UNIVERSITY DEPARTMENT OF ZOOLOGY

BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY

DHANBAD

Syllabus of M.Sc. (Zoology) as per CBCS Program
From the Academic year: 2018 -19 onwards

Syllabus of M.Sc. (Zoology) as per CBCS Programme
From the Academic year: 2018 -19

A brief description of the course:

Purpose:

- To understand the importance of taxonomy and the biodiversity of fauna (non chordate and chordate) and their conservation.
- To study comparative structure and function of the different organ systems and their physiological importance in relation to habit and habitat of the organism.
- To understand the biochemical integrity of various life processes.
- To have advanced knowledge on animal genetics, molecular biology and developmental biology and their applications
- To prepare the students for pursuing advance studies in various fields of animal's Sciences through research

Semester I **Paper 1** **Foundation of Zoology** **ZOO F 01**

Time 3 Hours **FM 70**

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer type 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

Foundation of Zoology : Group

A Animal Systematics and Evolution

1 Importance and application of biosystematics in biology.
2 Chemotaxonomy Cytotaxonomy, Molecular taxonomy,
3 Species and species concept.
4 Synthetic theory of Evolution
5 Molecular phylogeny – Construction of phylogenetic tree, Nucleic acid phylogeny – DNA – DNA hybridization, restriction enzyme site mapping technique, nucleotide sequence comparison.

Fundamentals of Histotechniques

6 Histochemistry

Histochemical stains: Histochemical identification and localization of the following:

i. General protein localization by Mercury Bromophenol Blue
ii. Ninhydrin-Schiff reaction
iii. General lipids by Sudan Black B method
iv. DNA by Feulgen reaction

Foundation of Zoology: Group-B

Tools and Techniques

7 General Principle and applications of
Spectrophotometry: Visible and UV.
8 Separation technique: Electrophoresis, Principles, types and applications PAGE and Agarose gel Electrophoresis
9 Microscopy, principle & applications
b. Fluorescence microscope
c. Electron microscope
10 Molecular biology techniques
d. Southern blotting
e. Northern blotting
f. Western blotting
g. DNA Sequencing
11 Autoradiography.
12 Polymerase chain reaction (PCR)

Books Recommended

1. Dobzhansky Th. (1964): Genetics and the Origin of Species. Columbia.
2. Futuyma D. J. (1998): Evolutionary Biology. Sinauer
3. Kimura M. (1984): The Neutral Theory of Molecular Evolution. Cambridge.
4. Mayr E. (1966): Animal Species and Evolution. Belknap Press
5. Strickberger M. W. (2000): Evolution. Jones and Bartlett
6. Wilson and Walker Practical Biochemistry
7. Pearse, A.G.E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill-Livingstones, 1980-1993
8. Staining methods Histologic and Histochemical, J F AMcMannus and Rubert W Mowry, Harper and Row 1964

Semester – 1 **ZOOC 02**

Paper 2 Animal Diversity (Non chordate and Chordate)

Time 3 Hours **FM 70**

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

Animal Diversity: Group-A

1. Origin of metazoan
2. Locomotion.
    2.1 Modern concept of Flageller and Ciliary movement in protozoa
3. Nutrition and Digestion
    3.1 Filter feeding in polychaeta.
4. Respiration
    4.1 Respiration in Arthropoda, Respiration in mollusca
5. Excretion in invertebrates
    5.1 Excretion and osmoregulation in annelids.
6. Invertebrate larval forms and their evolutionary significance: Larval forms of crustacea
7. Miscellaneous topics
    7.1 Adaptive radiation in polychaetes
    7.2 Ancestral mollusc and derivation of different modern classes

Animal Diversity: Group-B

8. Geological time scale and fossil
9. Origin and evolution of: Amphibia & Birds
10. Rhyncocephalia
11. Dinosaurs and their causes of extinction
12. Adaptive radiation in Mammals
13. Dentition in mammals
14. Primitive mammals:
    14.1 Prototheria
    14.2 Metatheria

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.
4. Hildebrand, M. Analysis of Vertebrate Structure, 4th edition, John Wiley & Sons, Inc., New York, 1995.
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., TextBook of Zoology, Vol. II, ELBS, 1978.
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 – 1 **ZOOC 03**

Paper 3

Endocrinology and Developmental Biology

Time 3 Hours **FM 70**

Paper consists of 60 credit hours

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions of fill in the blanks/one word answer, /true /false type. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Group-A Endocrinology

1 Hormonal regulation of implantation pregnancy Parturition, Placental hormones
2 Hormones and mechanism of their action
3 Neuroendocrine system and Neurohormones
4 Pineal in vertebrates, its hormones and their function.
5 Functions of the hormones secreted from – Hypothalamus (mammals only)
6 Biosynthesis and secretion of
    6.1 Amino acid derived hormone (T_3T_4)
    6.2 Biosynthesis of steroid hormones
7 Hormonal control of fuel metabolism: Insulin Glucagon Epinephrine
8 Hormone and Homeostasis
9 Gastrointestinal hormones and their regulation

Group- B Developmental Biology

10 Molecular events of fertilization and prevention of polyspermy.

11 Organiser concept

12 *Caenorhabditis elegans* - Cell lineage and developmental events.
13 Cell differentiation:
    12.1 Myogenesis (skeletal muscle - formation, regeneration and hypertrophy)
    12.2 Haemopoetic Stem cells and their diversification
    12.3 Haemoglobin biosynthesis
14 Genes controlling embryogenesis
    13.1 Determination of the embryonic axes (Drosophila)
    13.2 Homeotic genes

Books Recommended

1. Human Embryology & Developmental Biology, 5E, Bruce M. Carlson, MD,

PhD Saunders, ISBN 978-1-4557-2794-0 (pbk.)

