तार : विश्वविद्यालय
Gram : UNIVERSITY

टेलीफोन : कार्या0 : 2320496
कुलसचिव : निवास : 2321214
फैक्स : 0510 : 2321667

बुन्देलखण्ड विश्वविद्यालय, झाँसी
BUNDELKHAND UNIVERSITY, JHANSI

झाँसी (उ.प्र.) 284128

संदर्भ. BU/Zoo/2022-23/447

दिनाँक 03/12/22

The Minutes of Meeting of BOS

In reference to the BOS of department of Zoology ....., Institute of Basic Science B.U. Jhansi ..... held on 02/07/22 regarding the revision of syllabus in tune with CBCS/NEP-2020 and subsequent approval from Academic Council. This is to certify that the syllabus is 100% revised.

Registrar
Bundelkhand University
JHANSI

03/12/22

HOD/Coordinator

Coordinator
Deptt. of Zoology
Instt. of Basic Science
Bundelkhand University, JHANSI

BUNDELKHAND UNIVERSITY JHANSI

Department of Zoology

Board of Studies 2022-2023

The meeting of Board of studies for Zoology was held on 02/07/2022 at 11:00 a.m in V.C Committee room regarding NEP and Panel of Examiners for Session 2022-23. Following teachers were present.

1. Dr. Kaneez Zahra – Convener
2. Dr.Kusum Singh – Coordinator
3. Dr. Pankaja Sharma – Member
4. Dr. Ravindra Sironiya – Member
5. Dr. P.K. Bajpai – External Expert

Following points were discussed during the meeting.

1. M.Sc. 1st & 2nd Semester Syllabus as per NEP 2020 along with Panel of Examiner for setting paper and conducting Practical Examination.
2. Some Suggestion given by External Expert Dr. P.K. Bajpai were done in the Syllabus.
3. It was also discussed that the colleges which are not having facility to conduct practical as per new syllabus will do it according to their facilities available.
4. The Panel of Examiner was submitted of COE for B.Sc. Semester 1st and 4th and B.Sc. 3rd Year along with M.Sc. 1st to 4th Semester.

Kusum

Dr. Kusum Singh
Coordinator
Department of Zoology
B.U.Campus Jhansi

Department of Higher Education
Government of Uttar Pradesh
Lucknow

National Education Policy-2020

Common Minimum Syllabus for all UP State Universities and Colleges

For First Three Years of Higher Education (UG)

Proposed Titles for Theory and Practical Papers
Under Graduate Programme
SUBJECT: ZOOLOGY

Dr. Monisha Banerjee
Professor& Dean Research
Molecular & Human Genetics Lab
Department of Zoology
University of Lucknow, Lucknow

Dr. Samar Vir Singh Rathore
Assistant Professor
Department of Zoology
St. John's College
Agra, UP

Dr. Praveen Ojha
Sr. Assistant Professor
Department of Zoology
Kishori Raman PG College
Mathura, UP

Name	Designation	Affiliation
Steering Committee		
Mrs. Monika S. Garg, (I.A.S.) Chairperson Steering Committee	Additional Chief Secretary	Dept. of Higher Education U.P., Lucknow
Prof. Poonam Tandan	Professor, Dept. of Physics	Lucknow University, U.P.
Prof. Hare Krishna	Professor, Dept. of Statistics	CCS University Meerut, U.P.
Dr. Dinesh C. Sharma	Associate Professor, Dept. of Zoology	K.M. Govt. Girls P.G. College Badalpur, G.B. Nagar, U.P.
Supervisory Committee-Science Faculty		
Dr. Vijay Kumar Singh	Associate Professor, Dept. of Zoology	Agra College, Agra
Dr. Santosh Singh	Dean, Dept. of Agriculture	Mahatma Gandhi Kashi Vidhyapeeth, Varanasi
Dr. Baby Tabussam	Associate Professor, Dept. of Zoology	Govt. Raza P.G. College Rampur, U.P.
Dr. Sanjay Jain	Associate Professor, Dept. of Statistics	St. John's College, Agra

Syllabus Developed by:

S.No.	Name	Designation	Department	College/University
1.	Dr. Monisha Banerjee	Professor & Dean, Research	Zoology	University of Lucknow, Lucknow
2.	Dr. Samar Vir Singh Rathore	Assistant Professor	Zoology	St. John's College, Agra
3.	Dr. Praveen Ojha	Assistant Professor	Zoology	Kishori Raman PG College, Mathura

Semester-wise Titles of the Papers in B.Sc (Zoology)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
1	I	**B050101T**	Cytology, Genetics and Infectious Diseases	Theory	04
		B050102P	Cell Biology and Cytogenetics Lab	Practical	02
	II	**B050201T**	Biochemistry and Physiology	Theory	04
		B050202P/R	Physiological, Biochemical &Hematology Lab	Practical/Field work	02
2	III	**B050301T**	Molecular Biology, Bioinstrumentation &Biotechniques	Theory	04
		B050302P	Bioinstrumentation& Molecular Biology Lab	Practical	02
	IV	**B050401T**	Gene Technology, Immunology and Computational Biology	Theory	04
		B050402P/R	Genetic Engineering and Counselling Lab	Practical/Field work	02
3	V	**B050501T**	Diversity of Non-Chordates, Parasitology and Economic Zoology	Theory	04
		B050502T	Diversity of Chordates and Comparative Anatomy	Theory	04
		B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	Practical	02
	VI	**B050601T**	Evolutionary and Developmental Biology	Theory	04
		B050602T	Ecology, Ethology, Environmental Science and Wildlife	Theory	04
		B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	Practical	02

Proposed Year wise Structure of UG Program in Zoology

Programme/Year	Semester	Course Codes	Paper Title	Credits	Teaching Hours
1 Certificate Course in Medical Diagnostics & Public Health	I	**B050101T**	Cytology, Genetics and Infectious Diseases	04	60
		B050102P	Cell Biology & Cytogenetics Lab	02	60
	II	**B050201T**	Biochemistry and Physiology	04	60
		B050202P/R	Physiological, Biochemical &Hematology Lab	02	60
2 Diploma in Molecular Diagnostics and Genetic Counselling	III	**B050301T**	Molecular Biology, Bioinstrumentation & Biotechniques	04	60
		B050302P	Bioinstrumentation & Molecular Biology Lab	02	60
	IV	**B050401T**	Gene Technology, Immunology and Computational Biology	04	60
		B050402P/R	Genetic Engineering and Counselling Lab	02	60
3 Degree in Bachelor of Science	V	**B050501T**	Diversity of Non-Chordates, Parasitology and Economic Zoology	04	60
		B050502T	Diversity of Chordates and Comparative Anatomy	04	60
		B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	02	60
	VI	**B050601T**	Evolutionary and Developmental Biology	04	60
		B050602T	Ecology, Ethology, Environmental Science and Wildlife	04	60
		B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	02	60

Subject prerequisite

To study Zoology in undergraduate, a student must have studied Biology, Biotechnology or Life Science in Class 12.

Programme Objectives (POs)

1. The programme has been designed in such a way so that the students get the flavour of both classical and modern aspects of Zoology/Animal Sciences. It aims to enable the students to study animal diversity in Indian subcontinent, environmental science and behavioural ecology.
2. The modern areas including cell biology and genetics, molecular biology, biochemistry, physiology followed by biostatistics, Evolutionary biology, bioinformatics and genetic engineering have been included to make the study of animals more interesting and relevant to human studies which is the requirement in recent times.
3. The lab courses have been designed in such a way that students will be trained to join public or private labs.

