# Syllabus of Zoology

## For Master of Science

## Under Choice Based Credit System

**Academic Session**

**w.e.f. 2020-2022 onwards**

# BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY,

# DHANBAD, JHARKHAND

## Table of Contents

**Members of Board of Studies of CBCS Post-Graduate Syllabus as per Guidelines of the Binod Bihari Mahto Koyalanchal University, Dhanbad**

## COURSE STRUCTURE

### Semester Wise Examination/Course Structure for Science Faculty

| Semester | Paper Code (Credit, Lectures) | Paper Name | Full Marks | End Semester Marks | Mid Semester (Internal) Marks (Written 20 marks) + Day to Day assessment includes extracurricular activities (5 marks) + Attendance (5 marks) |
|---|---|---|---|---|---|
| I | ZOO-F-101 (5 Credits, 60 Lectures + 15 Tutorials ) | Foundation of Zoology | 100 | 70 | 30 |
| | ZOO-C-102 (5 Credits, 60 Lectures + 15 Tutorials ) | Core Animal Diversity (Non- Chordate & Chordate) | 100 | 70 | 30 |
| | ZOO-C-103 (5 Credits, 60 Lectures + 15 Tutorials ) | Core Endocrinology, Reproductive Biology & Developmental Biology | 100 | 70 | 30 |
| | ZOO-C/P-104 ( 5Credits, 75x2 Lectures) | Practical | 100 | 70 | 30 |
| II | ZOO-S-205 (5 Credits, 60 Lectures + 15 Tutorials ) | Skill development Course (SEC) Bioinformatics & Biostatistics | 100 | 70 | 30 |
| | ZOO-C-206 (5 Credits, 60 Lectures + 15 Tutorials ) | System Physiology & Biochemistry | 100 | 70 | 30 |
| | ZOO-C-207 (5 Credits, 60 Lectures + 15 Tutorials ) | Immunology & Microbiology | 100 | 70 | 30 |

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|---|---|---|---|---|---|
| | **ZOO-C/P-208 (5 Credits, 75x2 Lectures)** | **Practical** | **100** | **70** | **30** |
| **III** | **ZOO-A-309 (5 Credits, 60 Lectures + 15 Tutorials )** | **Open Elective Medical Zoology Human Disease** | **100** | **70** | **30** |
| | **ZOO-C-310 (5 Credits, 60 Lectures + 15 Tutorials )** | **Cell Biology & genetics** | **100** | **70** | **30** |
| | **ZOO-C-311 (5 Credits, 60 Lectures + 15 Tutorials )** | **Environmental Biology & Toxicology** | **100** | **70** | **30** |
| | **ZOO-C/P-312 (5 Credits, 75x2 Lectures)** | **Practical** | **100** | **70** | **30** |
| **IV** | **ZOO-E-413A/ ZOO-E-413B/ ZOO-E-413C (5 Credits, 60 Lectures + 15 Tutorials )** | **A.** Fish Diversity & Fish Biology<br>**B.** Molecular Biology<br>**C.** Insect Diversity and Insect Biology | **100** | **70** | **30** |
| | **ZOO-E-414A/ ZOO-E-414B/ ZOO-E-414C (5 Credits, 60 Lectures + 15 Tutorials )** | **A.** Applied Fish Biology<br>**B.** Advanced Molecular Biology<br>**C.** Agricultural Entomology | **100** | **70** | **30** |
| | **ZOO-E/P-415A/ ZOO-E/P-415B/ ZOO-E/P-415C (5 Credits, 75x2 Lectures)** | **Practical** | **100** | **70** | **30** |
| | **ZOO-D-416 (5 Credits, 150 Lectures)** | **Dissertation/ Project** | **100** | **70** | **30** |

| Attendance (in Percentage) | Marks |
|---|---|
| Attendance up to 75% | 1 Mark |
| Attendance From 75% - 80% | 2 Marks |
| Attendance From 80% - 85 % | 3 Marks |
| Attendance From 85% - 90% | 4 Marks |
| Attendance More than 90% | 5 Marks |

## Mid Semester/ Internal Assessment Examination 30 Marks

The Mid Semester/ Internal Assessment Examination shall have three Components

a) Two Semester Internal Assessment test (SIA) of 20 Marks each
b) Class Attendance Score of 5 Marks
c) Day to day and extracurricular activities of 5 Marks

Best of two applicable for computation of marks for SIA

**Semester Internal Assessment Test**

Written examination – 20 Marks

- In all six questions are to be set in Two Groups A & B and four questions are to be answered.
- Group A: Q No. 1 will be compulsory which will include MCQ type carrying one mark each (1x5=5).
- Group B: Rest five questions will be descriptive answer type are to be set and examinees are required to answer any three, each carrying Five marks (5x3=15).

**SEMESTER – I,**
**COMPULSORY FOUNDATION COURSE**
**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – F – 101 | Foundation of Zoology | F.M=100 (End Sem = 70 + Mid Sem = 30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A and B.**
- **Group A will be comprised of question no. 1 which will consist of two parts I & II. Part I will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part II will comprise short answer type questions. Each carries 4 marks (2x4=8). There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Animal Systematics and Histochemical Techniques<br>1.1. Importance and application of biosystematics in biology.<br>1.2. Chemotaxonomy, Cytotaxonomy, Molecular taxonomy<br>1.3. Species and Species concept.<br>1.4. Synthetic theory of Evolution | 08 |
| 2 | Fundamentals of Histochemistry<br>2.1 Histochemistry: Types of Histochemical stains and their principle<br>2.2 General protein localization by Mercury Bromophenol Blue<br>2.3 Proteins with – NH2 groups by Ninhydrin-Schiff reaction<br>2.4 General lipids by Sudan Black B method<br>2.5 DNA by Feulgen reaction<br>2.6 DNA and RNA by Methyl green-pyronin | 10 |
| 3 | . Histotechniques:<br>3.1 Fixation and tissue processing:<br>3.2 Types of Fixative<br>3.2.1 Fixative<br>3.2.2 Dehydration<br>3.2.3 Clearing<br>3.2.4 Embedding<br>3.3 Microtomy<br>3.4. Staining of Paraffin section<br>3.4.1. Principle and method of staining<br>3.4.2. Histological stains | 08 |

| GROUP _ B | | |
|---|---|---|
| 4 | General Principle and applications of<br>4.1. Spectrophotometry: Visible, UV visible<br>4.2. Centrifuge: its types and uses in biology. | 06 |
| 5 | Separation technique:<br>5.1. Electrophoresis: Principles and application<br>5.2. Type: Native, SDS PAGE and Agarose gel electrophoresis. | 03 |
| 6 | Immunological techniques: Principle of ELISA and its types | 03 |
| 7 | Microscopy, principle & applications<br>7.1. Fluorescence microscope<br>7.2. Electron microscope<br>7.2.1. TEM<br>7.2.2. SEM | 06 |
| 8 | Molecular biology techniques<br>8.1 Southern blotting<br>8.2. Northern blotting<br>8.3. Western blotting<br>8.4 DNA Sequencing | 04 |
| 9 | Autoradiography:<br>9.1. Radioactive isotopes<br>9.2. Method and application of autoradiography | 03 |
| 10 | Polymerase chain reaction (PCR) | 03 |

Recommended

1. A Text Book of Histology, William Bloom and Don W Fawcett, Saunders
2. Bancroft, J.D. & Stevens, A. Theory and Practice of Histological techniques, Churchill- Livingstone, 2002
3. Casselman, W.G.B.: Histochemical techniques, John Wiley, 1959
4. Pearse, A.G.E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill-Livingstones, 1980-1993
5. Staining methods Histologic and Histochemical, J F A McMannus and Rubert W Mowry, Harper and Row 1964

**SEMESTER – I,**
**Animal Diversity (Non- Chordate & Chordate)**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – C – 102 | Animal Diversity (Non-Chordate & Chordate) | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will be comprised of question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8). There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Origin of metazoan | 03 |
| 2 | Origin of Coelom-Acoela, Pseudocoela, Schizocoela and Enterocoela | 03 |
| 3 | Locomotion<br>3.1 Modern concept of Flagellar and Ciliary movement in protozoa<br>3.2 Foot and its modification in Mollusca<br>3.3. Hydrostatic movements in Echinodermata | 06 |
| 4 | Nutrition and Digestion: Filter feeding in Polychaeta. | 02 |
| 5 | Respiration<br>5.1 Respiratory pigments.<br>5.2 Respiration in Arthropoda<br>5.2.1 Branchial/Gill respiration<br>5.2.2 Respiration by Book lungs<br>5.2.3 Tracheal respiration<br>5.3 Respiration in Mollusca<br>5.3.1Aquatic respiration<br>5.3.2 Aerial respiration | 10 |
| 6 | Excretion in invertebrates: Excretion and osmoregulation in annelids. | 02 |
| 7 | Invertebrate larval forms and their evolutionary significance<br>7.1 Larval forms of Trematoda and Cestoda<br>7.2 Larval forms of Echinodermata | 04 |