2. A Text Book of Histology, William Bloom and Don W Fawcett, Saunders
3. General and Comparative Physiology, William S Hoar, Prentice Hall of India, 2004
4. Developmental Biology, S F Gilbert_9e.
5. A Text Book of Medical Physiology, 11e, Arthur C Guyton
6. Principles of Anatomy and Physiology 12th Edition – Gerard J Tortora, Wiley 2009
7. Vander's Human Physiology: The Mechanisms of Body Function (13th edition)

McGraw Hill, ERIC P. WIDMAIER, HERSHEL RAFF, KEVIN T. STRANG

Books Recommended:

1. Alberts et al.: Molecular biology of the cell. Garland, 2002.
2. Gilbert: Developmental biology. Sinauers, 2003.
3. Kalthoff: Analysis of biological development. McGraw-Hill, 1996.
4. Wolpert: Principles of development. Oxford, 2002.
5. Molecular Biology of the Gene, Watson
6. Molecular Cell Biology, Lodish, Berk, Zipursky, Matsudaira, Baltimore, Darnell

Books Recommended

1. Hadley: Endocrinology, Prentice hall. International Edition. 2000
2. Norris: Vertebrate Endocrinology (2nd ed). Lea &Febriger. 1997
3. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science. 1995
4. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia. 1984
5. Larson: Williams Text Book of Endocrinology, 10th edition. W. B. Saunders Company, Philadelphia. 2002.

Semester I **Paper IV Practical** **ZOOP 04**

Full Marks-70 **Time 6 Hours**

Practicals

			Marks distribution
!. Dissection:			6**X2=12**
a. Vertebrate		06	
b. Invertebrate		06	
2. Slide preparation			**04**
3. Spotting		2X10=	**20**
a. Slides	(04)	2X4=08	
b. Museum Specimens	(04	2X4=08	
c. Bones	(02)	2X2=04	
4. Reproductive Physiology& Endocrinology			5X2=**10**
a. Reproductive physiology		05	
b. Endocrinology		05	
5. Systematics and Evolution			**04**
6. Class record, poster/models/collection			**10**
7. *viva-voce*			**10**

1. A. 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
   B. Slide preparation- Gemmule of sponge, Obelia colony, Statocyst of prawn, ovary of earthworm, Daphnia, placoid and cycloid scale.
2. Museum Specimens- Euspongia, Physalia, Metridium, Taenia, Ascaries, Nereis, Aphrodite,
3. Permanent Slides: Invertebrate and Mammals (General histology, reproductive organs and endocrine glands.
4. Bones: Fish & Mammals, Different types of Teeth of mammals
5. 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 – 2 **ZOOS 05**

Paper 5 **Skill Development programme**

Time 3 Hours **FM: 35**

Paper consists of 60 credit hours,

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Basics of Bioinformatics and Biostatistics

Group – A Bioinformatics

1. Principles of bioinformatics and its application.
2. Concepts of digital library.
3. Biological databases:
   i. File formats- FASTA, and Clustal W.
   ii. Nucleic acid sequences databases: Gene bank.
   iii. Protein sequence, structural and interacting proteins databases: SOPMA, PDB,
   iv. Literature databases: PubMed. OMIM, NCBI.

7. Access to molecular biology data bases
   7.1 Entrez
   7.2 Sequence retrieval system (SRS)
   7.3 Protein identification resource (PIR)
   7.4 BLAST

Group – A Biostatistics

8. Sampling:
   8.1 Concept of sampling and sampling methods,
   8.2 Test of significance for small sample (t-test).
   8.3 Hypothesis formulation and testing of Hypothesis
9. Parametric and Non parametric statistics.
10. Chi-square analysis.
11. Probability distributions and their properties.
11 Theoretical distribution:
   11.1 Normal distribution.
   11.2 Binomial distribution.
   11.3 Poisson distribution.

12. Correlation:
   12.1 Definition types of correlation

12.2. Methods of studying correlation

12.3 Karl Pearson coefficient of correlation

12.4 Rank correlation method.

13. Regression analysis: 13.1

Regression lines

13.2 Regression equations

Books Recommended

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.