Certificate Course in Medical Diagnostics & Public Health

B.Sc I Programme Specific Outcomes (PSOs)

PSO1	This course introduces System Biology and various functional components of an organism. Emphasis will be on physiological understanding abnormalities and anomalies associated with white blood cells and red blood cells. The course emphasizes cell identification, cell differentiation and cell morphology evaluation procedures. This will enhance hematology analytical skills along with skill of using many instruments.
PSO 2	The students will learn the basic principles of genetics and how to prepare karyotypes to study the chromosomes.
PSO 3	How chromosomal aberrations are inherited in humans by pedigree analysis in families.
PSO 4	The students will have hands-on training in the techniques like microscopy, centrifugation and chromatography, and various biochemical techniques, preparation of slides which will help them in getting employment in pathology labs and contribute to health care system.
PSO 5	**The Certificate courses will enable students to apply for technical positions in government and private labs/institutes.**

Diploma in Molecular Diagnostics and Genetic Counselling	
B.Sc II Programme Specific Outcomes (PSOs)	
PSO1	The student at the completion of the course will be able to have a detailed and conceptual understanding of molecular processes *viz.* DNA to trait. The differential regulation of genes in prokaryotes and eukaryotes leads to the development of an organism from an embryo.
PSO 2	The students will be able to understand and apply the principles and techniques of molecular biology which prepares students for further career in molecular biology. Independently execute a laboratory experiment using the standard methods and techniques.
PSO 3	The principles of genetic engineering, gene cloning, immunology and related technologies will enable students to play an important role in applications of biotechnology in various fields like agriculture, forensic sciences, industry and human health and make a career out of it. Students can have their own start-ups as well.
PSO 4	The basic tools of bioinformatics will enable students to analyze large amount of genomic data and its application to evolutionary biology.Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
PSO 5	**The Diploma courses will ensure employability in Hospitals/Diagnostics and Pathology labs with good hands-on training. It will also enable students to take up higher studies and Research as their career and work in renowned labs in the country and abroad.**

Degree in Bachelor of Science	
B.Sc III Programme Specific Outcomes (PSOs)	
PSO1	• This programme aims to introduce students to animal diversity of invertebrates and vertebrates. The students will be taught about invertebrates and vertebrates using observational strategies, museum specimens and field reports.
PSO 2	• A variety of interacting processes generate an organism's heterogeneous shapes, size, and structural features.
PSO 3	• Inclusion of ecology and environmental sciences will enrich students with our world which is crucial for human well being and prosperity. This section will provide new knowledge of the interdependence between people and nature that is vital for food production, maintaining clean air and water, and sustaining biodiversity in a changing climate.
PSO 4	• Students will also come to know about the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
PSO 5	• The basic concepts of biosystematics, evolutionary biology and biodiversity will enable students to solve the biological problems related to environment.
PSO 6	• At the end of the course the students will be capable enough to comprehend the reason behind such a huge diversity of animals and reason out why two animals are grouped together or remain separate due to similarities and differences which exist at many levels along with ecological, environmental and cellular inputs.
PSO 7	• **The Degree courses will enable students to go for higher studies like Masters and Ph.D in Zoology and Allied subjects.**

Programme/Class: Certificate	**Year**: First	**Semester**: First
Subject: ZOOLOGY		
Course Code: B050101T	**Course Title**: Cytology, Genetics and Infectious Diseases	

Course outcomes:

The student at the completion of the course will be able to:

- Understand the structure and function of all the cell organelles.
- Know about the chromatin structure and its location.
- To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
- How one cell communicates with its neighboring cells?
- Understand the basic principles of genetics and how genes (earlier called factors) are inherited from one generation to another.
- Understand the Mendel's laws and the deviations from conventional patterns of inheritance.
- Comprehend how environment plays an important role by interacting with genetic factors.
- How to detect chromosomal aberrations in humans and study the pattern of inheritance by pedigree analysis in families.

Credits: 4	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Structure and Function of Cell Organelles I** • Plasma membrane: chemical structure—lipids and proteins • Cell-cell interaction: cell adhesion molecules, cellular junctions • Endomembrane system: protein targeting and sorting, endocytosis, exocytosis **Introduction to all national and international Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tribute to ancient and modern biology will be included as part of the Continuous Internal Evaluation (CIE)**	6
II	**Structure and Function of Cell Organelles II** • Cytoskeleton: microtubules, microfilaments, intermediate filaments • Mitochondria: Structure, oxidative phosphorylation • Peroxisome and ribosome: structure and function	6
III	**Nucleus and Chromatin Structure** • Structure and function of nucleus in eukaryotes • Chemical structure and base composition of DNA and RNA • DNA supercoiling, chromatin organization, structure of chromosomes • Types of DNA and RNA	8

IV	**Cell cycle, Cell Division and Cell Signalling** • Cell division: mitosis and meiosis • Cell cycle and its regulation, apoptosis • Signal transduction: intracellular signaling and cell surface receptors, via G-protein linked receptors, JAK-STAT pathway	**8**
V	**Mendelism and Sex Determination** • Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses • Complete and Incomplete Dominance • Penetrance and expressivity • Genic Sex-Determining Systems, Environmental Sex Determination, Sex Determination in *Drosophila,* Sex Determination in Humans • Sex-linked characteristics and Dosage compensation	**8**
VI	**Extensions of Mendelism, Genes and Environment** • Extensions of Mendelism: Multiple Alleles, Gene Interaction • The Interaction Between Sex and Heredity: Sex-Influenced and Sex-Limited Characteristics • Cytoplasmic Inheritance, Genetic Maternal Effects • Genomic Imprinting, Anticipation • Interaction Between Genes and Environment: Environmental Effects on Gene Expression, Inheritance of Continuous Characteristics	**8**
VII	**Human Chromosomes and Patterns of Inheritance** • Human karyotype • Chromosomal anomalies: Structural and numerical aberrations with examples • Pedigree analysis • Patterns of inheritance: autosomal dominant, autosomal recessive, X-linked recessive, X-linked dominant	**8**
VIII	**Infectious Diseases** • Introduction to pathogenic organisms: viruses, bacteria, fungi, protozoa, and worms. • Structure, life cycle, pathogenicity, including diseases, causes, symptoms and control of common parasites: *Trypanosoma, Giardia and Wuchereria*	**8**

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).
8. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).
9. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)

Course Books published in Hindi may be prescribed by the Universities and Colleges
Course prerequisites: To study this course, a student must have had the subject biology in class/12th
Suggested Continuous Evaluation Methods: **Total Marks: 25** **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation**: 5 Marks
Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	**Year**: First	**Semester**: First
Subject: ZOOLOGY		
Course Code: B050102P	**Course Title**: Cell Biology & Cytogenetics Lab	

Course outcomes:

At the completion of the course students will learn Hands-on:

1. To use simple and compound microscopes.
2. To prepare slides and stain them to see the cell organelles.
3. To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
4. The chromosomal aberrations by preparing karyotypes.
5. How chromosomal aberrations are inherited in humans by pedigree analysis in families.
6. The antigen-antibody reaction.

