C.B.; Himalaya Publications.
3. Molecular Biology of the gene; Watson J.D; Benjamin/ Cummings
4. Molecular Biology of the Gene. I.D Watson, N.H. Hopkins, J.W. Roberts, J.A. Steiz and AM Weiner The Benjamin/Cummings Pub. Co., Inc., California.
5. Molecular Cell Biology, J. Darnell H.Lodish and D. Baltimore Scientific American Books, Inc., USA.
6. Molecular Biology of the cell. B.Alberts, D.D.Bray, J.Lewis, M.Rafif, K. Roberts and J.D.Watson. Garland Publishing inc., New York.
7. Gene IV, Benjamin Lewin. Oxford University Press, UK.
8. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A.Meyers (Ed.), VCH Publishers, Inc., New York.
9. Molecular Cloning: A Laboratory Manual, J.Sambrook, E.F.Fristsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
10. Introduction to Practical Molecular Biology, P.D.Dabre, John Wiley & Sons Ltd. New York.
11. Molecular Biology Lab Fax, T.A.Brown (Ed.), Bios Scientific Publishers Ltd., Oxford.

#### **Core Elective IV**

##### **MZO-404[Biomonitoring & Bioremediation]**

**Duration: 3 hrs.**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

## UNIT I

### **Biofertilizers, and Biopesticides & Bioindicators**

- Biofertilizers in Agrosystem
- Biopesticides
- Bioindicators
- Microbial and Antimicrobial pesticides
- Integrated Pest Management

### **Composting**

- Type substrate and process
- Decomposing stages and methods
- Vermi composting and its application

## UNIT II

### **Bio accumulation, Bio magnification**

Degradation of xenobiotic compounds

- Aliphatic compound
- Aromatic : benzene, toluene, naphthalene
- Pesticide : DDT, propanil, 2,4,D

Role of micro organism in Bio degradation

Genetically engineered micro organism in Bio degradation.

## UNIT – III

### **Biomonitoring**

Objectives of Biomonitoring

Bioindicators and Environmental monitoring

Bioassay and its applications in Toxicology

- Toxicology of Pesticides – (Types; Effects on Human Health).
- Toxicology of Heavy Metals - Arsenic, Cadmium, Lead and Mercury- (Sources and Emissions and Harmful effects on Human Health)
- Toxicology of Radioactive Substances – (Types and Biological Effects on animals – Somatic and Genetic effects).

## UNIT IV

### **Bioremediation**

- Microorganisms in Bioremediation and their role in bioremediation
- Bioremediation Processes and Technologies
- Monitoring the efficacy of bioremediation
- Bioremediation of Marine Oil pollutants and air pollutants

### **SUGGESTED READING:**

1. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
2. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
3. Casserett and Doull's Toxicology: The basic source of Poisons. (VI Edition)
4. Gleick, H.P. 1993. Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press.

5. Study Material (Handbooks) of Sikkim Manipal University for Science Health and Technology for the Degree of Post Graduation in Ecology and Environment
6. Smith, Keith (1996) Environmental Hazards- Assessing risk and reducing disaster, 2nd Edition, London & New York.
7. Wisnr B., Adams, J. (Ed.) (2002) WHO Environmental Health in Emergencies and Disaster- A practical guide, World Health Organisations.
8. Conner, David (1994) Managing the environment with rapid Industrialisation- Lessons from the East Asian Experience, OECD, Paris.
9. Khanna, GopeshNath (1990) Environment Problems and the United Nations, Ashish Publishing House, New Delhi.
10. Sharma P.D., Environmental Biology and Toxicology, Meerut: Rastogi Publications
11. Sharma, B.K. Environmental Chemistry. Meerut publication
12. Pandey, Shukla, Trivedi, Fundamentals of Toxicology. New Central book agency

### **MZO 404 B [Occupational Exposure and Radiation Safety]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

#### **UNIT I**

##### **Industrial radiography**

Overview of industrial radiography; types of exposure devices (gamma radiography sources and containers; X ray radiography equipment; pipe crawler equipment; real time radiography); radiation protection programme: protection of workers; protection of the public; emergency preparedness and response; lessons learned from accidental exposure in industrial radiography