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|---|---|---|
| 8 | Miscellaneous topics:<br>8.1 Structural peculiarities and affinities of Onychophora<br>8.2 Adaptive radiation in Polychaetes<br>8.3 Ancestral mollusc and derivation of different modern classes | 06 |

| **GROUP - B** | | |
|---|---|---|
| 9 | Origin of the following:<br>9.1 Birds<br>9.2 Mammals | 04 |
| 10 | Skull in Reptiles | 02 |
| 11 | Rhyncocephalia | 02 |
| 12 | Dinosaurs and their causes of extinction | 02 |
| 13 | Modification of palate in birds | 03 |
| 14 | Aerodynamics and energetic of flying and gliding in birds | 03 |
| 15 | Dentition in mammals | 03 |
| 16 | Primitive mammals:<br>17.1 Prototheria<br>17.2 Metatheria | 02 |
| 17 | Aquatic mammals. | 03 |

Books Recommended


1. Boolootian, R. A. and Stiles, K. A., College Zoology, 10th edition, Macmillan Publishing Co., Inc. New York, 1981.
2. Colbert, E. H., Morales, M. and Minkoff, E. C. Colbert's Evolution of the Vertebrates: A history of the backboned animals through time, 5th edition, John Wiley - Liss, Inc., New York, 2002.
3. Goodrich, E. S, Studies on Structure and Development of Vertebrates, Dover Publication, New York, 1958.
5. Marshall, A. J., Biology and Comparative Physiology of Birds, Volume I & II, 1960.
6. McFarland, W. N., Pough, F. H., Cade, T. J. and Heiser, J. B., Vertebrate Life, Macmillan Publishing Co., Inc., New York, 1979.
7. Moore, J. A., Biology of Amphibia, Academic Press, 1964.
8. Parker, T. S. and Haswell, W. A., Text Book of Zoology, Vol. II, ELBS,
9. Romer, A. S. and Parsons, T. S., The vertebrate body, 6th edition, CBS Publishing Japan Ltd, 1986.
10. Sinha, A. K., Adhikari, S. and Ganguli, B. B.: Biology of Animals, Vol. II, New Central Book Agency, Calcutta, 1988.
11. Young, J. Z. The life of vertebrates, 3rd edition, ELBS with Oxford University Press, 1981.
12. Vishwanath, Vertebrate Zoology

**SEMESTER – I,**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – C – 103 | Endocrinology, Reproductive Biology & Developmental Biology | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8). There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group. Each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Hormones<br>1.1.Biosynthesis of hormones<br>1.1.1. Amino acid derived hormones ($T_3$, $T_4$)<br>1.1.2. Steroid hormones: Mineralocorticoids, glucocorticoids & Sex hormones.<br>1.2. Hormone Action<br>1.2.1. Types of receptors, second messenger, cytosolic receptors and their action | 03 |
| 2 | Neuroendocrines and neurohormones | 03 |
| 3 | Pineal in vertebrates: Its structure, hormones, and their function | 06 |
| 4 | Structure and function of Parathyroid | 02 |
| 5 | Hormonal control of<br>5.1. Fuel metabolism: Insulin, Glucagon, and Epinephrine<br>5.2. Hormonal regulation of Osmoregulation<br>5.3. Hormonal control of calcium regulation | 10 |

| | | |
|---|---|---|
| 6 | Histophysiology of mammalian gonads<br>6.1. Histophysiology of testes<br>6.2. Histophysiology of ovary | 02 |
| 7 | Semen formation and composition | 04 |
| 8 | Pregnancy<br>8.1. Hormonal regulation of implantation and pregnancy<br>8.2. Placental hormones<br>8.3. Parturition<br>8.3.1. Stages of Parturition<br>8.3.2. Hormonal interplay | 06 |
| 9 | Lactation<br>9.1. Structure and functions of mammary gland<br>9.2. Role of various hormones in lactation | 02 |

| **GROUP - B** | | |
|---|---|---|
| 10 | Fertilization<br>10.1. Molecular events of fertilization<br>10.2. Prevention of polyspermy | 04 |
| 11 | Laying down of embryonic body plan<br>11.1. Organizer concept<br>11.2. Cell lineage in *Coenorhabditis elegans* | 05 |
| 12 | Cell differentiation<br>12.1. Myogenesis of skeletal muscle<br>12.1.1. Formation<br>12.1.2. Regeneration<br>12.1.3. Hypertrophy<br>12.2. Haemopoeitic stem cells and their diversification<br>12.3. Haemoglobin biosynthesis | 04 |
| 13 | Genes controlling embryogenesis<br>13.1. Determination of anterior and posterior axes of *Drosophila*<br>13.2. Determination of dorso-ventral axis in *Drosophila*<br>13.3. Homoeotic genes in *Drosophila*<br>13.4. Homoeobox genes in mammals | 05 |

**SEMESTER – I,**
**Practical based on ZOO C 101,102 and 103**
**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – C/P – 104 | PRACTICAL | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

| **Practical** | | **Marks distribution** |
|---|---|---|
| **1. Dissection:** | | **6X2=12** |
| **1.1. Vertebrate** | | **06** |
| **1.2. Invertebrate** | | **06** |
| **2. Slide preparation** | | **04** |
| **3. Spotting** | | **2X10=20** |
| **3.1. Slides (04), (02 Invertebrate, 02 Vertebrate)** | | **2X4=08** |
| **3.2. Museum Specimens (04)** | | **2X4=08** |
| **[(02) Invertebrate, (02) Vertebrate]** | | |
| **3.3. Bones (02)** | | **2X2=04** |
| **4. Reproductive Physiology & Endocrinology** | | **5×2=10** |
| **4.1. Reproductive physiology** | **05** | |
| **4.2. Endocrinology** | **05** | |
| **5. Population genetics/ biosystematics** | | **04** |
| **6. Class record, poster/models/collection** | | **10** |
| **7. *viva-voce*** | | **10** |
| **TOTAL** | | **70** |

List of Practical

1. Dissection:

1.-Local bony fish- Afferent, Efferent and cranial nervous system

2'- Prawn-Nervous system and appendages of Prawn

3. Earthworm –Nerve ring, Reproductive system and digestive system

2. Slide preparation- Gemmule of sponge, Obelia colony, Statocyst of prawn, ovary of earthworm, Daphnia, placoid and cycloid scale .

3. Museum Specimens- *Euspongia, Physalia, Metridium,Taenia, Ascaries, Nereis, Aphrodite, Limulus, Octopus, loligo, sepia, Echinus, Asterias, Holothuria, Exocoetus, Hyla Racophorous ,Draco , Phrynosoma, Bat*

4. Permanent Slides: Invertebrate& Vertebrate (General histology, reproductive organs and endocrine glands)

5. Bones: Fish & Mammals, Different types of Teeth of mammals

6. Bio-Systematic and Population genetics

1. Preparation of Taxonomic Key

2. Specimens/models showing convergent and divergent evolution Connecting link, living fossil, serial homology.

3. Estimation of gene and genotype frequency in human population.

**SEMESTER – II**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – S – 205 | Bioinformatics & Biostatistics | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

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- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8) . There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Introduction to computational biology & bioinformatics. Branches of bioinformatics. | 03 |
| 2 | Nature of biological data. Biological data formats. Concepts of digital library. | 03 |
| 3 | Bioinformatics databases:<br>3.1 Literature databases (PubMed),<br>3.2 Primary nucleotide sequence databases (NCBI, EMBL, DDBJ),<br>3.3 Protein sequence databases (SwissProt, PIR),<br>3.4 Sequence motif databases (Pfam, PROSITE),<br>3.5 Structure databases (PDB, SCOP, CATH). | 06 |
| 4 | Algorithms and bio-tools:<br>4.1 Sequence alignment and database similarity searching.<br>4.2 Scoring matrix, BLAST series, PSI- BLAST, FASTA.<br>4.3 Global Alignments – Needleman Wunsch Algorithm, | 02 |

| | | |
|---|---|---|
| | 4.4 Local Alignments – Smith Waterman Algorithm.<br>4.5 Multiple sequence alignments (ClustalW). | |
| 5 | Basic concepts on phylogenetic markers and molecular phylogeny. | 10 |
| 6 | Structural bioinformatics: prediction of secondary & tertiary structure of proteins. | 02 |
| 7 | Human genome projects. | 04 |
| 8 | Other biological tools and resources: EMBOSS, Expasy, OMIM, etc. | 06 |
| 9 | Introduction of Nanotechnology,<br>9.1 Role of bioinformatics in nanotechnology.<br>9.2 Current progress in biomedical nanotechnology with bioinformatics. | 05 |

| **GROUP - B** | | |
|---|---|---|
| 10 | Statistics of location and dispersion Measures of central value- Mean, Median, Mode. Measures of dispersion- standard deviation, coefficient of variation. Skewness and Kurtosis. | 04 |
| 11 | Sampling statistics and testing of hypothesis. Procedure for testing hypothesis. | 02 |
| 12 | Test of significance based on small samples and large samples (‘t’ test and ‘z’ test), Chi-square test | 02 |
| 13 | Analysis of variance- One-way and Two-way ANOVA. | 04 |
| 14 | Correlation:<br>14.1. Definition types of correlation<br>14.2 Methods of studying correlation<br>14.3. Karl Pearson coefficient of correlation<br>14.4. Rank correlation method. | 04 |
| 15 | . Regression analysis:<br>15.1 Regression lines<br>15.2. Regression equations. | 02 |