Credits: 2	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**0-0-4

Unit	Topics	Total No. of Lectures (60)
I	1. To study different cell typessuch asbuccal epithelial cells, neurons, striated muscle cells using Methylene blue. 2. To study the different stages of Mitosis in root tip of onion. 3. To study the different stages of Meiosis in grasshopper testis. 4. To prepare molecular models of nucleotides, amino acids, dipeptides using bead and stick method. 5. To check the permeability of cells using salt solution of different concentrations.	**15**
II	1. Study of parasites (eg. Protozoans, helminths *etc*.) from permanent slides. 2. To learn the procedures for preparation of temporary and permanent stained/unstained slides.	**15**
III	1. Study of mutant phenotypes of *Drosophila.* 2. Preparation of polytene chromosomes. 3. Study of sex chromatin (Barr bodies) in buccal smear and hair bud cells (Human). 4. Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided. 5. To prepare family pedigrees.	**15**
IV	**Virtual Labs (Suggestive sites)** https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	**15**

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).
6. Kesar, Saroj and Vashishta N. (2007). Experimental Physiology: Comprehensive Manual. Heritage Publishers, New Delhi

Course Books published in Hindi may be prescribed by the Universities and Colleges

Course prerequisites: To study this course, a student must have had the subject biology in class/12th
The eligibility for this paper is 10+2 from Arts/ Commerce/ Science

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Certificate	**Year**: First	**Semester**: Second
Subject: ZOOLOGY		
Course Code: B050201T	**Course Title**: Biochemistry and Physiology	

Course outcomes:

The student at the completion of the course will learn:

- To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates
- How simple molecules together form complex macromolecules.
- To understand the thermodynamics of enzyme catalyzed reactions.
- Mechanisms of energy production at cellular and molecular levels.
- To understand systems biology and various functional components of an organism.
- To explore the complex network of these functional components.
- To comprehend the regulatory mechanisms for maintenance of function in the body.

Credits: 4	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	Topics	Total No. of Lectures (60)
I	**Structure and Function of Biomolecules** • Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides,Polysaccharides and Glycoconjugates) • Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids) • Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, Levels of organization in proteins; Simple and conjugate proteins.	8
II	**Enzyme Action and Regulation** • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action • Isozymes; Mechanism of enzyme action • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Enzyme inhibition; • Allosteric enzymes and their kinetics; Regulation of enzyme action	8
III	**Metabolism of Carbohydrates and Lipids** • Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway • Glycogenolysis and Glycogenesis • Lipids --- Biosynthesis of palmitic acid; Ketogenesis,	8

	• β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms	
IV	**Metabolism of Proteins and Nucleotides** • Catabolism of amino acids: Transamination, Deamination, Urea cycle • Nucleotides and vitamins • Review of mitochondrial respiratory chain, Oxidative phosphorylation, and its regulation	**6**
V	**Digestion and Respiration** • Structural organization and functions of gastrointestinal tract and associated glands • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Histology of trachea and lung • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration	**7**
VI	**Circulation and Excretion** • Components of blood and their functions • Haemostasis: Blood clotting system, Blood groups: Rh factor, ABO and MN • Structure of mammalian heart • Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation • Structure of kidney and its functional unit; Mechanism of urine formation	**8**
VII	**Nervous System and Endocrinology** • Structure of neuron, resting membrane potential • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers • Types of synapse • Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them • Classification of hormones; Mechanism of Hormone action	**8**
VIII	**Muscular System** Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus	**7**

Suggested Readings:

1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000)
2. Zubay*et al:* Principles of Biochemistry: WCB (1995)
3. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
4. Murray *et al:* Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press

5. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. (2006).
6. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
7. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
8. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
9. Chatterjee C C Human Physiology Volume 1 & 2. 11th edition. CBS Publishers(2016).

Course Books published in Hindi may be prescribed by the Universities and Colleges

Course prerequisites: To study this course, a student must have had the subject biology in class/12th

Suggested Continuous Evaluation Methods:

Total Marks: 25

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Certificate	**Year**: First	**Semester**: Second
Subject: ZOOLOGY		
Course Code: B050202P/R	**Course Title**: Physiological, Biochemical & Hematology Lab	

Course outcomes:

The student at the completion of the course will be able to:

- Understand the structure of biomolecules like proteins, lipids and carbohydrates
- Perform basic hematological laboratory testing,
- Distinguish normal and abnormal hematological laboratory findings to predict the diagnosis of hematological disorders and diseases.

Credits: 2	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**0-0-4

Unit	Topics	Total No. of Lectures (60)
I	1. Estimation of haemoglobin using Sahli'shaemoglobinometer 2. Preparation of haemin and haemochromogen crystals 3. Counting of RBCs and WBCs using Haemocytometer 4. To study different mammalian blood cell types using Leishman stain. 5. Recording of blood pressure using a sphygmomanometer 6. Recording of blood glucose level by using glucometer	**20**
II	1. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid 2. Recording of simple muscle twitch with electrical stimulation (or Virtual) **3.** Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)	**15**
III	1. Ninhydrin test for α-amino acids. 2. Benedict's test for reducing sugar and iodine test for starch. 3. Test for sugar and acetone in urine. 4. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 5. Action of salivary amylase under optimum conditions.	**10**
IV	**Virtual Labs (Suggestive sites)** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu	**15**

Suggested Readings: 1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York. 2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York. 3. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. 4. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons 5. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition.Lippincott W. & Wilkins. 6. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders. 7. Kesar, Saroj and Vashishta N. (2007). Experimental Physiology: Comprehensive Manual. Heritage Publishers, New Delhi **Course Books published in Hindi may be prescribed by the Universities and Colleges**		
Course prerequisites: To study this course, a student must have had the subject biology in class/12th The eligibility for this paper is 10+2 from Arts/ Commerce/ Science		
Suggested Continuous Evaluation Methods: **Total Marks: 25** **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation:**5 Marks		
Further Suggestions: None		

At the End of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Diploma	**Year:** Second	**Semester:** Third
Subject: ZOOLOGY		
Course Code:B050301T	**Course Title:** Molecular Biology, Bioinstrumentation & Biotechniques	

Course outcomes:

The student at the completion of the course will be able to have:

- A detailed and conceptual understanding of molecular processes *viz.* DNA to trait.
- A clear understanding of the processes of central dogma *viz.* transcription, translation *etc.* underlying survival and propagation of life at molecular level.
- Understanding of how genes are ultimately expressed as proteins which are responsible for the structure and function of all organisms.
- Learn how four sequences (3 letter codons) generate the transcripts of life and determine the phenotypes of organisms.
- How genes are regulated differently at different time and place in prokaryotes and eukaryotes.