Books Recommended

1. Biostatistics: Principles and Practice 1e. Prasanna Samuelson, Solomon Christopher, B Antonisamy
2. Introduction to Biostatistics and Research Methods 5th Edition, SUNDAR RAO, RICHARD

Practical: V **Time 4 Hours** **FM:35**

Practicals Marks distribution

1.	Data presentation	5 Marks
2.	Problem from I. Measurement of central tendencies II. Measures of deviation III. Test of significance- chi square test IV. Co-relation and regression analysis of data	5 + 5 = 10 Marks
3.	Comment on the spot	5 Marks
4.	Create a file format of given gene / protein	5 Marks
5.	viva-voce	5 Marks
6.	Practical record	5 Marks

Biostatistics: Practical will be based on theory paper

1. Sampling, Data collection, tabulation and graphical representation.
2. Measurement of central tendencies
3. Measures of deviation
4. Test of significance- chi square test
5. Co-relation and regression analysis of data

1. Writing file format for Protein and Nucleic acid
2. To perform experiment with Blast
3. Prediction of Secondary structure by using SOPMA
4. To study hard and soft devices of computer.

Semester – 2 **ZOOC 06**

Paper 6 **System Physiology and Biochemistry**

Time 3 Hours **FM 70**

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

Group-A System Physiology

1. Role of Haemoglobin in transport of gases, Hill equation
2. Excretion
    - 2.1 Urine formation
        - 2.1.1 Glomerular filtration
        - 2.1.2 Tubular reabsorption and secretion
        - 2.1.3 Counter current mechanism
        - 2.1.4 Hormonal regulation
    - 2.2 Ornithine cycle
    - 2.3 Acid-base balance and homeostasis
3. Nervous system
    - 3.1 Axonal transmission
        - 3.1.1 Neuron and its types
        - 3.1.2 Genesis of membrane potential and action potential
        - 3.1.3 Sodium-potassium pump
    - 3.2 Synaptic transmission
        - 3.2.1 Types of synapses and synaptic knobs
        - 3.2.2 Excitatory and inhibitory post-synaptic potential

3.2.3 Chemical transmission, neurotransmitters

4. Muscle
    - 4.1 Ultrastructure of skeletal muscle fibers
    - 4.2 Muscle proteins
    - 4.3 Sequence of events in contraction and relaxation of skeletal muscle
    - 4.4 Energetics of muscle contraction
    - 4.5 Muscle twitch, summation, tetanus and fatigue
    - 4.6 Isotonic and isometric contraction
    - 4.7 Cori cycle

5 Cardiovascular System: myogenic heart, ECG – its principle and significance, cardiac cycle,

6 Physiology of sense organs – Vision and hearing.

Group-B Biochemistry

7 Amino acid
    - 7.1 Structure
    - 7.2 Reactions due to functional groups

7.3 Titration curve

8 Protein: Primary structure, peptide bond,
Secondary structure-α helix, β pleated sheet & Protein folding, Ramachandran plot
Tertiary and Quaternary structure – Bonds stabilizing structure, Domains and motifs

9. Enzymes
9.1 Classification and general properties
9.2 Enzyme kinetics Derivation of Michaelis-Menten equation
9.3 Concepts of regulation of enzyme activity

10. Carbohydrates
10.1Structure and classification of Carbohydrates. Properties of monosaccharaides and Oligosaccharides
10.2 Polysaccharide of physiological significance.

10. Metabolism: Electron transport chain, oxidative phosphorylation

11.Lipids: Lipids of physiologic (Clinical) significance, membrane lipids, cholesterol
11.2 Synthesis of fatty acids

12. Errors in Biosynthetic Pathways:
Inborn Errors of Amino acids catabolism- Alkaptonuria, Albinism and Phenylketonuria

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.), Williams and Wilkins, 1981.

Books Recommended

1. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
2. Berg et al: Biochemistry (5th Ed.), Freeman, 2002
3. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004
4. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
5. Biochemistry, 7e, Jeremy M. Berg, John L. Tymoczko,
LubertStryer W. H. Freeman and Company, New York
6. Lehninger, PRINCIPLES OF BIOCHEMISTRY, 5e. David L. Nelson, Michael M. Cox

Semester – 2 ZOOC 07

Paper 7 Immunology and Microbiology

Time 3 Hours FM 70

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

Immunology and Microbiology

Group-A

1. Overview of the immune system:
    - 1.1 Components of the immune system
    - 1.2 Biology of vertebrate Immune System, Innate and Acquired Immunity
2. Organs of immune system: organization and structure.
3. Antigen
    - 3.1 Nature of antigens and superantigens
    - 3.2 Antigenicity and immunogenicity
    - 3.3 Hapten and Epitopes
4. Antibody, organization and expression of lg genes, Generation of antibody diversity
5. Cells of the immune system:
    - 5.1 B-cell - generation activation and differentiation
    - 5.2 T- cell generation activation and differentiation
6. Lymphocyte trafficking
7. Cytokines: Structure and functions and their receptors
8. Hypersensitivity
9. Transplantation Immunology
10. Autoimmunity
    - 10.1 Organ-Specific Autoimmune Diseases
    - 10.2 Systemic Autoimmune Diseases
    - 10 3 Evidence Implicating the CD4+ T Cell, MHC, and TCR in Autoimmunity

Group-B

13. Methods in microbiology:
    - 13.1 Theory and practice of sterilization
    - 13.2 Culture media and types

14. Bacteria: Bacterial growth and growth curve

15. Virus
    - 15.1 Classification
    - 15.2 Structure of viruses
    - 15.3 Reproduction
        - 15.3.1 Lytic cycle
        - 15.3.2 Lysogenic cycle
        - 15.3.3 Role of lambda repressor
16. Pathogenic microbes
    - 16.1 Rabies
    - 16.2 Prions
17. Antibiotics: Chemistry their mode of action
18. Vaccine: Types, Vaccine preparation.