**Suggested readings/Text Book (s):**


**1. Barnes & Gray (ed): Bioinformatics for geneticists, Wiley (2003)**
**2. Lesk: Bioinformatics, Oxford (2003, Indian ed)**
**3. Westhead et al: Bioinformatics Instant Notes, Viva Books (2003, Indian ed)**
**4. Prakash S Lohar, Bioinformatics, M J P publishers, Chennai**
**5. David W Mount, Bioinformatics – Sequence and Genome analysis 2e. CBS Publishers New Delhi.**
**6. Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.**
**7. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, Cold Spring Harbor Laboratory**
**8. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by A.D. Baxevanis and B.F.F. Ouellette, Wiley-interscience.**
**9. Understanding Bioinformatics by Marketa Zvelebil and Jeremy Baum, Garland Science.**
**10. Modern statistics for the Life Sciences by A. Grafen and R. Hails, Oxford University Press. 4.**
**11.An Introduction to Biostatistics by Thomas Glover and Kevin Mitchell, Waveland PrInc.**
**12. Biostatistics: Principles and Practice 1e. Prasanna Samuelson, Solomon Christopher, B Antonisamy**
**13. Introduction to Biostatistics and Research Methods 5th Edition, SUNDAR RAO, RICHARD**
**14. Introduction to Nanotechnology, By Charles P. Poole, Jr., Charles P.. Poole, Frank J.Owens, Autor Owens,2003 Wiley Interscience.**

**15. Integrating Biologically-Inspired Nanotechnology into Medical Practice.B.K. Nayak (K.M. Centre for Post Graduate Studies, India), Anima Nanda (Sathyabama University, India) and M. Amin Bhat (Sathyabama University, India)**

**SEMESTER – II**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – S – 206 | System Physiology & Biochemistry | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8) . There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Environmental Physiology<br>1.1. Elementary idea of stress and strain.<br>1.2. Physiological response to:<br>1.2.1. Cold and Heat<br>1.2.2. Pressure (high and low)<br>1.2.3. Electromagnetic radiations.<br>1.3. Thermoregulation in vertebrates.<br>1.3.1. Ectotherms and Endotherms.<br>1.3.2 Physiological adaptations in Endotherms to extreme cold and Extreme heat. | 03 |
| 2 | Excretion<br>2.1 Mechanism of Urine formation<br>2.1.1 Glomerular filtration<br>2.1.2 Tubular reabsorption and secretion<br>2.1.3 Counter current mechanism<br>2.1.4 Hormonal regulation (ADH & Renin-Angiotensin system) | 03 |

| | | |
|---|---|---|
| 3 | Nervous system<br>3.1 Axonal transmission<br>3.1.1 Neuron and its types<br>3.1.2 Genesis of membrane potential and action potential<br>3.1.3 Sodium-potassium pump<br>3.2 Synaptic transmission<br>3.2.1 Types of synapses and synaptic knobs<br>3.2.2 Excitatory and inhibitory post-synaptic potential | 06 |
| 4 | Muscle<br>4.1 Ultrastructure of skeletal muscle fibers<br>4.2 Muscle proteins<br>4.3 Sequence of events in contraction and relaxation of skeletal muscle<br>4.4 Energetics of muscle contraction<br>4.5 Muscle twitch, summation, tetanus and fatigue<br>4.6 Isotonic and isometric contraction | 02 |
| 5 | Cardiovascular System: myogenic heart, ECG – its principle and significance, cardiac cycle. | 10 |
| 6 | Physiology of sense organs – Vision and hearing. | 02 |

| **GROUP - B** | | |
|---|---|---|
| 7 | Amino acid<br>7.1 Structure and Classification<br>7.2 Reactions due to functional groups.<br>7.3 Titration curve | 04 |
| 8 | Proteins:<br>8.1Primary structure, peptide bond.<br>8.2 Secondary structure-α helix, β pleated sheet & Protein folding.<br>8.3 Ramachandran plot<br>8.4 Tertiary and Quaternary structure – Bonds stabilizing structure, Domains<br>And motifs. | 04 |
| 9 | Enzymes<br>9.1 Classification and general properties | 08 |

| | | |
|---|---|---|
| | 9.2 Enzyme kinetics Derivation of Michaelis-Menten equation<br>9.3 Enzyme regulation and inhibition. | |
| 10 | Carbohydrates: Structure and physiological significance<br>10.1Structure and Properties of monosaccharaides.<br>10.2 Structure and Properties of Oligosaccharides.<br>10.3 Polysaccharide of physiological significance.<br>10.4. Carbohydrate Metabolism:<br>10.4.1. Glycolysis & Krebs cycle: Pathway and regulation.<br>10.4.2. Oxidative metabolism: electron transport chain, oxidative Phosphorylation,<br>10.4.3. Gluconeogenesis.<br>10.4.4. Hexose Monophosphate shunt | 10 |
| 11 | Lipids:<br>11.1. Lipids of physiologic (Clinical) significance, membrane lipids, Cholesterol<br>11.2. Synthesis and β oxidation of fatty acids. | 04 |
| 12 | . Errors in Biosynthetic Pathways:<br>12.1. Inborn Errors of Amino acid catabolism.<br>12.2. Alkaptonuria,<br>12.3. Albinism<br>12.4. Phenylketonuria | 04 |

**Books Recommended**


**1. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003**
**2. Guyton and Hall: Text Book of Medical Physiology (10th Ed.), W.B. Saunders, 2001**
**3. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989**
**4. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003**
**5. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.)**

**SEMESTER – II**
**Immunology & Microbiology**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – S – 207 | Immunology & Microbiology | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8) . There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Introduction to Human Immune System and Immunity<br>1.1. Types of Immunity<br>1.1.1: Innate Immunity<br>1.1.2: Acquired Immunity | 03 |
| 2 | Cells and Organs of Immune System<br>2.1. Immuno-Competent Cells and Accessory Cells<br>2.2. Lymphoid Organs<br>2.2.1: Primary Lymphoid organs: Thymus, Bone marrow, Bursa Fabricius<br>2.2.2: Secondary Lymphoid Organs: Lymph Nodes, Spleen, MALT, Tonsils & GALT | 03 |
| 3 | T- cell - generation activation and differentiation | 06 |
| 4 | B-cell - generation activation and differentiation | 02 |
| 5 | Lymphocyte traffic | 10 |
| 6 | Antigen | 02 |

| | | |
|---|---|---|
| | 6.1 Nature of antigens and super antigens<br>6.2 Antigenicity and immunogenicity<br>6.3 Epitopes and hapten | |
| 7 | Major Histocompatibility Complex (MHC) in mouse and HLA system in human | 02 |
| 8 | Organization and expression of lg genes, Generation of antibody diversity. | 03 |
| 9 | Cytokines: Structure and functions and their receptors | 02 |
| 10 | Complement system: Component and functions | 02 |
| 11 | Hypersensitivity<br>11.1. Types of Hypersensitivity<br>11.2. Immediate type Hypersensitivity<br>11.3. Delayed type Hypersensitivity | 02 |
| 12 | Transplantation Immunology | 02 |
| 13 | Autoimmunity<br>13.1 Organ specific autoimmune diseases (Myasthenia gravis, IDDM, Hashimoto Thyroditis)<br>13.2 Systemic Autoimmune Diseases (SLE, Rheumatoid arthritis, Multiple Sclerosis)<br>13.3 Evidence Implicating the CD4+ T Cell, MHC and TCR in autoimmunity | 03 |

| **GROUP - B** | | |
|---|---|---|
| 15 | Methods in microbiology:<br>15.1 Sterilization<br>15.1.1. Physical method<br>15.1.2. Chemical method<br>15.2 Culture media<br>1.2.1. Chemically Defined Media<br>1.2.2. Complex Media<br>1.2.3. Anaerobic Growth Media<br>1.2.4. Special Culture Techniques | 03 |

| | | |
|---|---|---|
| | 15.2.5. Selective and Differential Media<br>15.2.6. Enrichment Culture<br>15.2.7. Pure Culture Techniques | |
| 16 | Bacteria<br>2.1. Types and Structure<br>2.2. Bacterial growth and growth curve kinetics | 02 |
| 17 | Virus<br>17.1 Outline of Classification<br>17.2 Structure of viruses<br>17.3 Reproduction<br>17.3.1 Lytic cycle<br>17.3.2 Lysogenic cycle<br>17.3.3 Role of lambda repressor | 02 |
| 18 | Pathogenic microbes<br>4.1 HIV<br>4.2 Rabies<br>4.3 Prions | 02 |
| 19 | Antibiotics: Chemistry and their mode of action | 04 |
| 20 | Vaccine:<br>6.1. Types<br>6.2. Vaccine preparation. | 05 |

**Books Recommended**

**Books Recommended**
**Immunology:**

**1. Alberts et al: Molecular Biology of cell (4th Edition) Garland Science, 2002.**
**2. Ivan Roitt and Peter J Delves: Roitt's Essential Immunology (10 th Ed.) Oxford, Backwill,**
**Science Publication London.**
**3. Elgert: Immunology understanding the immune system, John Willy & Sons, Inc. Publication,**
**New York, 1996.**
**4. Abbas et al. cellular and Molecular Immunology (3rd Ed.) W.B. Saunders Company, 2000**
**5. Kuby Immunology Current edition.**