Credits: 4	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Process of Transcription** • Fine structure of gene • RNA polymerases • Transcription factors and machinery • Formation of initiation complex • Initiation, elongation and termination of transcription in prokaryotes and eukaryotes	**7**
II	**Process of Translation** • The Genetic code • Ribosome • Factors involved in translation • Aminoacylation of tRNA, tRNA-identity, aminoacyltRNAsynthetase • Initiation, elongation and termination of translation in prokaryotes and eukaryotes	**7**
III	**Regulation of Gene Expression I** • Regulation of gene expression in prokaryotes: *lac* and *trp*operons in *E. coli* • Regulation of gene expression in eukaryotes: Role of chromatin in gene expression • Regulation at transcriptional level, Post-transcriptional	**8**

	modifications: Capping, Splicing, Polyadenylation • RNA editing.	
IV	**Regulation of Gene Expression II** • Regulation of gene expression in eukaryotes: • Regulation at translational level, Post- translational modifications: protein folding etc. • Intracellular protein degradation • Gene silencing, RNA interference (RNAi)	**8**
V	**Principle and Types of Microscopes** • Principle of Microscopy and Applications • Types of Microscopes: light microscopy, dark field microscopy, phase-contrast microscopy, • Fluorescence microscopy, confocal microscopy, electron microscopy	**6**
VI	**Centrifugation and Chromatography** • Principle of Centrifugation • Types of Centrifuges: high speed and ultracentrifuge • Types of rotors: Vertical, Swing-out, Fixed-angle etc. • Principle and Types of Chromatography: paper, ion-exchange, gel filtration, HPLC, affinity	**8**
VII	**Spectrophotometry and Biochemical Techniques** • Biochemical techniques: Measurement of pH, Preparation of buffers and solutions • Principle of Colorimetry/Spectrophotometry: Beer-Lambert law • Measurement, applications and safety measures of radio-tracer techniques	**8**
VIII	**Molecular Techniques** • Detection of nucleic acid by gel electrophoresis • DNA sequencingDNA fingerprinting, RFLP • Polymerase Chain Reaction (PCR) • Detection of proteins, PAGE, ELISA, Western blotting	**8**

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002).
5. Watson et al. Molecular Biology of the Gene. Pearson (2004).
6. Lewin. Genes VIII. Pearson (2004).
7. Pierce B. Genetics. Freeman (2004).
8. Sambrook*et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
9. Primrose. Molecular Biotechnology. Panima (2001).
10. Clark & Switzer. Experimental Biochemistry. Freeman (2000)

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 with Biology as one of the subject
Suggested Continuous Evaluation Methods: **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation**: 5 Marks
Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

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Programme/Class: Diploma	**Year:** Second	**Semester:** Third
Subject: ZOOLOGY		
Course Code:B050302P	**Course Title:** Bioinstrumentation & Molecular Biology Lab	

Course outcomes:
The student at the completion of the course will be able to

- Understand the basic principles of microscopy, working of different types of microscopes
- Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules
- Understand the principle of measuring the concentrations of macromolecules in solutions by colorimeter and spectrophotometer and use them in Biochemistry.
- Learn about some of the commonly used advance DNA testing methods.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit	Topic	Total No. of Lectures (60)
I	1. To study the working principle and Simple, Compound and Binocular microscopes. **2.** To study the working principle of various lab equipments such as pH Meter, Electronic balance, use of glass and micropipettes, Laminar flow, Incubator, Waterbath, Centrifuge, Chromatography apparatus, etc.	**15**
II	1. To prepare solutions and buffers. 2. To measure absorbance in Colorimeter or Spectrphotometer. 3. Demonstration of differential centrifugation to fractionate different components in a mixture.	**15**
III	1. To prepare dilutions of Riboflavin and verify the principle of spectrophotometry. 2. To identify different amino acids in a mixture using paper chromatography. 3. Demonstration of DNA extraction from blood or tissue samples. 4. To estimate amount of DNA using spectrophotometer.	**15**
IV	**Virtual Labs (Suggestive sites)** www.labinapp.com www.uwlax.edu www.labster.com www.onlinelabs.in www.powershow.in https://vlab.amrita.edu	**15**

	info@premiereducationaltechnologyies.com https://li.wsu.edu	

Suggested Readings:

1. Sambrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
2. Primrose. Molecular Biotechnology. Panima (2001).
3. Clark & Switzer. Experimental Biochemistry. Freeman (2000)

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 from Arts/Commerce/Science

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Diploma	**Year:** Second	**Semester:** Fourth
Subject: ZOOLOGY		
Course Code:B050401T	**Course Title:** Gene Technology, Immunology and Computational Biology	

Course outcomes:

The student at the completion of the course will be able to:

- Understand the principles of genetic engineering, how genes can be cloned in bacteria and the various technologies involved in it.
- Know the applications of biotechnology in various fields like agriculture, industry and human health.
- To have an in depth understanding about Immune System & its mechanisms.
- Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
- Get introduced to computers and use of bioinformatics tools.
- **Enable students to get employment in pathology/Hospital.**
- **Take up research in biological sciences.**

Credits: 4	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Principles of Gene Manipulation** • Recombinant DNA Technology • Selection and identification of recombinant cells • Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation • Gene transfer techniques, Gene therapy	10
II	**Applications of Genetic Engineering** • Single cell proteins • Biosensors, Biochips • Crop and live stock improvement, development of transgenics • Development of DNA drugs and vaccines	8
III	**DNA Diagnostics** • Genetic analysis of human diseases, detection of known and unknown mutations • Concept of pharmacogenomics and pharmacogenetics	4
IV	**Immune System and its Components** • Historical perspective of Immunology, Innate and Adaptive Immunity, clonal selection, complement system • Structure and functions of different classes of immunoglobulins, Hypersensitivity • Humoral immunity and cell mediated immunity • HLA complex: organization, class I and II HLA molecules	10
V	**Biostatistics I** • Calculations of mean, median, mode, variance, standard deviation • Concepts of coefficient of variation, Skewness, Kurtosis • Elementary idea of probability and application	7

VI	**Biostatistics II** • Data summarizing: frequency distribution, graphical presentation- pie diagram, histogram • Tests of significance: one and two sample tests, t-test and Chi-square test	**7**
VII	**Basics of Computers** • Basics (CPU, I/O units) and operating systems • Concept of homepages and websites, World Wide Web, URLs, using search engines	**6**
VIII	**Bioinformatics** • Databases: nucleic acids, genomes, protein sequences and structures, Bibliography • Sequence analysis (homology): pairwise and multiple sequence alignments-BLAST, CLUSTALW • Phylogenetic analysis	**8**

Suggested Readings:

1. Primrose &Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl& Jones. Genetics: principles &Analsysis of Genes & Genomes. Jones & Bartlett (1998).
3. S6mbrook *et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).
5. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
6. Sudbery. Human Molecular Genetics. Prentice-Hall (2002).
7. Wilson. Clinical Genetics-A Short Course, Wiley (2000).
8. Pasternak. An Introduction to Molecular Human Genetics. Fritzgerald (2000).
9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.
10. Statistical Methods (Eighth Edition) by G. W. Snecdecor and W. G. Cochran, Willey Blackwell
11. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
12. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners
13. Westhead*et al* Bioinformatics: Instant Notes. Viva Books (2003).

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions:

Programme/Class: Degree	**Year:** Second	**Semester:** Fourth
Subject: ZOOLOGY		
Course Code:B050402P/R	**Course Title:** Genetic Engineering and Counselling Lab	

Course outcomes:

The student at the completion of the course will be able to:

- Understand the principles of genetic engineering with hands-on experiments in mutation detection, testing of infectious diseases like Covid 19.
- Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
- Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
- Use bioinformatics tools to find out evolutionary/phylogenetic relationship of organisms using gene sequences.
- Get employment in Hospitals/Diagnostic and forensic labs/Counsel families with genetic disorders.
- **Enable students to take up research in biological sciences.**