Books Recommended

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 4e.

Books Recommended

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 Diseases,4e,Kenneth J Ryan and C.George ray,McGraw Hill.
5. Michael C Pelczar, Microbiology,
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

Semester – 2 Practical ZOOP 08

Paper 8 Time 6 Hours F. M. =70

1.	Physiology & Biochemistry	
	a. Physiological Experiment	10
	b. Biochemistry	10
2.	Tools & Techniques	
	1. Apparatus (one)	05
	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**:
   - I. Determination of blood pressure by sphygnmanometer.
   - II. Demonstration of diffusion process/osmosis across a membrane
   - III. Determination of clotting and bleeding time
   - IV. Heamin Crystal preparation

2. **Biochemistry**

   - I. Construction of models of bio molecules by wire and beads.
   - II. Preparation of haemin crystal.
   - III. Estimation of Hb concentration.
   - IV. Detection of presence of blood by Benzedrine test
   - V. Quantitative estimation of glucose in the unknown sample

3. **Study of laboratory apparatus**- autoclave, Microtome, pH meter, Centrifuge, Colorimeter,

4. **Hstological and otherTechniques**

   1. Microtomy- Fixation , block preparation, section cutting ,spreading and staining of tissues section.
   2. Histochemical demonstration
      - I. Sudan black for lipid
      - II. PAS for carbohydrate
      - III. Bromophenol blue for protein
   3. Morphometric measurement by oculometer and stage micrometer
   4. Image drawing by camera lucida
   5. Paper chromatography

5. Microbiology

   1. Sterilisation technique
   2. Media preparation for microbial culture
   3. Gram staining of bacteria
   4. Antibody sensitivity test

6. Immunology

I. Study of Immune cells in a blood film.
II. Demonstration of agglutination reaction by blood grouping.
III. Mancini's radial Immunodiffusion test
IV. Ouchterlony double Immunodiffusion test

PAPER – 09 **ZOO-OE-09**

Open elective: Medical Laboratory techniques

Time 3 Hours **FM 35**

In all **NINE questions are to be set of equal values (7 marks each) and five questions are to be answered.** Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 7 marks each)

Paper consists of 60 credit hours

Medical Laboratory techniques

1. Hemopoetic tissue, Hemopoetin and Hemopoesis
2. Blood composition
3. Blood Group and Blood transfusion
4. Methods of Measuring Blood Pressure
5. Blood cells
6. Hb % analysis
7. Blood smear preparation
8. TC/DC
9. Serum analysis
   I. Glucose II.
   Uric acid
   III.Kidney function test

   V. Thyroid panel test
10. ELISA technique: Theory, Kit study, ELISA plate reader
11. Medical Imaging techniques using photographs and reports:
    a. X-ray
    b. MRI
    c. Ultra sound

Suggested readings:

1. Preventive and Social medicine, Park, K
2. Text Book of Medical Laboratory Technology, 11 Edition, Bhalani Publishing House, Godkar P B and Godkar D P
3. Test Book of Medical Physiology, A C Guyton, Saunders Publication
4. A Laboratory Manual for Rural Tropical Hospitals, A basis for Training Courses
5. Pathologic Basis of Disease, VIII Edition, Saunders, Robbins and Carton
6. Lab Manual on Blood Analysis and Medical Diagnostics, S Chand & Company Ltd., Prakash

Practical based on theory Syllabus

Practical IX	**Time 6 Hours**	**FM:35**
Practical		**Marks**
1.	Major experiment	1 x 10 Marks = 10 Marks
2.	Minor experiment	1 x 5 Marks = 5 Marks
3.	Spotting	5 x 2 Marks = 10 Marks
4.	Record	5 Marks
5.	viva-voce	5 Marks

List of Practicals

A Major experiment

1 Hb % estimation

2 RBC and WBC count

3 Estimation of Blood glucose

4 Estimation of Serum Uric acid

BMinor experiments

1 Blood smear preparation

2 Blood cell identification

3 Blood grouping

4 Measurement of Blood pressure

5 Determination of Bleeding and Clotting time

CStudy of lab apparatus

Semester – 3 **ZOOC 10**

Paper 10 **Cell Biology and Genetics**

Time 3 Hours **FM 70**

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Cell Biology and Genetics

Group-A Cell Biology

1. Cell Division- theory of Chromosomal movement, Cell cycle, Role of CDK and regulatory points.
2. Bio-membrane
    - 2.1 Molecular organization, Fluid-Mosaic model
    - 2.2 Transport across the cell membrane
3. Nucleus - Structure of Nuclear membrane and nuclear transport
4. Protein Trafficking:
    - 4.1 Protein synthesis on free and bound polysomes
    - 4.2 Uptake into ER
    - 4.3 Golgi sorting
    - 4.4 Post translational Modification-Glycosylation