**Microbiology**

**1. Brock Biology of Microorganisms (13th ed.) Michael T. Madigan, John M. Martinko, David A. Stahl, Pearson Publication**
**2. Microbiology an Introduction: 11 e. Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Pearson Publication 2007**
**3, Microbiology, 5th Edition, Lansing M. Prescott, ISBN: 0-07-282905-2,**

**4. Sherris Medical Microbiology, An Introduction to Infectious Disease, Current edition.**
**5. Michael C Pelczar, Microbiology, Current edition.**
**6. Text Book of Microbiology, Edited by CKJ Panikar, 5 e. 2005, Orient Longman**
**7. Microbiology 5e. Michael C Pelczar, ECS Chan, Noel R Kraig, TMH 1986**
**8. A Textbook of Microbiology, by R.C. Dubey and D.K. Maheshwari, 2010, S Chand & Co.**

## SEMESTER – II
## Based on 205,206 & 207

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – S – 208 | PRACTICAL | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

| Practicals | Marks Distribution |
|---|---|
| **1. Physiology& Biochemistry** | |
| **1.1. Physiological Experiment** | **10** |
| **1.2.Biochemistry** | **10** |
| **2. Tools & Techniques** | |
| **2.1. Apparatus (one)** | **05** |
| **2.2. Technique (One)** | **05** |
| **3. Immunology** | **10** |
| **4. Microbiology** | **10** |
| **5. Class Record, chart,/models** | **10** |
| **6. Viva-voce** | **10** |
| | **Total Marks-70** |

**List of Practicals**

1. Physiology Experiment:
    - 1.1. Determination of blood pressure by sphygmomanometer.
    - 1.2. Demonstration of diffusion process/osmosis across a membrane
    - 1.3. Determination of clotting and bleeding time
    - 1.4. Haemin Crystal preparation
    - 1.5. Estimation of Hb concentration.

2. Biochemistry:

2.1. Construction of models of bio molecules by wire and beads.

2.2. Detection of presence of blood glucose by Benzedrine test

2.3. Quantitative estimation of glucose, urea and Protein in the unknown sample

3. Study of laboratory apparatus:-

3.1 Autoclave

3.2. Microtome

3.3. pH meter

3.4. Centrifuge

3.5. Colorimeter

3.6. Spectrophotometer

4. Techniques :

4.1. Microtomy-

4.1.1. Fixation

4.1.2. Block preparation:

4.1.3. Section cutting

4.1.4. Spreading and

4.1.5. Staining of tissues section.

4.2. Histochemical demonstration:

4.2.1. Sudan black for lipid

4.2.2. PAS for carbohydrate

4.2.3. Bromophenol blue for protein

4.3. Paper chromatography

5. Microbiology:

5.1. Sterilisation technique

5.2. Media preparation for microbial culture

5.3. Gram staining of bacteria

6. Immunology:

6.1. Antibody sensitivity test

6.2. Study of Immune cells in a blood film.

6.3. Demonstration of agglutination reaction by blood grouping.

6.4. Mancini's radial Immunodiffusion test

6.5. Ouchterlony double Immunodiffusion test

**SEMESTER – III**
**Open Elective**
**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – A – 309 | Medical Zoology: Human Diseases | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries4 marks (2x4=8) . There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Basic concept of parasite, host, mode of infection, Host-parasite relationship and prophylaxis<br>1.1. Protozoan diseases:<br>1.1.1 *Entamoeba histolytica* – causative pathogen for diarrhoea, dysentery and liver abscess in human<br>1.1.2. *Leishmania donovani* – causative pathogen for Kala-azar<br>1.1.3. *Plasmodium vivax* – Malaria- with special reference: Life Cycle, Pathogenicity, prophylaxis and Treatment | 20 |
| 2 | Helminthes (worm) Diseases:<br>2.1 *Ascaris lumbricoides* – causative pathogen for Ascariasis<br>2.2 *Taenia solium* and *T saginata*- with special reference: Life Cycle, Pathogenicity, Prophylaxis and Treatment | 15 |
| 3 | Arthropods as Vector of Human Disease<br>3.1 Mode of Transmission of Disease by Arthropod vector | 15 |

| | | |
|---|---|---|
| | 3.2 Comparative Bionomic & Disease Transmitted By<br>3.2.2: *Anopheles* (Female): Malaria<br>3.2.3: *Culex* (Female): *Filaria*<br>3.2.4: *Aedes*: Dengue, Zika virus infection<br>3.2.5: National Filarial Control Programme (NFCP)<br>3.2.6: National Malarial Eradication Programme (NMEP) | |

| | **GROUP - B** | |
|---|---|---|
| 4 | 4. Human disease caused by viruses & bacteria: Causative agents & pathogenicity<br>4.1 Diseases caused by Viruses<br>4.1.1 Contagious and respiratory Air borne viral diseases: common cold and different types of flu, and CoVid<br>4.1.2 Gastrointestinal and exanthematous (skin) viral diseases: Measles and Chicken Pox<br>4.1.3 Hepatic viral diseases: Hepatitis<br>4.1.4 Hemorrhagic viral Diseases: Yellow fever and Dengue fever<br>4.1.5 Neurologic viral diseases: Polio<br>4.1.6 Auto immune diseases: AIDS<br>4.2 Diseases caused by bacteria<br>4.2.1 Air borne bacterial diseases: Tuberculosis and Diphtheria<br>4.2.2 Food and water borne bacterial diseases: Botulism, Cholera and Typhoid.<br>4.3 Eradication Programme for Polio- Pulse Polio.<br>4.4 National AIDS control Programme. | 10 |

**Suggested book in Medical Zoology**

**1. Parasitology by K. D. Chaterjee 21 edition**

**ONLINE TOOLS AND WEB RESOURCES**

- **https://www.skillstat.com/tools/ecg-simulator**
- **https://www.youtube.com/watch?v=ZoGfQM5JCnI**
- **https://www.youtube.com/watch?v=Qbnz4_qed9Q&t=276s**

- **https://www.youtube.com/watch?v=djAxjtN_7VE**
- **https://www.youtube.com/watch?v=9SUHgtREWQc&t=188s**
- **https://www.youtube.com/watch?v=fHUzVqoDnts**

## SEMESTER – III

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – S – 310 | Cell Biology and Genetics | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8) . There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Biomembrane<br>1.1 Molecular organization, Fluid-Mosaic model<br>1.2 Transport across the cell membrane | 07 |
| 2 | Nucleus - Structure of Nuclear membrane and nuclear transport | 05 |
| 3 | . . Protein Trafficking:<br>3.1 Protein synthesis on free and bound polysomes<br>3.2 Uptake into ER<br>3.3 Membrane proteins<br>3.4 Golgi sorting<br>3.5 Post translational modification | 06 |
| 4 | Cell Signalling:<br>4.1. Intracellular receptors<br>4.2. Cell surface receptors<br>4.2.1. Ion channel linked receptors<br>4.2.2. G-Protein linked receptors | 06 |

| | | |
|---|---|---|
| | 4.2.3. Enzyme linked receptors<br>4.3 Signal transduction pathway | |
| 5 | Cytoskeleton- Structure and function<br>5.1. Microfilaments<br>5.2. Intermediate filaments<br>5.3. Microtubules<br>5.4. Intracellular transport-role of kinesin and dynein | 04 |
| 6 | Cell cycle:<br>6.1. Cyclins and<br>6.2. CDK Regulation<br>6.3. Checkpoints | 02 |
| 7 | Programmed cell death (Apoptosis). | 01 |
| 8 | Biology of Chromosome-Ultra structure of Chromatin fibre | 04 |
| 9 | Telomere and its maintenance. | 02 |
| 10 | Cell and its society<br>10.1 Cell junction and Focal adhesion<br>10.2 Cell-Cell adhesion | 03 |

| **GROUP - B** | | |
|---|---|---|
| 11 | Gene mapping methods – linkage maps, mapping with molecular markers RFLP | 04 |
| 12 | Extra chromosomal inheritance:<br>12.1. Inheritance of mitochondrial and chloroplast gene | 02 |
| 13 | Recombination, site-specific recombination | 02 |
| 14 | 4. Sex determination in *Drosophila* and Human<br>14.1 Role of alternate splicing<br>14.2 Role of SRY gene<br>14.3 SXL – gene | 01 |
| 15 | DNA library | 01 |

| | | |
|---|---|---|
| | 15.1 c- DNA library<br>15.2 Genomic library | |
| 16 | Reverse genetics: Antisense RNA | 01 |
| 17 | Transposons / Mobile genetic element<br><br>7.1 Transposable elements in Bacteria<br>7.2 Transposable elements in Eukaryotes<br>7.3 Transposable elements in Human | 03 |
| 18 | Gene regulation<br><br>18.1 Regulation of Prokaryotic gene expression<br>18.1.1 Inducible and Repressible gene expression<br>18.1.2 Positive and negative control of gene expression<br>18.1.3. Lac operon<br>18.1.3.1. Induction<br>18.1.3.2.Catabolic repressor<br>18.1.3.3.Use of IPTG<br>18.1.4. Trp operon<br>Repression<br>Attenuation | 03 |
| 19 | Genetics of cancer | 03 |