Credits: 2	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**0-0-4

Unit	Topic	Total No. of Lectures (60)
I	1. Measure the pre and post clitellar lengths of earthworms and calculate mean, median, mode, standard deviation etc. 2. Measure the height and weight of all students in the class and apply statistical measures.	**10**
II	1. Determination of ABO Blood group 2. To perform bacterial culture and calculate generation time of bacteria. 3. To study Restriction enzyme digestion using teaching kits. 4. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits. 5. Demonstration of agarose gel electrophoresis for detection of DNA. 6. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins. 7. To calculate molecular weight of unknown DNA and protein fragments from gel pictures.	**20**
III	1. To learn the basics of computer applications 2. To learn sequence analysis using BLAST 3. To learn Multiple sequence alignment using CLUSTALW 4. To learn about Phylogenetic analysis using the programme PHYLIP. **5.** To learn how to perform Primer designing for PCR	**15**

	using available softwares etc.	
IV	**Virtual Labs (Suggestive sites)** 1. Gel Documentation System- https://youtu.be/WPpt3-FanNE 2. Colorimeter- https://youtu.be/v4aK6G0bGuU 3. PCR Part 1- https://youtu.be/CpGX1UFSl4A 4. PCR Part 2- https://youtu.be/6IcHAYPTAEw 5. DNA isolation Part 1- https://youtu.be/QE7Ul0JnY9A 6. DNA isolation part 2- https://youtu.be/-efr_HFeHxM 7. DNA curve- https://youtu.be/ubL8QxTeuG4 8. Spectrophotometer- https://youtu.be/ubL8QxTeuG4 9. Agarose Part 1- https://youtu.be/7gvHPFww--g 10. Agarose part 2- https://youtu.be/j_bOZCHNsSg 11. Use softwares like Primer3, NEB cutter 12. NCBI, BLAST, CLUSTAL W, PHYLIP	**15**

Suggested Readings:

1. Primrose &Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl& Jones. Genetics: principles &Analsysis of Genes & Genomes. Jones & Bartlett (1998).
3. Sambrook*et al* .Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 from Arts/Commerce/Science

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Degree	**Year:** Third	**Semester:**Fifth
Subject:ZOOLOGY		
Course Code: B050501T	**Course Title:** Diversity of Non-Chordates and Economic Zoology	

Course outcomes:

The student at the completion of the course will be able to:

The student at the completion of the course will be able to:

- demonstrate comprehensive identification abilities of non-chordate diversity
- explain structural and functional diversity of non-chordate
- explain evolutionary relationship amongst non-chordate groups
- Get employment in different applied sectors
- Students can start their own business i.e. self employments.
- Enable students to take up research in Biological Science

Credits: 4	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Protozoa to Coelenterate** • Protozoa – *Paramecium* (Morphology and Reproduction) • Porifera – *Sycon*(Canal System) • Coelenterata – *Obelia* (Morphology and Reproduction)	7
II	**Ctenophora to Nemathelminthes** • Ctenophora - Salient features • Platyhelminthes - *Taenia* (Tape worm) (Morphology and Reproduction) • Nemathelminthes –*Ascaris lumbricoides* (Morphology and Reproduction)	7
III	**Annelida** • Annelida –*Hirudinaria* (Leech) (Morphology and Reproduction)	8
IV	**Arthropoda** • Arthropoda – *Palaemon* (Prawn) (Morphology, Appendages, Nervous System and Reproduction)	8
V	**Mollusca to Hemichordata** • Mollusca – *Pila*(Morphology, Shell, Respiration, Nervous System and Reproduction) • Echinodermata –*Pentaceros* (Morphology and Water Vascular System)	8

VI	**Vectors and pests** Life cycle and their control of following pests: Gundhi bug,Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control	**8**
VII	**Economic Zoology-1** Animal breeding and culture: Pisciculture	**7**
VIII	**Economic Zoology- 2** Sericulture, Apiculture, Lac-culture, Vermiculture	**7**

Suggested Readings:

1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17
2. Hunter: Life of Invertebrates (1979, Collier Macmillan)
3. Marshall: Parker &Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
4. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
5. Brusca and Brusca (2016) Invertebrates. Sinauer
6. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
7. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford
8. Parasitology- Chatterjee
9. Parasitology- Chakraborty
10. Thomos C. Chung. General Parasitology. Hardcourt Brace and Co. Ltd. Asia, New Delhi.
11. Gerard D. Schmidt and Larry S Roberts. Foundations of Parasitology. McGraw Hill.
12. Bisht. D.S., *Apiculture*, ICAR Publication.
13. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.
14. Jhingran. V.G. Fish and fisheries in India.,
15. Khanna. S.S, An introduction to fishes
16. Boyd. C.E. &Tucker.C.S, Pond aquaculture water quality management,
17. Biswas.K.P, Fish and prawn diseases,
18. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
19. Lee, Earthworm Ecology
20. Stevenson, Biology of Earthworms
21. Destructive and Useful Insects by C. L. Metcalf
22. Sericulture for Rural Development : Hanumappa (1978), Himalaya Publication,
23. Sriculture in India Sarkar, D.C. (1988), CSB, Bangalore.

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions:

Programme/Class: Degree	**Year:** Third	**Semester:**Fifth
Subject:ZOOLOGY		
Course Code: B050502T	**Course Title:** Diversity of Chordates and Comparative Anatomy	

Course outcomes:

The student at the completion of the course will be able to:

- Demonstrate comprehensive identification abilities of chordate diversity
- Explain structural and functional diversity of chordates
- Explain evolutionary relationship amongst chordates
- Take up research in biological sciences.

Credits:4	**Core Compulsory/Elective**
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Origin of Chordates & Hemichordata** • Origin of Chordates. Classification of Phylum Chordata upto the class. • Hemichordata: General characteristics, classification and detailed study of *Balanoglossus*(Habit and Habitat, Morphology, Anatomy, Physiology and Development).	6
II	**Cephalochordata and Urochordata** • Cephalochordata : General characteristics, classification and detailed study of *Branchiostoma* (*Amphioxus*) (Habit and Habitat, Morphology, Anatomy, Physiology). • (ii)Urochordata : General characteristics, classification and detailed study of *Herdmania*(Habit and Habitat, Morphology, Anatomy, Physiology and Post Embryonic Development).	6
III	**Classification and General Characteristics of Vertebrates** • General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) up to the order with examples. • Poisonous and Non Poisonous Snakes and biting mechanism. • Neoteny and Paedogenesis • Migration in birds • Dentition in Mammals	8
IV	**Comparative Anatomy and Physiology of Vertebrates** **Integumentary System** Structure, functions and derivatives of integument **Skeletal System** Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	8
V	**Digestive System** Alimentary canal and associated glands, dentition	

		8
VI	**Respiratory System** Skin, gills, lungs and air sacs; Accessory respiratory organs	**8**
VII	**Circulatory System** General plan of circulation, evolution of heart and aortic arches **Urinogenital System** Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	**8**
VIII	**Nervous System** Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals **Sense Organs** Classification of receptors Brief account of visual and auditory receptors in man	**8**

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002,Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life(1979, Macmillan Publishing)
6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
8. Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)
9. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods:
House Examination/Test: 10 Marks
Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Further Suggestions: None

At the end of the whole syllabus any remarks/suggestions:

Programme/Class: Degree	**Year:** Third	**Semester:**Fifth
Subject:ZOOLOGY		
Course Code: B050503P	**Course Title:** Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	

Course outcomes:

The student at the completion of the course will be able to:

- demonstrate comprehensive identification abilities of chordate and non- chordates diversity
- explain structural and functional diversity of chordates and non- chordates
- explain evolutionary relationship amongst chordates and non- chordates
- Generate self employment
- Enable students to take up research in biological sciences.