5. Cytoskeleton- Assembly of cytoskeleton filaments Molecular motors and their roles.
6. Programmed cell death (Apoptosis).
7. Ultra structure of chromatin fibre
8. Telomere and its maintenance.
9. Cell junction and Cell-Cell adhesion

Group-B Genetics

10. Mendelism and its variations, discussion on problems related to Mendelism.
11. Gene mapping methods – linkage maps, mapping with molecular markers RFLP
12. Sex determination in *Drosophila* and Human
    - 12.1 Role of alternate splicing
    - 12.2 Role of SRY gene
    - 12.3 SXL – gene
13. Use of RDT to identify human genes
    - 13.1 Huntington's disease and chromosome jump
    - 13.2 Cystic fibrosis and chromosome walk
14. Transposons / Mobile genetic element
    - 14.1 Transposable elements in Bacteria
    - 14.3 Transposable elements in Eukaryotes
    - 14.3 Transposable elements in Human
15. Gene regulation: Regulation of Prokaryotic gene expression
    - 15.1 Inducible and Repressible gene expression

15.2 Positive and negative control of gene expression
15.3 Lac operon
I. Induction
II. Catabolic repressor
III. Use of IPTG
15.4 Trp operon
I. Repression
II. Attenuation

Book recommended

1. Alberts et al: Molecular Biology of the Cell(4th Ed.),Garland,2002
2. Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
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, 7ed, 2013 Wiley
7. Brooker: Genetics: Analysis and Principles (Addison-Wesley, 1999)
8. Gardner et al: Principles of Genetics (John Wiley, 1991)
9. Griffith et al: Modern Genetic Analysis (Freeman, 2002)
10. Hartl& Jones: Essential Genetics: A Genomic Perspective (Jones &Bartlet, 2002)
11. Lewin, Genes VIII (Wiley, 2004)
12. Russell: Genetics (Benjamin Cummings, 2002)
13. Snustad& Simmons: Principles of Genetics (John Wiley, 2003).

Semester – 3 **ZOOC 11**

Paper 11 Environment Biology & Toxicology
Time 3 Hours **FM 70**

Contract Hours: 60 Hrs **Credits: 5**

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Environment Biology & Toxicology
Group-A

1. Population
    - 1.1 Characteristics
    - 1.2 Competition- intra and interspecific competition.
    - 1.3 Competition theory, modelling competitive exclusion and coexistence.
2. Community organization
    - 2.1 Nature of communities, Analysis of community structure.
        - 2.1.1 Analytic characters
            - I. Qualitative character
            - II. Quantitative character
        - 2.1.2 Synthetic character
3. Ecological Niche concept
    - 3.1 Niche breadth
    - 3.2 Niche overlap
    - 3.3 Gaussian principles
4. Biodiversity
    - 4.1 Levels of biodiversity
    - 4.2 Uses of biodiversity
    - 4.3 Distribution of biodiversity
    - 4.4 Hot spots of biodiversity
    - 4.5 Threats and conservation of biodiversity
    - 4.6 India's biodiversity and its conservation
    - 4.7 Biodiversity Indices
5. Community function: Productivity
    - 5.1 Concept of productivity- Primary and Secondary Productivity,
    - 5.2 Factors affecting productivity and methods of measurements

6. Ecological restoration
    - 6.1 Terms and definition
    - 6.2 Bioremediation concept, Environmental limitation for bioremediation
7. Biosensors.

Group-B

8. Environmental wastes management: Domestic, agricultural and hazardous wastes management.
9. Major Anthropogenic Global environmental problems
    - 9.1 Acid rain
    - 9.2 green house effects
    - 9.3 Smog
    - 9.4 Ozone depletion
    - 9.5 Heavy metal toxicity
    - 9.6 Food additives and their effects.
    - 9.7 Public Health and occupational Hazards due to environmental disasters.
10. Environmental Impact Assessment (EIA), purpose, aim, process
11. Sustainable development and Ecological economics. Cost benefit analysis (models) and its application.