**Book recommended**

**Cell Biology:**


**1. Alberts et al: Molecular Biology of the Cell, Garland, Current edition.**

**2. Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, Current edition**

**3. DeRobertis & DeRobertis: Cell & Molecular Biology, Lea &Febriger, 1987**

**4. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002**

**5. Michael Jr.: Microbiology, Tata McGraw Hill, 1993**

**6. Gerald Karp: Cell and Molecular Biology Concepts and Experiments, Current edition.**


**Genetics:**


**1. Brooker: Genetics: Analysis and Principles (Addison-Wesley, 1999)**

**2. Gardner et al: Principles of Genetics (John Wiley, 1991)**

**3. Griffith et al: Modern Genetic Analysis (Freeman, 2002)**

**4. Hartl& Jones: Essential Genetics: A Genomic Perspective (Jones &Bartlet, 2002)**
**5. Lewin, Genes VIII (Wiley, 2004)**
**6. Russell: Genetics (Benjamin Cummings, 2002)**
**7. Snustad& Simmons: Principles of Genetics (John Wiley, 2003).**

**SEMESTER – III**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – S – 311 | Environmental Biology and Toxicology | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering the entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8) .There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Population Ecology<br>1.1 Characteristics of population:<br>1.1.1Population size and density<br>1.1.2Dispersion<br>1.1.3Age structure<br>1.1.4 Natality<br>1.1.5 Mortality: Survivorship curves, Life Tables<br>1.1.6 Biotic Potential<br>1.1.7 Carrying Capacity<br>1.2 Population Dynamics<br>1.2.1 Population growth and attributes<br>1.2.2 Exponential growth<br>1.2.3 Logistic growth<br>1.2.4 Growth curves: Sigmoid and J shaped growth curve<br>1.3 Regulation of population growth: Interaction<br>1.3.1 Intraspecific interaction<br>1.3.2 Interspecific interaction<br>1.3.2.1Commensalism<br>1.3.2.2 Mutualism<br>1.3.2.3 Proto co-operation<br>1.3.2.4 Prey and predator interaction | 10 |

| | | |
|---|---|---|
| | 1.3.2.5 Host parasite interaction<br>1.3.3 Competition:<br>1.3.3.1 Lotka Voltera model | |
| 2 | Organization of Biotic Community<br>2.1Characteristics of Biotic community<br>2.2 Classification and components of community<br>2.3 Structure of community<br>2.3.1 Quantitative characters<br>2.3.2 Qualitative characters<br>2.3.3Synthetic characters<br>2.4 Ecological Dominants, Ecotypes, Ecotone and Edge Effect. | 07 |
| 3 | Ecological Niche<br>3.1 Concept of Niche<br>3.2 Niche Dimension<br>3.3 Niche Breadth<br>3.4 Niche Overlaps<br>3.5 Gause's Principle | 08 |
| 4 | Biodiversity<br>4.1 Levels of biodiversity<br>4.2 Uses of biodiversity<br>4.3 Distribution of biodiversity<br>4.4 Hot spots of biodiversity<br>4.5 Biodiversity Indices<br>4.6 Threats and conservation of biodiversity with special reference to India | 04 |
| 5 | Community function: Productivity<br>5.1 Concept of productivity- Primary and Secondary Productivity,<br>5.2 Factors affecting productivity.<br>5.3 Methods of measurement of productivity: Primary and Secondary | 08 |
| 6 | Ecological restoration<br>6.1 Terms and definition<br>6.2 Bioremediation concept, Environmental limitation for bioremediation | 04 |
| 7 | Biosensors | 01 |
| | **GROUP - B** | |
| 8 | Environmental wastes management: Domestic/MSW, Vermicomposting, agricultural and hazardous wastes management | 04 |
| 9 | Major Anthropogenic Global environmental problems<br>9.1 Acid rain<br>9.2 Green house effects<br>9.3 Smog<br>9.4 Ozone depletion<br>9.5 Heavy metal toxicity: Mercury, Lead and Cadmium<br>9.6 Food additives and their effects<br>9.7 Public Health and occupational Hazards due to environmental Disasters:<br>9.7.1 Pneumoconiosis | 04 |

| | | |
|---|---|---|
| | 9.7.2 Silicosis<br>9.7.3 Asbestosis | |
| 10 | Environmental Impact Assessment (EIA), purpose, aim, process | 02 |
| 11 | Sustainable development: Cost benefit analysis and its application. | 02 |
| 12 | Toxicology:<br>12.1 Xenobiotics and Toxicants: Routes and rate of administration.<br>12.2 Synergism and Antagonism<br>12.3 Basic principle of Dose-Response relationship<br>12.4 Biotransformation of Toxicants; Translocation of Toxicants Antidotes<br>12.5 Toxicity tests: LD 50; LC 50. | 06 |

**Books Recommended**


1. Field Sampling: Principles and Practices in Environmental Analysis, Conklin, A.R. Jr., (2004), CRC Press
2. . 2. Principles and Standards for Measuring Primary Production, Fahey, T.J. and Knapp, A.K., (2007), Oxford University Press, UK
3. 3. Ecological Modeling, Grant, W.E. and Swannack, T.M., (2008), Blackwell.
4. 4. Fundamental Processes in Ecology: An Earth system Approach, Wilkinson, D.M., (2007), Oxford University Press, UK
5. 5. Ecology Environment and Resource conservation: J S Singh, S P Singh and S R Gupta, Anamaya Publishers, New Delhi
6. 6. Ecology Concept and application: Manuel C Molles Jr, McGraw Hill
7. 7. Living in the environment: G Tyler Miller, Thompson

**SEMESTER – III**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – S – 312 | Practical | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

| Practicals | Marks Distribution |
|---|---|
| **1. Environmental Biology** | **20** |
| **2. Cell Biology** | **15** |
| **3. Genetics** | **15** |
| **4. Class Records, Poster/ Models** | **10** |
| **5. Viva- Voce** | **10** |
| | **Total = 70 Marks** |

**List of Practicals**

1. Environmental Biology
    1. Study of adaptation in: Aquatic Insects, Fresh water fish, higher vertebrates
    2. Identification of some common plankton
    3. Water analysis for – Dissolved oxygen, Free Carbon dioxide, Total alkalinity and chloride in water.
    4. Determination of population structure by quadrate method.
    5. Estimation of Biodiversity indices.
    6. Preparation of ppm solution
2. Cell Biology
    1. Preparation of mitotic chromosomes from onion root tip
    2. Preparation of meiotic chromosome from Testis of Grasshopper
    3. Preparation of Polytene chromosomes from Drosophila chironomous.
    4. Staining of Mitochondrial from human cheek epithelial cells.
    5. Demonstration of Barr body in cheek epithelial cells/ hair follicle.
3. Genetics
    1. Proof of Mendelian ratio of law of inheritance using pea seed samples
    2. Determination of gene mapping.
    3. Study of Drosophila mutant.

**SEMESTER – IV**

**Discipline Centric Elective: Fish and Fisheries**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 413A | Fish Diversity & Fish Biology | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

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- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries4 marks (2x4=8) . There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Outline classification of fishes by L.S. Berg up to order with reference to living fresh and marine fishes of India | 08 |
| 2 | Origin and evolution of fishes | 07 |
| 3 | General organization of specialized groups of fishes<br>3.1. Holocephali<br>3.2. Coelacanths<br>3.3. Dipnoi | 07 |
| 4 | Fins<br>4.1. Unpaired fins (Dorsal and Ventral)<br>4.2 Paired fins (Pelvic and Pectoral)<br>4.3. Caudal fins and its modifications<br>4.4. Origin of paired fins | 04 |
| 5 | Locomotion in teleost<br>5.1. Locomotion in water (swimming) | 02 |

| | | |
|---|---|---|
| | 5.2. Locomotion on land<br>5.3. Gliding in air | |
| 6 | Aquatic respiration in teleost<br>6.1. Structure of gills<br>6.2. Opercular movement<br>6.3. Gaseous exchange and ventilation | 05 |
| 7 | Accessory respiratory organs | 03 |
| 8 | Digestive system in teleost<br>8.1. Alimentary canal and its modifications in relation to food and feeding habits | 04 |
| 9 | Lateral line system<br>9.1. Lateral line canal and its specialization in cartilaginous and bony fishes<br>9.2. Neuromast organs: Special types of neuromast<br>9.3. Functions of lateral line system | 02 |

| **GROUP - B** | | |
|---|---|---|
| 10 | Excretion and osmoregulation<br>10.1. Excretion: Physiology of excretion in teleost<br>10.1.1. Excretion in freshwater teleost<br>10.1.2. Excretion in marine teleost<br>10.2. Osmoregulation<br>10.2.1. Osmoregulation in stenohaline teleost's: freshwater teleost (hyper-osmotic) and salt water teleost (hypo-osmotic)<br>10.2.2. Osmoregulation in Euryhaline teleost | 04 |
| 11 | Histophysiology of endocrine organs/tissues<br>11.1. Pituitary<br>11.2. Thyroid<br>11.3. Adrenocortical tissue<br>11.4. Corpuscles of Stannius<br>11.5. Ultimobranchial<br>11.6. Europhysis | 04 |
| 12 | Adaptations in teleost | 02 |

| | | |
|---|---|---|
| | 12.1. Electric organs<br>12.2. Hill stream<br>12.3. Deep sea fishes<br>12.4. Bioluminescence<br>12.5. Colouration<br>12.6. Cave dwelling | |
| 13 | Ornamental fishes | 02 |
| 14 | Larvivorous fishses | 02 |
| 15 | Transgenic fishes | 04 |

**Books Recommended:**


1. Brown, M.E. Physiology of fishes, Vols. 1 and 2, Academic press, 1957
2. Hoar, W.S. & Randall, O.J. Fish Physiology, Vols I-X, Academic Press,1969- onwards
3. Lagler, K. F., Bardach J.E., Miller R.R. and May Passino, D.R. Ichthyology, John Wiley, 2003.
4. Norman and Greenwood: A History of Fishes, Third Ed., Ernest Bvenn Limited, 1975.
5. S.S. Khanna and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003.