Credits: 2	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit	Topic	Total No. of Lectures (60)
I	Study of animal specimens of various animal phyla. 1.To prepare permanent stained slide of septal nephridia of earthworm. 2.To take out the nerve ring of earthworm. 3.To take out hastate plate from *Palaemon.*	15
II	1.Study of animal specimens of various animal phyla 2. Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig). 3. To prepare stained/unstained slide of placoid scales. 1. Comparative study of bones of different vertebrates. 2. Comparative study of histological slides of different tissues of vertebrates.	15
III	1. Permanent Preparation of: *Euglena*, *Paramecium* 2. Study of prepared slides/specimens of *Entamoeba, Giardia, Leishmania, Trypanosoma, Plasmodium, Fasciola, Cotugnia, Taenia, Rallietina, Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma* 3. Permanent Preparation of *Cimex* (bed bug)/ *Pediculus* (Louse), *Haematopinus* (cattle louse), fresh water annelids, arthropods; and soil arthropods. 4. Larval stages of helminths and arthropods. 5. Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly. Permanent preparation of ticks/ mites, abdominal gills of aquatic insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly. 6. Identification of pests. 7. Life history of silkworm, honeybee and lac insect. 8. Different types of important edible fishes of India.	15

	9. Slides of plant nematodes. 10. Study of an aquatic ecosystem, its biotic components and food chain. 11. Project Report/ model chart making. 12. **Dissections** : through multimedia / models 13. **Cockroach** : Central nervous system 14. ***Wallago***: Afferent and efferent branchial vessels, Cranial nerves, Weberian ossicles.	
IV	**Virtual Labs (Suggestive sites)** https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	**15**

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002,Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life (1979, Macmillan Publishing)
6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
8. Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)
9. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17
10. Marshall: Parker &Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
11. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
12. Brusca and Brusca (2016) Invertebrates. Sinauer
13. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
14. Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home
15. Robert Leo Smith Ecology and field biology Harper and Row publisher
16. Handbook of Practical Sericulture :Ullal, S.R. and Narasimhanna, M.N. (1987),Central Silk Board Publication, Bangalore.
17. Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
18. Bisht. D.S., *Apiculture*, ICAR Publication.
19. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.
20. Ullal S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture: CSB,Bangalore
21. Jolly. M. S. Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
22. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co.
23. Santanam, B. *et al,* A manual of freshwater aquaculture
24. Boyd. C.E. &Tucker.C.S, Pond aquaculture water quality management
25. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
26. Ranganathan L.S, Vermicomposting technology- soil health to human health

Course Books published in Hindi may be prescribed by the Universities and Colleges
This course can be opted as an elective by the students of following subjects: The eligibility for this paper is 10+2 from Arts/Commerce/Science
Suggested Continuous Evaluation Methods: **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation**: 5 Marks
Further Suggestions: None

At the end of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Programme/Class: Degree	**Year:**Third	**Semester:**Sixth
Subject: ZOOLOGY		
Course Code:B050601T	**Course Title:** Evolutionary and Developmental Biology	

Course outcomes:

The student at the completion of the course will be able to:

- Understand that by biological evolution we mean that many of the organisms that inhabit the earth today are different from those that inhabited it in the past.
- Understand that natural selection is one of several processes that can bring about evolution, although it can also promote stability rather than change.
- Understand how the single cell formed at fertilisation forms an embryo and then a full adult organism.
- Integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development.
- Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features.
- Understand how a cell behaves in response to an autonomous determinant or an external signal, and the scientific reasoning exhibited in experimental life science.

Credits: 4	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Theories of Evolution** • Origin of Life • Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artifical selection) • Modern synthetic theory of evolution • Patterns of evolution (Divergence, Convergence, Parallel, Coevolution)	8
II	**Population Genetics** • Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy-Weinberg equilibrium and conditions for its maintenance • Forces of evolution: mutation, selection, genetic drift	8
III	**Direct Evidences of Evolution** Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse	7
IV	**Species Concept and Extinction** • Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)	7

	• Mass extinction (Causes, Names of five major extinctions	
V	**Gamete Fertilization and Early Development** • Gametogenesis, Fertilization • Cleavage pattern • Gastrulation, fate maps • Developmental mechanics of cell specification • Morphogenesis and cell adhesion	**6**
VI	**Developmental Genes** • Genes and development • Molecular basis of development • Differential gene expression	**8**
VII	**Early Vertebrate Development** • Early development of vertebrates (fish, birds & mammals) • Metamorphosis, regeneration and stem cells • Environmental regulation of development	**8**
VIII	**Late Developmental Processes** • The dynamics of organ development • Development of eye, kidney, limb • Metamorphosis: the hormonal reactivation of development in amphibians, insects • Regeneration: salamander limbs, mammalian liver, Hydras • Aging: the biology of senescence	**8**

Suggested Readings:

1. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
2. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
3. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
4. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
5. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
6. Developmental Biology: T. Subramaniam, (Reprint), Narosa Publishing House Pvt. Ltd., New Delhi (2013).
7. Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.), Wiley-Blackwell. (2012).
8. Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: Russ Hodge, Infobase Publishing. (2009).
9. Current Topics in Developmental Biology: Roger A. Pedersen, Gerald P. Schatten, Elsevier. (1998).
10. Developmental biology: Werner A. Müller, Springer Science & Business Media. (2012).
11. Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, Elsevier Health Sciences. (2018).
12. Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods: **House Examination/Test**: 10 Marks **Written Assignment/Presentation/Project / Term Papers/Seminar**: 10 Marks **Class performance/Participation:**5 Marks
Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Degree	**Year:** Third	**Semester:** Six
Subject: ZOOLOGY		
Course Code:B050602T	**Course Title:** Ecology, Ethology, Environmental Science and Wildlife	

Course outcomes:

The student at the completion of the course will learn:

- Complexities and interconnectedness of various environmental levels and their functioning.
- Global environmental issues, their causes, consequences and amelioration.
- To understand and identify behaviours in a variety of taxa.
- The proximate and ultimate causes of various behaviours.
- About the molecules, cells, and systems of biological timing systems.
- Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
- To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing.
- To understand the importance of wildlife conservation.

Credits: 4	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:**as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-0-0

Unit	Topic	Total No. of Lectures (60)
I	**Introduction to Ecology** • History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors	**4**
II	**Organization of Ecosystem** • Levels of organization, Laws of limiting factors, Study of physical factors, • Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion ,Exponential and logistic growth, • Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, , Food web, Energy flow through the ecosystem, • Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle	**12**
III	**Community Ecology** Community characteristics: species richness, dominance, diversity, abundance, Ecological succession with one example	**7**

IV	**Environmental Hazards** • Sources of Environmental hazards • Climate changes • Greenhouse gases and global warming • Acid rain, Ozone layer destruction	**7**
V	**Effects of Climate Change** • Effect of climate change on public health • Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, • Nuclear waste handling and disposal, Waste from thermal power plants, • Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.	**6**
VI	**Behavioural Ecology and Chronobiology** • Origin and history of Ethology, • Instinct vs. Learnt Behaviour • Associative learning, classical and operant conditioning, Habituation, Imprinting, • Circadian rhythms; Tidal rhythms and Lunar rhythms • Chronomedicine	**8**
VII	**Introduction to Wild Life** • Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.	**8**
VIII	**Protected areas** • National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve	**8**

Suggested Readings:

1. Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall.
2. Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
3. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.
4. Elements of Ecology. T.M. Smith and R.L. Smith, 2014, Pearson Education Inc.
5. Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
6. Environment. Raven, Berg, Johnson, 1993, Saunders College Publishing.
7. Essentials of Ecology. G.T. Miller, Jr. & Scott. E. Spoolman, 2014, Brooks/Cole, Cengage Learning.
8. Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.
9. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford

University Press, UK.
10. Fundamentals of Ecology. E.P. Odum& Gray. W. Barrett, 1971, Saunders
11. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
12. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.
13. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press.
14. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
15. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 with Biology as one of the subject

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class Performance/Participation: 5 Marks

Further Suggestions: None

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At the End of the whole syllabus any remarks/ suggestions: None

Programme/Class: Degree	**Year:** Third	**Semester:** Sixth
Subject: ZOOLOGY		
Course Code:B050603P	**Course Title:** Lab on Ecology, Environmental Science, Behavioral Ecology & wildlife	

Course outcomes:

The student at the completion of the course will be able to:

- To understand the basic concepts, importance, status and interaction between organisms and environment.
- Get employment in forest services, sanctuaries, conservatories etc.
- Enable students to take up research in wildlife.