Books Recommended

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

Sem III **Practical** **Time 6 Hours**

Paper XII **ZOOP 12**

Practical **Full marks-70**

1. Environment Biology	20
2. Cell Biology	15
3. Genetics	15
4. Class Records, poster/models	10
5. Viva voce	10
Total	70

List of practicals

1. **Environment Biology**
    1. Study of adaptation in; aquatic Insect, Fresh water fish, higher vertebrates
    2. Identification of some common planktons
    3. Water analysis for – Dissolved oxygen, free carbon di-oxide, total alkalinity and chloride in water.
    4. Determination of population structure by quadrate method.
    5. Estimation of biodiversity indices.
3. **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 *Drsophila*/*chironomous*
    4. Staining of mitochondria from human cheek epithelial cells
    5. Demonstration of barr body in cheek epithelial cells /hair follicle
4. **Genetics**
    1. Proof of mendelian ratio of law of inheritance using pea seed samples
    2. Determination of gene mapping.
    3. Study of *Drosophila* mutant

ENTOMOLOGY ZOOE 13

Sem IV Paper XIII

Time 3 Hours FM 70

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

Insect Diversity and Insect Physiology

Group-A

1. Classification and phylogeny of Insects
   - I. Classification of the Apterygote Orders: Thysanura, Diplura, and Collembola.
   - II. Classification of Exopterygote Orders: Orthoptera, Hemiptera.
   - iii. Classification of Endopterygote Orders: Lepidoptera, Diptera and Hymenoptera.
2. Structure and life processes:
   - I. Integument: Structure and chemistry, cuticular modifications, Apolysis, Ecdysis and sclerotization, modification.
   - II. Digestive system: General structure and modification of the alimentary canal, salivary glands, mechanism of digestion, micro-organisms of the intestine.
   - III. Respiration - Respiration in aquatic, terrestrial insects.
   - IV. Circulatory system: Haemolymph, constituent and their function, Heart and accessory pulsatile organs.
   - V. Excretion - Malphighian tubules and other organs of excretion, Metabolic pathways of nitrogenous excretion.

Group-B

3. Sense organs and perception:
   - I. Mechanoreceptors,
   - II. Chemoreceptors,
   - III. Visual organs: Compound eye
4. Effector organs: Light producing organs and mechanism of light production.
5. Insect Endocrinology:
   - a. NSC and neurohormones,
   - b. Corpora allata and JH,
   - c. Prothoracic gland and MH.
   - a. Hormonal control of ecdysis and metamorphpsis,
   - b. Hormonal control of reproduction.
6. Reproductive system and its Physiology

7.Diapauses in insects.

Books Recommended

1. Chapman: The Insects: structure and function 4th Ed. ELBS, 1998

2. Imms: A general text book of Entomology Vol I and II. Asia publishing house, 1977

3. Klowden: Physiological systems in Insects, Academic Press 2002

5. Srivastava:A text book of applied entomology Vol I & II Kalyani Publishers, New Delhi, 1988, 1993

6. Wigglesworth: Principles of Insect Physiology, ELBS, 1972.

7. Highnam and Hill: Invertebrate Endocrinology

8. Comprehensive Insect Physiology Biochemistry and Pharmacology, Executive Editors G A Kerkut and L I Gilbert Vol I to 13

ELECTIVE PAPER XIV ZOOE 14
AGRICULTURAL ENTOMOLOGY

Time 3 Hours **FM 70**

Paper consists of 60 credit hours

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

AGRICULTURAL ENTOMOLOGY

Group-A

Definition of pesticides, brief history, metabolism of insecticide; mode of action of insecticide

1 Principles of pest control.
2 Group characteristics of insecticide, structure and function of
   a. organochlorine,
   b. organophosphorus,
   c. fumigants,
   d. Chemo-sterilants.
3 Insecticide appliances – Duster and sprayers.
4 Identification, seasonal history, biology, nature of damage and control measures of important pests of-
   a. Paddy,
   b. Cotton,
   c. Sugarcane and
   d. Stored grain

Group-B

5 Locust- phase transition, periodicity, migration, biology and control measures
6 Biological control of pests.
7 Integrated Pest Management.
8 Pheromones- production, and their use in pest surveillance and management
9 Insect Society: group of social insects and their social life; evolution of sociality;
   a. social organization and social behaviour in honey bee,
   b. termites
10 Forensic Entomology: Introduction to forensically important insects.

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 KNayer
5. A Text Book of Agricultural Entomology: Hem Singh Pruthi, ICAR

Sem IV Paper XV ZOOP 15

ENTOMOLOGY PRACTICAL Time 6 Hours

Time 3 Hours **FM 70**

1.	Major Dissection	10
2.	Minor Dissection and temporary mounting (5+5)	10
3.	Spotting Permanent slides [mouth parts- 1, genitalia/ respiratory organs/ wings, histological slide- , endocrine organs- 1] (3 x 2.5 marks)	15
4.	Spotting [pests, parasites, - 1, predators/ venomous insects/ Beneficial insects- 1, insect catching devices- 1] (3 x 2.5 marks)	
5.	Study of common equipments used in insect control programmes	05
6.	Taxonomic description of Insects	10
7.	Records and Sessional work	10
8.	Viva voce	10