**SEMESTER – IV**
**MOLECULAR BIOLOGY**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 413B | Molecular Biology | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8) .There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | 1. Molecules of Central dogma of gene expression<br>1.1DNA: Chemical composition of DNA<br>1.2 DNA structure-single stranded DNA, double stranded DNA-A, B, C DNA and Z DNA Structure,<br>1.2.1 Types folding of DNA and their biological functions- Quadruplex DNA, Interrupted DNA, Overlapping DNA and Super coiling of DNA.<br>1.3 Changes from one form to the other, and the enzymes involved, concept of Linking numbers, linking number paradox.<br>1.3.1 Importance of super helical DNA and their structural forms.<br>1.3.2Types of Topoisomerases and their function in adding or removing super helical structures.<br>1.4 Characteristic features of highly repetitive DNA; Tandemly repetitive DNA and Mini and microsatellite | 10 |

| | | |
|---|---|---|
| | DNA and Insertional elements and their role and importance<br>1.5 C value paradox- Resolving the paradox by DNA-DNA and DNA-RNA hybridization and their kinetics. Cot curves | |
| 2 | 1. RNA-structure<br>2.1 rRNAs; Structural features of rRNAs- prokaryotic and eukaryotic.<br>2.2 tRNAs: structural features, their anticodon feature.<br>2.3 mRNAs- prokaryotic and eukaryotic mRNAs, structural features,<br>2.4 Sn-RNAs, Sno RNAs, RNAi | 07 |

| | **GROUP - B** | |
|---|---|---|
| 3 | DNA replication<br>3.1. Prokaryotic DNA replication; replication origin and site and structure and DNA Ter regions and structure.<br>3.2. DNA polymerases, composition and features, replication factors and the mechanism of replication and regulation of replication.<br>3.3. Replication of single stranded DNA (E. coli), Theta replication. | 07 |
| 4 | Eukaryotic-replication<br>4.1. Origins, replication, initiation complexes and their assembly, licensing factors,<br>4.2. DNA polymerases and their composition, telomerase and mode of action, replication factors,<br>4.3. Organelle genome and composition, replication origins, Enzymes and factors involved in the Mechanism of replication of mitochondrial DNA and Chloroplast DNA. | 08 |
| 5 | Transcription in Eukaryotes and role of transcription factors<br>5.1 Post transcriptional processing; Capping, Tailoring, splicing and alternate splicing, mRNA stability, RNA degradation, RNA editing.<br>5.2 Translation of Protein in Eukaryotes. | 08 |

| | | |
|---|---|---|
| | 5.3. Gene silencing, DNA methylation and acetylation, Histone code and RNA interference. | |

**Books Recommended:**

1. Alberts, B., Bray, D. and Hopkin, K. (2004). Essential Cell Biology. 3rd edition. Garland Science, U.S.A 2. Cox, M., Michael. Nelson, L. D. (2008). Principles of Biochemistry. 5th edition. W.H. Freeman and company, New York.

3. Dale, W.J. and Schontz, V.M.(2007). From Genes to Genomes. John Wiley & son's ltd., England.

4. David. A. Micklos, Greg. A. Freyer and David A. Crotty, (2003). DNA Science A First Course, 2nd edition, Cold Sprind Harbor Laboratory Press, New York.

5. Gerald Karp (1996). Cell and Molecular Biology – Concepts and Experiments. John Wiley and Sons, Inc., New York.

6. Griffiths AJF, H.J. Muller., D.T. Suzuki, R.C. Lewontin and W.M. Gelbart (2000). An introduction to genetic analysis. W.H. Freeman, New York

7. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky and James Darnell. (2003). Molecular Cell Biology, W.H. Freeman and Company, New York.

8. Kieleczawa, J. (2006). DNA Sequencing II. Jones and Bartlett Publishers, Canada.

9. Koenberg, A. and Baker, A.T. (2005). DNA Replication. 2nd edition. University Science Book, California. 10. Miglani G.S. (2002). Advanced Genetics, Narosa Publishing House, New Delhi.

11. Nickoloff, A. J. and Hoekstra, F.M. (1998). DNA Damage and repair. Volume II. Humana Press Inc., New Jersey.

12. Watson, Baker, Bell, Gann, Levine and Losick. (2006). Molecular Biology of the Gene, 5 th edition, Pearson Education.

13. Watson, J.D. T. A. Baker, S.P. Bell, A. Lann. M. Levine and R. Losick. (2004). Molecular Biology of genes, V edition, Perason Education RH Ltd., India.

**SEMESTER – IV**

**Discipline Centric Elective: Entomology**
**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 413C | Insect Diversity and Insect Physiology | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8) . There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Classification & Phylogeny of Insects:<br>1.1. Classification of the Apterygota orders:<br>1.1.1. Thysanura<br>1.1.2. Diplura<br>1.1.3. Collembola<br>1.2. Classification of Exopterygota:<br>1.2.1 Orthoptera<br>1.2.2. Hemiptera<br>1.3. Classification of Endopterygota<br>1.3.1. Lepidoptera<br>1.3.2. Diptera<br>1.3.3. Hymenoptera<br>1.3.4. Coleoptera. | 08 |
| 2 | Structure and Function | 15 |

| | | |
|---|---|---|
| | 2.1 Integument<br>2.1.1. Structure and Chemical composition<br>2.1.2. Cuticular modification<br>2.1.3. Apolysis and Ecdysis<br>2.1.4. Sclerotization<br>2.1.5. Modification<br>2.2. Digestive system<br>2.2.1. General Structure and Modification of Alimentary Canal<br>2.2.2. Salivary glands<br>2.2.3. Mechanism of Digestion<br>2.2.4. Micro organization in Intestine of Insects<br>2.3. Respiratory System<br>2.3.1. Structure of spiracles and its type in different insects<br>2.3.2. Mechanism of respiration in terrestrial insects<br>2.3.3. Mechanism of respiration in Aquatic and Parasitic insects<br>2.4. Circulatory System<br>2.4.1. Structural components of haemolymph and its function.<br>2.4.2. Structure of Heart and its functioning mechanism<br>2.4.3. Accessory pulsatile organs | |

| **GROUP - B** | | |
|---|---|---|
| 3 | Excretory System<br>3.1 Structure of Malpighian tubules and its association with alimentary canal<br>3.2 Other organs of excretion in Insects<br>3.3 Metabolic pathway of Nitrogenous excretion | 04 |
| 4 | Sensory Organs<br>4.1. Mechanoreceptors<br>4.2. Chemoreceptors<br>4.3. Visual Organs (Compound eye) | 04 |

| | | |
|---|---|---|
| 5 | Effector Organs<br>5.1. Light Producing organs<br>5.2. Mechanism of light production | 03 |
| 6 | Insect Endocrine organs<br>6.1. NSC & Neurohormones<br>6.2. Corpora allata and JH<br>6.3. Prothoracic gland and MH<br>6.4. Hormonal control of Ecdysis and Metamorphosis<br>6.5. Hormonal control of Reproduction<br>6.6 Pheromones | 08 |
| 7 | Male and Female Reproductive system and its Physiology. | 05 |
| 8 | Diapause in Insects. | 02 |

**Books Recommended:**


**1. Chapman: The insect structure and function. 4th Ed. ELBS 1998.**

**2. Imms: A general textbook of Entomology Vol. I and Vol. II Asia Publishing House 1977.**

**3. Klowden: Physiology system in Insects Academic Press – 2002.**

**4. Me Gavin: Essential Entomology Oxford Univ. Press 2001, New Delhi.**

**5. Srivastava: A textbook of Applied Entomology Vol. I &II Kalyan Publishers New Delhi, 1988; 1993.**

**6. Wiggles worth: Principles of Insects Physiology ELBS – 1972.**

**7. Higman and Hill: Invertebrate Endocrinology.**

**8. Comprehensive insects Physiology, Biochemistry and Pharmacology. Executive edition G A Kerhut and Li Gilbert Vol. 1-3.**