Credits: 2	**Core:**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit	Topic	Total No. of Lectures (60)
I	1.Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided. 2.Study of population dynamics through numerical problems. 3.Study of circadian functions in humans (daily eating, sleep and temperature patterns).	**26**
II	Report on a visit to National Park/Biodiversity Park/Wild life sanctuary	**4**
III	1. Demonstration of basic equipments needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses) 2. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc. 3. Demonstration of different field techniques for flora and fauna	**15**
IV	**Virtual Labs (Suggestive sites)** https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab	**15**

Suggested Readings:

1. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.
2. Fundamentals of Ecology. E.P. Odum& Gray. W. Barrett, 1971, Saunders.
3. Robert Leo Smith Ecology and field biology Harper and Row publisher
4. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
5. Methods and Practice in biodiversity Conservation by David Hawks worth, Springer publication.

Course Books published in Hindi may be prescribed by the Universities and Colleges

This course can be opted as an elective by the students of following subjects:

The eligibility for this paper is 10+2 from Arts/Commerce/Science

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks

Class performance/Participation: 5 Marks

Further Suggestions: None

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At the end of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all 04 units including virtual labs in practical evaluation.

Department of Zoology

Bundelkhand University Jhansi

Introduction

M.Sc. Zoology is two years (Four Semester) Post Graduate level course. This syllabus is based on learning and Practical knowledge of subject so that students are able to understand basics of zoology and its application in the field of biotechnology and research. The students are able to maintain the scientific aptitude and ski;; and well help the society to achieve advancement in the field of life sciences. After completion of the degree, the students are able to face the competitive examinations and can prepare the in the field of academics and research.

Program outcome (PO)

The learning outcome of the framed curriculum of Zoology allows developing thinking & learning aptitude in students of PG programme. This will provide following achievements to the students after complete of PG degree.

1. It will help students correlate the observed facts and understanding various physiological functions of living organism.
2. It will also help students to learn various skills to interpret the results during higher learning.
3. It will improve the understanding skills and use of various tools in scientific study.
4. It will develop competency and motivate students for higher learning

Programme specific outcome (PSO)

The programme specific outcome of M.Sc. Zoology is as follow.

1. Basic concept, theories and related experimental techniques to understand zoology in various specific disciplines like Fish and Fisheries, Cell Biology, Endocrinology, Entomology, Environmental Biology and Applied Zoology will be achieved by students.
2. They will get wide exposure to various branches of zoology along with experimental knowledge.
3. Students will be able to learn step of scientific experimentation and script/ repot writing during dissertation.
4. They will learn basics of computers along with power point presentation and develops skill of delivering seminar in their field.
5. Since the students are studying some special paper during this course they will develop and learn interdisciplinary skill and correlate their study with other subjects.

This course is in accordance to UGC guideline on adoption of choice based credit system(CBCS) and each semester is of 90 days and total course will completed in four semester (Two Years). The BOS has also given option to modify the course content as per Specific need to prove a quality and standard to education so that the students can enhance their skill to achieve success in teaching, academics and research.

DEPARTMENT OF ZOOLOGY
BUNDELKHAND UNIVERSITY JHANSI (U.P.)

SEMESTER-I

Paper	Paper Code	Paper Name	Internal Marks (10 +10+5)	Theory Marks	Total	Credit
1	ZOY -701	Comparative Structure & Function of Invertebrates	25	75	100	4
2	ZOY-702	Quantitative Biology	25	75	100	4
3	ZOY -703	Instrumentation and Biotechnology	25	75	100	4
4	ZOY-704	Molecular Cell Biology	25	75	100	4
5	ZOY-705	Practical Related to 701 to 704	25-Internal 75-External		100	4
6	ZOY-706	*Research project/Industrial training/Survey/field training	Submission of progress report		100	4
7	ZOY-707	**Miner Subject/Open Elative Papers	25	75	100	4
Total					**700**	**28**

* 4 credits will be allocated to students after the submission of dissertation progress report.

** Student(s) shall have to select one elective course as minor subject from any other faculty (except own faculty) as prescribed in university ordinance for post graduate programme.

DEPARTMENT OF ZOOLOGY
BUNDELKHAND UNIVERSITY JHANSI (U.P.)
SEMESTER-II

Paper	Paper Code	Paper Name	Internal Marks	Theory marks	Total	Credit
1	ZOY -801	Genetics	25	75	100	4
2	ZOY-802	Taxonomy and Evolution	25	75	100	4
3	ZOY -803	Biochemistry	25	75	100	4
4	ZOY-804	Ecology and animal behavior	25	75	100	4
5	ZOY-805	Practical Related to ZOY 801-804	25-Internal 75-External		100	4
6	ZOY-806		Submission of Progress Report		*100	4
Total					**600**	**24**

*Marks distributed as : Submission of research project – 50, presentation – 25, publication-25

DEPARTMENT OF ZOOLOGY
BUNDELKHAND UNIVERSITY JHANSI (U.P.)

SEMESTER-III

Paper	Paper Code	Paper Name	Internal Marks (10 +10+5)	Theory Marks	Total	Credit
1	ZOY - 901	Comparative Structure & Function in vertebrates	25	75	100	4
2	ZOY-902	Molecular cytogenetics	25	75	100	4
3	ZOY - 903/ 904/ 905/ 906/ 907/ 908	**Special A** (Fish & Fisheries, Endocrinology, Environmental Biology, Cell Biology, Applied Zoology, Entomology)	25	75	100	4
4	ZOY- 909/ 910/ 911/ 912/ 913 / 914	**Special B** (Fish & Fisheries, Endocrinology, Environmental Biology, Cell Biology, Applied Zoology, Entomology)	25	75	100	4
5	ZOY-915	General Practical Related to S.N. 1&2	10-Internal 40-External		50	2
	ZOY - 916	Special Practical Related to S.N. 3&4	10-Internal 40-External		50	2
6	ZOY- 917	*Dissertation (Research project)			100	4
Total					600	24

* 4 credits will be allocated to students after the submission of dissertation progress report.