List of Practicals

1. Major Dissection:
2. General anatomy and nervous system of *Poikilocerus*, *Apis*
3. Minor Dissection and temporary mounting:Tentorium of Cockroach, Arista and Haltere of House fly, Tympanum of Grasshopper, Spiracle of Grasshopper / Cockroach, Sting apparatus and Pollen basket of Honeybee, Scales of Butterfly/ Moth, Antennae of Coleoptera and Hymenoptera, Reproductive system of Mosquito.
4. Taxonomic description and identification of various insects belonging to the order:
5. Phasmida, Isoptera, Orthoptera, Dictyoptera, Hemiptera, Hymenoptera, Diptera, Coleoptera, and Lepidoptera
6. Study of permanent slides:Whole mount of mouth parts, antenna, wings, legs, and genitalia Histological slides of Digestive, Excretory, Reproductive, and Endocrine organs
   Study of pests: Stored grains, Paddy, Wheat, Vegetable, Sugarcane, Aphids, Termites, *Gryllotalpa*, and *Poikilocerus*
7. Study of life history of beneficial insects: Mulberry / Tassar silk moth, Lac insect
   Embryological studies: i. Study of the life –cycle of *Drosophila*
   ii. Study of the external genitalia and slide preparation of
   a) Diptera – *Drosophila,Musca*
   b) Orthoptera – Grasshopper
   c) Dictyoptera – *Periplaneta*
8. Study of common equipments used in insect control programmes

Sem IV Paper XVI ZOOD 16

DISSERTATION Full Marks 100

ZOOE 13 **Time 3 Hours** **FM 70**

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

FISH DIVERSITY AND FISH BIOLOGY

Group-A

1 Outline classification of fishes (with reference to living fresh water and marine fishes of India. (L S Berg)
2 Origin and evolution of fishes
3 General organization of a) Holocephali
b) Coelacanth.
4 Origin of paired fins.
5 Structure and modification of swim bladder.
6 Digestive system and its modification in teleosts in relation to food and feeding habits.
7 Respiration:
a. Respiratory organs and respiration in teleosts
b. Accessory respiratory organs.
8 Osmoregulation and excretion in fishes.
9 Lateral line system in fishes

FISH DIVERSITY AND FISH BIOLOGY : Group-A

10. Histophysiology of endocrine tissues
– a.Pituitary gland
b.Thyroid
c .Adrenocortical tissue
d.Corpuscles of Stannius

11 Adaptation in teleosts
– a.Hill stream,
b. Deep sea,
c.Bioluminescence.
d.Electric organs
12.Miscellaneous topics
a. Ornamental and
b. larvivorous fishes.
13. A concept of Transgenic fish and their applications

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

ELECTIVE PAPER **Paper XIV** **ZOOE 14**
FISH AND FISHERIES: **APPLIED FISH BIOLOGY**
Time 3 Hours **FM 70**

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

APPLIED FISH BIOLOGY

Group-A

1. Riverine fisheries in India and its problem -
    a. River system in India
    b. Productivity and production
    c. Over exploitation and remedies

2. Fish farm construction and maintenance –
    a. Different types of pond, size, depth
    b. Water quality, soil quality, site selection of the ideal farm.
3. Carp culture in India – Extensive, Semi-intensive, intensive and super intensive.
4. Composite fish culture – Methods in detail and constraints.
5. Role of Abiotc and Biotic factors in fish production –
    a. Role of soil parameters
    b. water parameters, and
    c. plankton.

6. Aquaculture and its scope –
    a. Prawn farming (mono and poly culture)
    b. pearl culture, edible oyster
7. Integrated fish farming its scope and constraints – Fish–cum–Animals, Paddy, Makhana, Trapa.

8. Reservoir fishes –
    a. Introduction to Reservoir fisheries in India
    b. Management of pre and post impoundment.

9. Fish diseases – Environmental and pathogenic diseases and its control.

Group-B

10. Natural breeding of carp–
    a. Life cycle of a carp
    b. Area of breeding
    c. factors responsible for breeding,
    d. collection of baby fish.

11. Role of different hormones in fish breeding.
12. Hypophysation –
    a. Technique of hypophysation
    b. hapa breeding
    c. bundh breeding
    d. cage farming
    e. construction and maintenance of circular hatchery
    f. Brood management, water requirement.
13. Nursery management –
    a. Rearing of spawn to fry
    b. fry to fingerlings
    c. fingerlings care and transport.

14. Natural and artificial feed –
15. Fish processing and preservation –Fish handling and different methods of preservation.

16. Fish by products –
    a. By products of fishes from marine source
    b. fresh water source.
17. Craft and Gears – Different types of crafts and gears used in different type of water bodies

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

Sem IV **FISH AND FISHERIES PRACTICAL**

Paper XV **Time 6 Hours** **ZOOP 15**

Full marks 70

1. Major Dissection (Bony fish) 10
   a. Afferent branchial arteries
   b. Efferent branchial arteries
   c. Cranial nerves
2. Minor dissection 05
   a. Weberian apparatus
   b. Accessory respiratory organ
   c. Pituitary gland
   d. Gonads
3. Mounting 05
   a. Scales
   b. fish fry
   c. fingerlings
4. Identification of two local fresh fishes with morphometric measurements up to species. 10
5. Spotting 2 Marks x 10 = 20
   a. Bones 03
   b. Histological slides 03
   c. Net and Crafts 02
   d. Adaptive features 02
6. Class record 10
7. Viva-voce 10

Sem IV **Paper XVI** **ZOOD 16**

DISSERTATION **Full Marks 100**

ELECTIVE PAPER XIII **ZOOE 13**

Molecular Biology

Time 3 Hours **FM 70**

In all NINE questions are to be set and five questions are to be answered. Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