**SEMESTER – IV**
**Discipline Centric Elective: Fish & Fisheries**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 414A | Applied Fish Biology | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
- **Questions will be grouped into two Groups A & Group B.**
- **Group A will comprise question no. 1 which will consist of two parts A & B. Part A will be MCQ type covering entire syllabus and carry one mark each (1x6=6). Part B will comprise short answer type questions. Each carries 4 marks (2x4=8) . There will be no option in question no. 1**
- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Physico-chemical of characteristics of (With special reference to India)<br>1.1. Marine<br>1.2. Fresh Water:<br>1.2.1. Lentic<br>1.2.2. Lotic<br>1.2.3. Riverine system in India<br>1.3. Estuaries | 07 |
| 2 | Fish farm construction & lay out<br>2.1. Site selection for Ideal Fish farm<br>2.2. Component ponds of a fish farm: Hatching ponds, Nursery Pond, Rearing & Stocking Ponds<br>2.3. Water & Soil: Physical and chemical properties | 07 |
| 3 | Role of Plankton in fish Production | 03 |
| 4 | Nutritional value & economic importance of fishes | 01 |
| 5 | Fishing Gears, Nets and Crafts used in different types of water bodies | 02 |
| 6 | Feeds of Fishes | 02 |

| | | |
|---|---|---|
| | 6.1. Natural Feeds<br>6.2. Supplementary & artificial Feeds | |
| 7 | Fish Pathology, Etiology & therapy of diseases<br>7.1. Nutritional Disease<br>7.2. Bacterial Disease<br>7.3. Viral Disease<br>7.4. Protozoan Disease<br>7.5. Helminthes Parasites | 05 |
| 8 | Role of hormones in Fish breeding | 04 |
| | **GROUP - B** | |
| 9 | Collection of seeds from Natural Sources | 04 |
| 10 | Carp Culture in India: Extensive, Semi- Intensive & Intensive | 02 |
| 11 | Integrated Fish farming<br>11.1 Fish cum Paddy farming<br>11.2. Fish cum animals<br>11.2.1. Poultry<br>11.2.2. Ducks<br>11.2.3. Pigs<br>11.3. Fish cum Makhana & Trapa | 02 |
| 12 | Nursery management<br>12.1. Rearing of Spawn to Fry<br>12.2. Fry to Fingerlings<br>12.3. Transport and marketing of fry & fingerlings | 03 |
| 13 | Composite or Poly culture of fishes<br>13.1. Methods of Culture<br>13.2. Constraints of Culture | 03 |
| 14 | Culture of non-Fish Organism<br>14.1. Prawn & Shrimp Culture in India<br>14.2. Edible Oyster<br>14.3. Culture of pearl Oyster | 04 |
| 15 | Reservoir Fisheries<br>15.1. Reservoirs of India<br>15.2. Pre & post management of reservoir | 04 |

| | | |
|---|---|---|
| 16 | Induced Breeding<br>16.1. Technique of Hypophysation<br>16.2. Hapa Breeding<br>16.3. Bundh Breeding | 03 |
| 17 | Special type of fish Farming<br>17.1. Cage Farming<br>17.2. Pen culture<br>17.3. Sewage fed fisheries<br>17.4. Cold water fisheries | 05 |
| 18 | Fish Spoilage<br>18.1. Rigor mortis: Factors responsible for Rigor Mortis<br>18.2. Rancidity & Autolysis<br>18.3. Microbial Spoilage | 02 |
| 19 | Fish Processing & Preservation | 01 |

## Books Recommended


1. Srivastava, C.B.L. A Textbook of Fishery Science and Indian Fisheries, KitabMahal ,1985
2. Fish and Fisheries of India, V G Jhingran
3. Fish and Fisheries of India, K Pandey and Shukla, Rastogi Publication
4. General and applied Ichthyology, Gupta and Gupta, S Chand and Co
5. Introduction to fishes, GopalJishrivastave,
6. Fresh Water fishes of India, K C Jayra

**SEMESTER – IV**
**Discipline Centric Elective: Molecular Biology**
**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 414B | Advanced Molecular Biology (Gene expression) | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
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- **Rest of eight questions will be descriptive type, set from the whole syllabus in group B. Examinees are required to answer any four from this group, each carrying 14 marks.**
- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | CONCEPT OF GENE<br>1.1Genome sizes: kinds of genes, gene numbers, functional genes, cryptic genes, pseudogenes, processed genes, overlapping genes, family of genes.<br>1.2 Gene structure: Structural organization of prokaryotic and eukaryotic genes-regulatory elements of genes (proximal or internal, including promoter, operator, activator and enhancers), coding region and terminal region of the genes.<br>1.3 Transcriptional Apparatus in prokaryotes: RNA polymerase structure, subunits and their function; sigma factor, their character and role; mechanism of transcription, initiation, elongation and termination. | 08 |

| | | |
|---|---|---|
| 2 | REGULATION OF PROKARYOTIC GENES EXPRESSION AND OPERONS<br>2.1 Genetic regulation of sporulation in B. subtilis, role of sigma factors in sporulation.<br>2.2 Regulation of Lac operon, Tryptophan operon and Arabinose-operon,<br>2.3 Concept of regulons, stimulons, operons, global regulators.<br>2.4 Lambda phage: Regulation of lytic and lysogenic pathway in lambda phage, cI-repressors, crorepressors, transcriptional terminators and antiterminator, early and late genes, their expression and regulation. | 07 |
| | **GROUP - B** | |
| 3 | EUKARYOTIC GENE EXPRESSION<br>3.1 DNA binding proteins- Concise account of Helix turn Helix proteins, Helix loop helix proteins, Helix turn beta, Zinc finger proteins, leucine zipper proteins, homeodomain proteins, beta barrels, .<br>3.2 Transcription factors (TFs): Concept of activators, activator domains, co-activators and mediator complex, enhancer proteins and their binding factors,<br>3.3 DNA binding sequence elements, response element binding factors and their role in general.<br>3.4 Mechanism of transcriptional initiation, elongation and termination. | 08 |
| 4 | EUKARYOTIC RNA POLYMERASE | 06 |

| | | |
|---|---|---|
| | 4.1 RNAP-I: rRNA gene clustering, structural organization of rRNA genes, Regulatory regions (core sequences and upstream control elements), coding and terminal regions;<br>4.2 RNAP I enzyme subunits, its associated transcriptional factors and their role, mechanism of transcription-initiation, elongation and termination.<br>4.3 RNAP-II : Structural organization of regulatory, coding and terminal regions of housekeeping genes; Genes that are regulated in response to stimuli-light, chemicals and hormones, stage specific and tissue specific gene regulation.<br>4.4 RNAP-III: Regulatory elements, (internal promoters), coding and terminal regions of 7sLRNA gene, tRNA genes, and 5SrRNA genes; RNAP III enzyme and its composition, transcriptional factors, assembly of the same and the mechanism of transcription and termination. | |

**Books Recommended:**

**1. Benjamin Lewin (2004), Gene VIII, Published by Pearson Prints Hall, Pearson Education inc. Upper saddle River, New Jerssey-07458**

**2. Bruce Alberts, Julian Lewis, Alexander Johnson, J. Lewis, M. Raff (1994), Molecular Biology of the Cell, Garland Publisher Inc., New York**

**3. Buchnan and Grussem et al, (2000) Biochemistry and Molecular biology of Plants by 5th edition, Oxford University Campus**

**4. Cooper, G M The cell: A molecular approach. 2nd edition, (2000), ASM Press, Washington**

**5. Eduardo Diego Patricio De Robertis, EMF De Robertis (1988), Cell and molecular biology, International Ed. Inst. Med. Ltd**

**6. Gerald Karp (2003), Cell and Molecular Biology, 3rd edition, John Wiley & Sons Publishers.(Concepts and Experiments)**

**7. Glick B.R. & J. J. Pasternal, (1994), ASM Press, Washington, D. C. Molecular Biotechnology**

**8. Gupta, PK, (2004) Biotechnology and Genomics, Rastogi Publishers, Meerut.**

**SEMESTER – IV**

**Discipline Centric Elective: Entomology**
**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 414C | AGRICULTURAL ENTOMOLOGY | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **In all nine questions are to be set of equal values and five questions are to be answered of which Question No. 1 will be compulsory.**
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- **The question No. 9 will be short notes type, each carrying seven marks (7x2=14) in which only 2 should be answered out of four options.**

| S. No. | Topic | Contact Hour |
|---|---|---|
| | **GROUP - A** | |
| 1 | Types of Pest and pest control. | 08 |
| 2 | Group characteristics of insecticide, structure and function of<br>2.1. Organochlorine,<br>2.2. Organophosphorus,<br>2.3. Fumigants,<br>2.4. Chemosterilants<br>2.5. IGR (Insect Growth Regulator) | 07 |
| 3 | Brief definition of Insecticide, Mode of action of insecticides; Metabolism and its toxicity on humans | 02 |
| 4 | Appliances used for insecticides<br>4.1. Dusters<br>4.2. Sprayers | 04 |
| 5 | Identification of pests, its seasonal history, biology, nature of damage and control measures of important pests of- | 02 |

| | | |
|---|---|---|
| | 5.1. Paddy pests<br>5.2. Cotton pests<br>5.3. Sugarcane pests<br>5.4. Stored grains pests<br>5.5 Vegetable pests | |

| **GROUP - B** | | |
|---|---|---|
| 6 | Locust- Its life history, phase transition, periodicity, migration, biology and control measures | 04 |
| 7 | Biological control of pests:<br>2.1. Definition, Agents of Biological Control<br>2.2. Parasites, Parasitoids, Predators and Pathogenic microorganism<br>2.3. Mass production, distribution, advantages and disadvantages of Biological Control | 02 |
| 8 | Integrated Pest Management (IPM): Other methods of Insect pest management | 02 |
| 9 | Pheromones-<br>9.1. Pheromones production, and their use in pest surveillance and management. | 02 |
| 10 | Social Insects:<br>10.1. Society of Insects, its social behaviour and management<br>10.2. Social organization of<br>10.2.1. Social organization of honey bee<br>10.2.2. Termites<br>10.2.3. Ants | 04 |
| 11 | Economic Zoology: Apiculture, Sericulture and Lac culture | 02 |
| 12 | Management of Insects: Attractants, repellants, antifeedants | 04 |
| 13 | Forensic Entomology & it's application. | 03 |