##### **UNIT II Mining and processing of raw materials**

Basic requirements for safety; ventilation; exclusion and exemption; radiation protection programme; protection of the workers

#### **UNIT III**

### **Nucleonic gauges**

Overview of gauging devices; organizational responsibilities; basic requirements for safety; safety associated to the equipment; radiation protection programme; protection of the workers

### **Radioisotope production plants**

Overview of radioisotope production plants; organizational responsibilities; basic requirements for safety. Safety associated to the plant; specific regulatory requirements; radiation protection programme. Control of effluents; protection of workers

## **UNIT IV**

### **Diagnostic radiology & radiotherapy**

- Overview of diagnostic radiology; classification of the equipment: general and specialized radiology, basic requirements for safety; safety associated to the equipment (IEC standards); shielding; radiation protection programme; protection of the workers
- Overview of radiotherapy. Radiation sources and equipment used in brachytherapy and teletherapy, basic requirements for safety; safety requirements on radiation sources and equipment (IEC and ISO) for radiotherapy; radiation protection programme, protection of the workers
- Nuclear medicine: diagnostic applications (in vivo and in vitro)

### **SUGGESTED READING:**

- Granien, R., Applied Radiobiology of Radiation Protection. Prentice Hall, 1990.
- Grosel, D.S. and Hop Zvood, L.E. Biological Effects of Radiations. Academic Press, New York, 2nd Edition, 1979 or Later Edition.
  - Hall. E.1. Radiobiology for the Radiologist. 3d Edition, Harper and Row, 1990 or Later edition.
  - Hall. E.1.: Radiation and Life. Pergamon Press, Oxford, U.K. 2<sup>nd</sup> Edition, 1987.
  - Hendec. w.R.: Health Effects of Low Level Radiation. Prentice Hall. 1984.
  - Huilgol. N.G. et al.: Low level Radiation and Living State. Naraza Publishing House, Community Center Panchsheel Park, New Delhi, 1993.
  - Kiefer J. Biological Radiation effects. Springer-Venlag, Berlin, 1989.
  - Kriegel, H. ef of. Developmental Effects of Prenatal Irradiation. VCH, . 1982.
  - Lawrence c.w. Cellular Radiobiology. Arnold, London, 1971 or Later Edition.
- Pant, G.S. and Basu, AK. Biological Aspects of Human Irradiation Eds. Himalaya Publishing House, Delhi, 1992.
- Pizzarello D. J. and Witcofsli Lea R.L. and Febiger: Basic Radiation Biology. Philadelphia, 1970 or Later.
  - Prasad, K.N., Human Radiation Biology. CRC Press, inc. Cleveland, Ohio, USA, 1984.
  - Rajan O. Advanced Medical Radiation Dosimetry. Prentice-Hall of India Pvt. Ltd., New Delhi, 1992.
  - Riklin, E. ed. Frontiers of Radiation Biology. VCH, 1990.
  - Scheres, E. ,c. Streffer, K.R. Trott.: Radiation Exposure and Occupational Risks Eds. Berlin, 1990.
  - Seiwan J. Elements of Radiobiology, Thomas, C.C. 1983.
  - Steve Forshie: Essentials of Radiation Biology and Protection, Publisher: Delmar Cengage Learning.
  - Upton, A.C. Radiation Carcinogenesis. Ehseviees, 19

## **MZO-404 C [Insect Toxicology and Pest Control]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT-I**

Definition and history of various methods of insect pest control

- Physical
- Mechanical
- Chemical
- Cultural
- Quarantine regulations.

### **UNIT-II**

Nomenclature and classification of insecticides. Concept of

- Ist , IInd and IIIrd generation pesticides
- Pesticides act of India.
- Selection of insecticides, their formulation and mode of action.
- Preventive measures and antidotes.
- Fumigants and appliances used for application of insecticides.
- Mechanism of insecticides resistance in insects. Insecticide synergists and antagonist.