Molecular Biology

Group-A

1. Molecules of Central dogma of gene expression
    - 1.1DNA:
        - 1.1.1 Structure, Types of DNA
        - 1.1.2 Quadruplex DNA
        - 1.1.3 Interrupted DNA
        - 1.1.4 Overlapping DNA
        - 1.1.5 Super coiling of DNA and linking number paradox
        - 1.1.6 C-Value paradox,
        - 1.1.7 DNA Replication
    - 1.2*In-vitro* synthesis of DNA
2. RNA
    - 2.1 Transcription in Eukaryote and role of transcription factors.
    - 2.2 Post transcriptional processing: Capping, Tailoring, splicing and alternate splicing, mRNA Stability, RNA degradation, RNA editing

Group-B

- 2.3 Protein sequencing, protein splicing
- 2.4 *In-vitro* synthesis of Protein
- 2.5 Protein folding and thermodynamics: Levienthal paradox, molten globules, Chaperonin & chaperones
- 2.6 Proteasomal degradation system
- 2.7 Translation of protein in eukaryotes

3. Gene Silencing
    - 3.1 DNA methylation and acetylation
    - 3.2 Doses compensation
    - 3.3 Histone code
    - 3.4 RNA interference
    - 3.5 Antisense RNA
4. DNA finger printing
5. Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, virus-induced cancer, metastasis, interaction of cancer cells with normal cells.

Books Recommended

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).

ELECTIVE PAPER XIV ZOOE 14

Biotechnology

Time 3 Hours **FM 70**

In all **NINE questions are to be set and five questions are to be answered.** Question number 1is compulsory of very short type (2 marks each) and includes 7 questions. Rest eight questions are to be set and examinees are required to answer **four** questions (long answer 14 marks each) selecting not more than two from each group.

Paper consists of 60 credit hours

Biotechnology -Group-A

1. Basic principles of genetic engineering
    I. Enzymology – restriction enzymes, DNA ligase, polymerase,
    II. Cloning vehicles – Plasmids, Cosmids, λ (lambda) – phage, Shuttle vectors, Ti – plasmids, YAC.
2. Introduction of cloned genes into host cells.
    I. Transformation, Transduction, Particle gun electroporation, Liposome.
3. Analysis and expression of cloned genes in host cells
    i. RFLP, RAPD, AFLP analysis.
    ii. PCR, DNA probes, expression of genes.
4. Gene libraries
    I. Construction and analysis of C- DNA library,
    II. Genomic DNA library,
5. Changing genes
    i. Site directed mutagenesis.
    ii. Protein engineering

Group-B

6. Molecular biotechnology of Microbial system
    I. Production of pharmaceutical enzymes,
    II. Monoclonal antibody
    III. Production of vaccines:
    IV. Production of single cell protein.
7. Transgenic animals
8. Human gene therapy
    i. Viral gene delivery system,
    ii. Non viral gene delivery system
    iii. Prodrug activation therapy
    iv. Nucleic acid as therapeutic agent.
    v. Oligonucleotide correction of genetic system.
9. Patenting biotechnology inventions, ethical issues and biosafety regulations.

Books Recommended

1. Bernard R Glick and Jack J Pasternak, Molecular Biotechnology - Principles and application of Recombinant DNA.
2. Primrose: Principles of Gene Manipulation, Blackwell,2001

3. Asubel et al: Current Protocol in Molecular Biology, Wiley, 1994

Sem IV Molecular Biology and Biotechnology
Paper XV Time 6 Hours ZOOP 15

PRACTICAL

Full marks 70

1.	Use of an Instrument		10
2.	Spotting (Photographs)	5X2=	10

1. Detection of concentration of solute in the sample with the help of Lambert Beer law/lambda max 10
2. Estimation of protein 10
3. Separation of molecules with the help of chromatography / Electrophoresis. 10
4. Records and Sessional work 10
5. Viva voce 10

Suggested Practical

1. **Study of use of Following Instrument**
   - 1.1 Use of Autoclave
   - 1.2 Use of Laminar flow
   - 1.3 Use of Micropipette
   - 1.4 Use of Centrifuge
   - 1.5 Use of colorimeter
   - 1.6. Use of Spectrophotometer
   - 1.7 Use of ELISA plate reader
   - 1.8. Use of PCR
2. Preparation of Agarose Gel
3. Study of Some photographs of biotech Importance and Molecular Biology
4. Isolation of DNA from Blood /Liver
5. Isolation of Protein
6. Preparation of Karyotype from Brain cells of Drosophila
7. Preparation of Idiogram of human karyotype
8. Preparation of G- band chromosomes
9. Preparation of polytene chromosome for study of Gene amplification
10. Estimation of Protein
11. Separation of amino acids by Paper chromatography
12. Separation of Lipids by Thin Layer Chromatography
13. Separation of DNA by Agarose Gel Electrophoresis

Sem IV Paper XVI ZOOD 16

DISSERTATION Full Marks 100