**Books Recommended**

**1. Atwal: Agricultural pests of India and south east Asia, Kalyani Publishers, 1986**

**2. Kumar and Nigam: Agricultural Entomology, Emkay Publication.**

**3. Kumar and Nigam: Applied Entomology, Emkay Publication.**

**4. Applied Entomology: K K Nayer**
**5. A Text Book of Agricultural Entomology: Hem Singh Pruthi, ICAR**

**SEMESTER – IV**
**Discipline Centric Elective: Fish and Fisheries**

**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 415A | Fish & Fisheries (Practical)based on ZOO E 413A & 414A | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

| Practicals | | | Marks Distribution |
|---|---|---|---|
| 1. Major Dissection (Bony fish) | | | 10 |
| | 1.1.Afferent branchial arteries | | |
| | 1.2.Efferent branchial arteries | | |
| | 1.3.Cranial nerves | | |
| 2. Minor dissection | | | 05 |
| | 2.1.Weberian apparatus | | |
| | 2.2.Accessory respiratory organ | | |
| | 2.3. Pituitary gland | | |
| | 2.4. Gonads | | |
| 3. Mounting | | | 05 |
| | 3.1.Scales | | |
| | 3.2.fish fry | | |
| | 3.3.fingerlings | | |
| 4. Identification of two local fresh fishes with morphometric measurements up to species. | | | 10 |
| 5. Spotting | | 2 Marks×10= | 20 |
| | 5.1. Bones | 03 | |
| | 5.2. Histological slides | 03 | |
| | 5.3. Net and Crafts | 02 | |
| | 5.4.Adaptive features | 02 | |
| 6. Class record | | | 10 |
| 7. Viva-voce | | | 10 |
| | | | TOTAL - 70 |

## SEMESTER IV

## Discipline Centric Elective: Molecular Biology

| PAPER-ZOO-E-415B | Practical based on ZOO E 413B & 414B | F.M=100(Extn.70+Int.30) |
|---|---|---|

**Time: 6 Hours** **Full Marks: 70**

| | | |
|---|---|---|
| **1. Quantitative analysis of Protein/ DNA** | | **12** |
| **2. Isolation and determination of size of DNA by AGE** | | **12** |
| **3 Isolation of plasmid from bacteria** | | **12** |
| **4. Spotting** | **2 x 6=12** | |
| **5. Models /Charts/Sessional work** | | **06** |
| **6. Practical records** | | **06** |
| **7. Viva-voce** | | **10** |
| | | **TOTAL - 70** |

**List of suggested practical's:**

1. **Quantitative analysis of DNA.**
2. **Spectral analysis of Proteins.**
3. **Isolation of genomic DNA from plants / animals / microorganisms.**
4. **Separation of DNA by Agarose Gel Electrophoresis**
5. **Determination of molecular weight and quantification of DNA using AGE.**
6. **Isolation of plasmid and determination of purity.**
7. **Estimation of RNA from sample.**
8. **Restriction digestion of genomic DNA from plants/ animal tissue/ microorganisms.**
9. **Agarose gel electrophoresis of restriction fragment.**
10. **PCR amplification of DNA.**
11. **Extraction of total RNA from Plant tissue /animals/micro organisms**
12. **Separation of RNA through AGE.**
13. **For spotting- Instruments used in Molecular Biology, Photographs of Gel, Plasmid etc.**

**SEMESTER – IV**

**Discipline Centric Elective: Entomology**
**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 415C | Practical based on ZOO E 413C &414C | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

**Practicals Distribution** **Marks**

1. **Minor dissections and Temporary mounting** **10**
2. **Major dissections** **10**
3. **Spotting**
   a. **Permanent slides: Mouth parts of male & female mosquito(Anopheles)**
   b. **genitalia**
   c. **respiratory organs**
   d. **wings: Scales & whole mounts of wings of Dipteral & Hymenoptera**
   e. **endocrine organs**
4. **Spotting of pests & Parasites**
   a. **Predators/ Venomous Insects**
   b. **Beneficial insects**
   c. **Insect Catching Devices** **6x2.5=15**
5. **Study of common equipments used in insect control programmes** **05**
6. **Taxonomic identification - Spotting (5 marks x2)** **10**
7. **Records and Sessional work** **10**
8. **Viva voce** **10**

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**Total = 70**

**List of Practicals**

1. **Major Dissection:**
   **General anatomy and nervous system of Cockroach, Honey bee Grasshopper**
2. **Minor Dissection and temporary mounting:**
   a) **Tentorium of Cockroach,**
   b) **Arista and Haltere of House fly,**
   c) **Tympanum of Grasshopper,**
   d) **Spiracle of Grasshopper / Cockroach,**
   e) **Sting apparatus and Pollen basket of Honeybee,**
   f) **Scales of Butterfly/ Moth,**
   g) **Antennae of Termite & Coleoptera**
3. **Taxonomic description and identification of various insects belonging to the order: Phasmida, Isoptera, Dictyoptera, Hemiptera, Hymenoptera, Coleoptera.**
4. **Study of permanent slides: Whole mount of mouth parts, antenna, wings, legs, and genitalia**
5. **Histological slides of**
   **Digestive, Excretory, Reproductive, and Endocrine organs**

**6. Study of pests:**

a) **Stored grains,**
b) **Paddy,**
c) **Wheat,**
d) **Sugarcane,**
e) **Termites,**

**SEMESTER – IV**
**Dissertation**
**(Credit – 05, Lectures – 60, Tutorials - 15)**

| PAPER – ZOO – E – 416 A* /B*/C* | Dissertation | F.M=100 (Extn.70 + Int.30) |
|---|---|---|

- **Mid-Semester/Internal Assessment Examination = 30 marks**
- **End Semester Examination: Project model (if any) and the Project record notebook, Project presentation and viva-voce = 70 marks**
  **(Jointly conducted by One External & One Internal Examiners)**

**Overall project dissertation will be evaluated under the following heads:**

- Motivation for the choice of topic
- Project dissertation design
- Methodology and Content depth
- Results and Discussion
- Future Scope & References
- Participation in Internship programme with reputed organization
- Application of Research technique in Data collection
- Report Presentation
- Presentation style
- Viva-voce

**Note**:

**(a)** Each student must submit two copies of the dissertation work duly forwarded by the Head of the Department and duly signed by the supervisor concerned. The forwarded copies will be submitted to the concerned Department of University, for evaluation. The paper will consist of

- Field work/Lab work related to the project
- Preparation of dissertation based on the work undertaken.
- Presentation of project works in the seminar on the assigned topic & open viva there on.

**(b)** Each student shall have to complete a project work on a topic allotted by his/her Project Guide/Supervisor/Department in Semester -IV. This is compulsory and the candidates shall ensure that his project is on a relevant topic completed by him

independently with the help and inputs from his/her guide/supervisor. Other guidelines pertaining to this paper shall be provided by the Department.

**(c)** Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular intervals.

**(d)** Students will select topics for the project work in consultation with a teacher of the Department. The Seminar will be held in the concerned Department of University.

**The Dissertation/Project** shall be presented with the following specifications:

**(a) Size of Paper**: A4. Dissertation/Project must be printed on one side of the paper.

**(b) Font Type**: Times New Roman.

**(c) Font Size**: Font size for English text is 12pt.

**(d) Font of Chapter Headings and Sub-Headings**:

- Chapter headings may be written in all Capitals, bold text in font size 14
- Sub-headings are written with left margin alignment
- First level sub-headings are written in normal sentence case using bold text in point size 14
- Second level sub-headings are point size 13

**(e) Spacing and Paragraphing:**

- Printing shall be in standardised form with 1.5 line spacing
- Leave as triple spacing (2 empty lines) in base font size 12 before and after subheadings and one empty line after all sub-headings
- Use one empty line between left-justified paragraphs

**(f) Margin**: Left margin should be 4cm and right, top and bottom margin should be 2cm. No ornamental bordering of sides is permitted.

**(g) Page Numbering**: Preliminary pages of the Dissertation/Project, i.e. those preceding in text are to be numbered in Roman numbered. Text should be numbered in Arabic beginning with Page No 1 on the first page of chapter 1

**(h) Preliminary sections of the Dissertation/Project** should include, Declaration of Attendance, Certificate from Supervisor, Declaration by Candidate and Supervisor regarding Plagiarism, Acknowledgement, Table of Contents, List of Tables, List of Figures/Diagrams, List of Abbreviations (if any) and an Abstract of the Dissertation/Project.

**(i)** **Referencing and Citation Style**: Citation i.e. a way of giving credit to individuals for their creative and intellectual works that you utilised to

support your research, differs by faculty in the style of ordering, punctuating and formatting of name, date, page, work etc. The referencing of work and Citation style in the Dissertation/Project submitted in Faculty of Science (Zoology) will be in **American Psychological Association (APA)** style (6th edition).

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**A*- Fish and Fisheries**

**B*- Molecular Biology**

**C*- Entomology**