### **UNIT-III**

Biological control:

- Definition, biological control agents

Parasites :

- Parasitoids
- Predators
- Microbial pesticides
- Mass production and distribution
- Advantages and disadvantages of biological control.

### **UNIT-IV**

Integrated pest management (IPM)

- Definition, importance,
- Tools, basic principles
- Evolutionary trends.

Dynamics of environmental pollution.

Pesticides:

- Their impact on wild life
- Their impact on human health (bio accumulation, bio magnification, biodegradation)

### **SUGGESTED READING:**

1. A text book of Applied Entomology, vol.2 - K. P. Srivastava, 1996.
2. Elements of Entomology- Rajendra singh.
3. A text book of Forest Entomology – T.V. Sathe, 2009.
4. Sericulture and Pest Management – T.V. Sathe and A.D. Jadhav, 2001.
5. Sericultural crop protection – T.V Sathe, 1998.
6. Agricultural Pests of India and South East Asia – A.S. Atwal, 1993.
7. Crickets and Household pests – T.V. Sathe and M.R. Awate, 2009.
8. Beekeeping in the tropics – G.S. Smit, 1960.
9. Beekeeping in India, ICAR, New Delhi, S. Singh, 1975.
10. A handbook of practical Sericulture, CSB, Ullal and Narsimhanna, 1981.
11. Lac culture in India farm information unit, DEMOFA, New Delhi, S. Krishnaswami,
12. A text book of applied entomology- K. P. Srivastava.
13. Elements of entomology- Rajendra singh

### **MZO 404D [Molecular Immunology]**

**Duration: 3 hrs**

**Max. Marks: 70**

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry Two mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

### **UNIT I: MOLECULAR IMMUNOLOGY**

1. Discovery of humoral and cellular immunity.
2. Innate (nonspecific) immunity.
3. Adaptive (specific) Immunity.
4. Cells and organs of immune system.
5. Hematopoiesis.
6. B-lymphocytes, T-lymphocytes, Null cells.
7. Mononuclear cells
8. Granulocytic cells
9. Mast Cells.
10. Dendritic cells.

### **ORGANS OF IMMUNE SYSTEM.**

11. Primary lymphoid organs
12. Lymphatic system.
13. Secondary lymphoid organs

### **UNIT II: ANTIGENS IMMUNOGEN**

1. Immunogenicity versus antigenicity.
2. Factors that influence immunogenicity
3. Contribution of the immunogens (foreignness, molecular size, chemical composition and heterogeneity, susceptibility to antigen processing and presentation).

Contribution of Biological system. Genotype of the recipient animal, immunogen dosage and route of administration, adjuvants).

4. Epitopes
5. Haptans.

### **IMMUNOGLOBULINS: STRUCTURE AND FUNCTION.**

1. Molecular structure of Ig, Light chain and Heavy chain
2. Immunoglobulin domains.
3. Immunoglobulin classes
4. Immunoglobulin-mediated effector functions (Opsonization, activation of complement, antibody dependent cell mediated cytotoxicity).
5. Antigenic determinants on immunoglobulin (isotype, allotype and idiotype).
6. Monoclonal antibodies.

### **UNIT III: ANTIGEN-ANTIBODY INTERACTION.**

1. Major Histocompatibility complex.
2. General organization and inheritance of MHC.
3. MHC molecules and genes.
4. Genomic maps of MHC genes.
5. Cellular distribution of MHC molecules.
6. Regulation of MHC expression.
7. MHC and immune responsiveness.
8. MHC and disease susceptibility.

### **UNIT IV: ANTIGEN PROCESSING AND PRESENTATION.**

1. Role of antigen presenting cell.
2. Evidence for two processing and presentation pathways.
3. Endogenous antigens: The cytosolic pathways.
4. Exogenous antigens: The endocytic pathway.
5. Presentation of nonpeptide bacterial antigens.
6. Cytokines
7. Properties of cytokines.
8. General structure of cytokines.
9. Functions of cytokines.
10. Cytokine related diseases.  
Immune system in Health and Disease.
11. Immune response to infectious disease.

- i. Viral infections.
- ii. Bacterial infections.
- iii. Protozoa and diseases.
- iv. Diseases caused by helminthes.

**ESSENTIAL READINGS:**

1. De Robertis E.D.P. and De Robertis Jr, E.M.F., Cell and Molecular Biology. K. M. Varghese Cop. Bombay, 1998.
2. Adams R.L.P. Knowler J.T. and Leader D.P. The Biochemistry of the Nucleic Acids. Chapman and Hall, London, 1986
3. Walker J.M. and Gingold E.B. Molecular Biology and Biotechnology Parima Educational Book Agency, New Delhi, 1992.
4. Alhberts B, Bray D, LewioJ, RaffM, Roberts K and Watson J.D. Molecular Biology of the Cell. Garland Publishing, Inc. New York, 1994.
5. Glick B. R. and Pasternak 1.1. Molecular Biotechnology Principles and Applications of Recombinant liDNA. ASM Press, Washington, 1998.
6. Bolrover S.R. Hyams J.S., Jones S. Shephard E.A. and White H.A. From genes to cells. Wiley-liss, New York, 1997.
7. Winnacker E.L. From genes to clones Introduction to gene technology Panima Education BookAgency, New Delhi. æ VCH Publishers, New York, 1987.
8. Gerbare J. and Kirschner M. Cells, Embryos and Evolution. Blackwell science, Inc. Massachusetts, 1997.
9. Giese A. C. Cell Physiology, WB. Saunders Co., Philadelphia, 1979
10. Freifelder D. Molecular Biology, Naroja Publishing House, New Delhi, 1997.
11. Frierg E.C., Walker G.C. and Siede, W DNA Repair and Mutagen- esis. ASM Press Waddington DC, 1995.
12. Karp G. Cell and Molecular Biology. Concepts and experiments. John Wiley and sons. Inc. New York, 1999
13. Malacinski G.M. and Freifelder D. Essentials of Molecular Biology Jones and Bartlett Publishers Boston, 1999
14. Cooper, G .M. The cell A molecular approach. ASM Press, Washington DC, 2000.
15. Shelve P. and Blanch DEW, Cell and Molecular Biology. John Wile) and Sons Inc., New York, 1994.
16. Darnell, J.L. Lodish, H and Baltimore, D. Molecular Cell Biology, Scien tific American Books Inc. New York.
17. Watson, J.D., Hopkins, N.H. Roberts, J.W Steitz, J.A. and Weiner A.M. Molecular Biology of the Gene. The Benjamin/Cumings Pub. Co. Inc. California
18. Gardner, E.J. Simons, MJ. and Snustad, D.P. Principles of Genetics. John Wiley .& Sons Inc. New York
19. Voet, D. and Voet, J.G. Biochemistry, John Wiley & Sons Inc New York.

20. Zubay, G.L. Parson, WW and Vance, D.E. Principles of Biochemistry. Wm.C. Brown Publishers, Oxford, England.
21. Goldsby, RA.. Kindt, T.J. and Osborne, B.A. Kuby Immunology, WH Free- I man & Co. New York.
22. Abbas. AK Lichtman, AR. and Pahes, J.S. Molecular Immunology, WB Saunders & Co, London
23. Cruse. J.M. and Lewis, RE. Atlas of Immunology, CRC Press,New York.
24. Talwar, G.P. and Gupta. S.K A HandbookofPractical and Clinical Immuno logy. Vall & II. Vikas Publishing House Pvt. Ltd. NewDelhi.
25. Dabre, D.D. Introduction to Practical Molecular Biology, John Wiley & Sons Inc; New York.
26. Micklos D.A. and Freyer G. A. DNA science A first course in recombinantDNA Techanology. Carolina Biological supply compo and Cold Spring Harbour Lahovatoy Press, Burhington , North corolina, 1990.
27. Lucent Micklos D.A. and Freyer G. A. DNA science A first course in recombinantDNA Techanology. Carolina Biological supply compo and Cold Spring Harbour Lahovatoy Press, Burhington , North corolina, 1990B. Genes VII. Oxford University Press, Oxford, 2000.
28. Old R. W. and Primrose S. B. Principles of Gene Manipulation An introduction to genetic engineering. Blackwell Scientific Pub li- cation. London, 1989.
29. Twyman R. M. and Wisden W. Advanced Molecular Biology A Concise Reference Viva Books Pvt. Ltd. New Delhi: 1999
30. Gasque, C. E. A. Manual of laboratory experiences in Cell Biology Uni versal Book Stall New Delhi.
31. Meyers R.A. Molecular Biology and Biotechnology A comprehen- sive desk Reference. VCH Publishers, Inc. New York, 1995
32. Lodish H, BerkA, Zipurjky S. L., Matsudaira P, Baltimore D. and Darnell 3. Molecular Cell Biology W.H. freeman and company New York, 2000

## **PRACTICALS**

### **TOXICOLOGY**

1. Estimation of Non-Respirable Dust in Air by using Dust Sampler
2. Estimation of Respirable Dust in Air by using Dust Sampler
3. Microbial analysis in Water
4. Analysis of Adulteration in food samples
5. Bacteriological analysis of drinking water by MPN method
6. IMVIC Test
7. Microbial analysis in soil
8. Practical Training & dissertation
9. Visit to In situ or Ex situ Conservation Centre/ Social Service Organization/ Environmental Education Centre
10. Visit to Local Polluted Site -Observations and Remedial Measures

### **RADIATION BIOLOGY**

1. Personnel monitoring: use of survey meter, film badge, and room contamination monitor
2. Decontamination of contaminated material.
3. Radioresponse of tumors

4. Chemoprevention of chemical carcinogenesis
5. Morphological, histopathological, and biochemical studies of various cancerous tissues.
6. Study of Pre-cancerous and cancerous lesions of oral cancer , Breast cancer, Cervix cancer,prostate cancer etc.
7. Visits to the Radiotherapy Department, S.M.S. Medical College, Jaipur: Rajasthan Atomic Power Project. Kota and Bhabha Atomic Research Centre, Mumbai.
8. Class Record.
9. Viva

## **ENTOMOLOGY**

### **1. ANATOMY**

- Honey bee- Nervous system
- House fly-Nervous system
- Gryllus-Nervous system, Alimentary canal

### **2. PERMANENT PREPARATION**

- Sting apparatus, pollen basket, mouth parts, antennae, leg and wings of honeyBee.
- Sponging mouth parts, antennae, legs and wings of house fly
- Whole mounts thrips' and aphids

### **3. TESTING OF INSECTICIDE – BIOASSAY METHOD (LC50 AND LD 50 OF ANY ONE SYNTHETIC AND ONENATURAL INSECTICIDE IN STORED GRAIN PESTS)**

### **4. STUDY OF PREPARED SLIDES**

- Whole mount of insects
- Legs
- Mouth Parts
- Wings
- Histology of insect
- Antennae

### **5. APPLIANCES FOR APPLICATION OF INSECTICIDES**

- Knap sack sprayer
- Knap sack duster
- Hand sprayer

### **6. STUDY OF SELECTED INSECTS**

- Study of selected insects as museum specimens.
- Identification of selected insect and their identification with the help of taxonomic ke

### **7. EXERCISE IN PHYSIOLOGY**

- Analysis of honey and its quality control
- Analysis of chitin presence in the insect integument Study of pH of the gut in larvae of insects
- Application of Dyar,s law
- Study of giant chromosome

## **CELL & MOLECULAR BIOLOGY**

### **1. MICROTOMY:**

- Use of oculometer-standardization and measurement of cell height, nuclear diameter and tubular diameter
- Use of grid-standardization and counting of cells or nuclei in cross section of epithelium.

### **2. CYTOCHEMISTRY/HISTOCHEMISTRY:**

- Carbohydrate (a) PAS method (b) Alcian blue method
- Protein (a) Lorry's method (b) Ninhydrin method
- Nucleic acid (a) Feulgen method (b) Methyl green –Pyronin method
- Detection of enzymes (a) Alkaline phosphatase (b) Acid Phosphatase

### **3. PERMANENT SLIDES:**

- Histopathological changes in organs
- Mitosis
- Meiosis