DEPARTMENT OF ZOOLOGY
BUNDELKHAND UNIVERSITY JHANSI (U.P.)
SEMESTER-IV

Paper	Paper Code	Paper Name	Internal Marks	Theory marks	Total	Credit
1	ZOY -1001	Infection biology and immunology	25	75	100	4
2	ZOY-1002	Developmental biology	25	75	100	4
3	ZOY 1003/1004/1005/ 1006/1007/1008	**Special A** (Fish & Fisheries, Endocrinology, Environmental Biology, Cell Biology, Applied Zoology, Entomology)	25	75	100	4
4	ZOY-1009/1010/1011/ 1012/1013/1014	**Special B** (Fish & Fisheries, Endocrinology, Environmental Biology, Cell Biology, Applied Zoology, Entomology)	25	75	100	4
5	ZOY-1015	General Paper Practical	25-Internal 75-External		50	4
	ZOY- 1016	Special Practical			50	
6	ZOY- 1017	Dissertation	Submission of research project		*100	4
Total					600	24
GRAND TOTAL		M.Sc. Zoology			**2300**	100

**Marks distributed as: Submission of research project – 50, presentation – 25, publication-25

M.Sc.1st Semester
General Paper-I, ZOY-701
Comparative Structure & Function of Invertebrates

Course Objectives

Students are able to understand

- Basic structure of invertebrates
- The locomotory organs and mechanism in Invertebrates
- The patterns of feeding in Lower & higher invertebrates
- Various physiological function including respiration & excretion and nerve conduction in all invertebrates

Unit – I

- Symmetry in animal organization : Asymmetry, radial, and bilateral symmertry and their Significance.
- Coelom : Evolution of coelom, Acoelomate, pseudocoelomate, coelomate groups: Protostomia and Deuterostomia.
- Organiztion of coelom: Enterocoelic, Schizocoelic and gonocoelic
- Metamerism : Evolution of metamerism – Pseudometamerism, cyclo metamerism. Corm theory.Embryological theory and Significance,

Unit – II

- Flagellar and ciliary movements in Protozoa
- Hydrostatic movement in Coelenterate, Annelid and Echinoderm
- Patterns of feeding and digestion in lower metazoan
- Filter feeding in Polychaeta, Mollusca and Echinodermata

Unit – III

- Different types of respiratory organs – Gills, lungs and trachea
- Respiratory pigments
- Mechanism of respiration
- Different types of excretory organs- coelomoducts, Nephridia and Malphigian tubules.
- Mechanisms of excretion and osmoregulation.

Unit – IV

- Primitive nervous system: Coelenterata and Echinodermata
- Advanced nervous system: Annelida, (Polychaeta and Oligochaeta), Arthopoda (Crustacea and Insecta) and Mollusca (Cephalopoda).
- Endocrine glands in crustaceans and Insects , Pheromones and Semiochemicals.

Unit – V

- Pattern of sexual and asexual reproduction.
- Larval forms of parasites and their phylogenic significance.
- Larval forms of annelida,crustacea, mollusca and echinodermata.
- General Characters and affinities of Minor phyla: Rotifera, Chaetogneatha, Phoronida and Sipunculida.

Suggested Readings:

1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17
2. Hunter: Life of Invertebrates (1979, Collier Macmillan)
3. Marshall: Parker &Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
4. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
5. Brusca and Brusca (2016) Invertebrates. Sinauer
6. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
7. R.L Kotepal, Text book of invertebrate, Rastogi publication.
8.EJW Barrington-Invertebrate structure and function.

M.Sc.1st Semester
General Paper-II – ZOY 702
Quantitative Biology

Course Objectives

Students are able to understand and learn

- Students are able to understand the basic concept of Biostatistics
- Learn various methods to analyses data
- Lear basic concept of computation
- Learn make to PPT, use of internet, MS Office, Excel, etc
- Learn graphical representation of data

Unit – I

- Basic concepts of biostatistics.
- Significance & Applications of biostatistics.
- Classification & Graphical representation of data.
- Analysis of frequency & frequency distribution

Unit – II

- Measures of central tendency (Mean, Median, Mode)
- Measures of Dispersal (Mean deviation, Standard deviation)
- Probability distribution (bionomial, & normal)

Unit-III

- Sampling distribution
- Hypothesis testing
- Chi-square test
- Student's t-test

Unit-IV

- F-test & Analysis of Variance(ANOVA), ANCOVA
- Correlation
- Regression

Unit-V

- General application of computer
- M.S. Word, Excel and PowerPoint
- Hardware and software , statistical software ie. SPSS.
- Internet & E-mail

Note : Non scientific (Simple) calculator is allowed for students.

Suggested Reading:

- Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.

- Statistical Methods (Eighth Edition) by G. W. Snecdecor and W. G. Cochran, Willey Blackwell.
- Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
- Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners
- Introduction to biostatistics, Dr. P.K. Banerjee, S. Chand publication.
- Elements of biostatistics, S. Prasad, Rastogi publication.
- Biostatistics, P.N. Arora and P.K.Malhan, Himalaya publishing house.

M.Sc.1st Semester
General Paper-III – ZOY 703
Instrumentation and Biotechnology

Course Objectives

Students are able to understand and learn

- Various types of tools used is scientific study
- Learn and understand various techniques to perform scientific study
- Understands culture techniques to perform microbial study
- Understand working various qualitative and qualitative analysis by using Sophisticated instruments

Unit-I

- Principle and applications of microscopy, types of microscope : Light and compound microscope, flourscence microscope, phase contrast microscope.
- Electron microscope: SEM and TEM.
- pH meter : Principle and measurement of pH.

Unit-II

- Principle of centrifugation.
- Types of centrifuge and rotors.
- Princples of chromatography.
- Types to chromatography.

Unit-III

- Colorimeter and spectrophoto meter: Beer lambert law, absorption spectrum.
- Electrophoresis:Principle ,types and applications.
- Radio tracer techniques : Detection and measurement of radio isotopes used in biology,Incorporation of radio isotopes in tissue and cells, safety measures.

Unit-IV

- Concept of rDNA technology.
- DNA modifying enzymes.
- Cloning vectors.
- Preparation of genomic and cDNA liberary ,Molecular probes .
- Amplification of gene :Polymerase chain reaction (PCR),RAPD

Unit-V

- DNA finger printing.
- Detection of genetic diseases,Gene transfer techniques and gene therapy.
- Development of DNA drugs and vaccines.
- Live stock improvement

Suggested Readings:

1. Karp: Cell and Molecular Biology: Wiley (2002).
2. Watson et al. Molecular Biology of the Gene. Pearson (2004).
3. Lewin. Genes VIII. Pearson (2004).
4. Pierce B. Genetics. Freeman (2004).
5. Sambrooket al .Molecular Cloning Vols I, II, III. CSHL (2001).
6. Primrose. Molecular Biotechnology. Panima (2001).
7. Clark & Switzer. Experimental Biochemistry. Freeman (2000).

8. L.Veera Kumari, Bio instrumentation MJP publishers

M.Sc.1st Semester

General Paper-IV – ZOY 704
Molecular Cell Biology

Course Objectives

Students are able to understand and learn

- Structure and functions of Biomembranes
- Various cytoskeleton structure and their functions
- Cell- cell interaction signaling
- Adhesion molecular and their Regulation & functions

Unit-I

- Transport across cell membrane: diffusion active transport & uniport, symport & antiport.
- Membrane potential
- Transport across epithelia.

Unit-II

- Microfilaments, microtubules, intermediate filament & their dynamics.
- Microtubules & mitosis
- Cell movement intracellular transport, role of kinesin & dynein.

Unit-III

- Signals transduction mechanism.
- Cell surface receptors
- Second messenger system
- MAP kinase pathway
- Signaling from plasma-membrane to nucleus

Unit-IV

- Ca^{++} dependent hemophilic cell-cell adhesion
- Ca^{++} independent hemophilic cell-cell adhesion
- Gap junction & connexins

Unit-V

- Itergrins, collagens and non collagen components.
- Cyclins & cyclin dependent kinases
- Regulation of CDK-cyclin activity
- Apoptosis and Necrosis.

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. P.K Gupta, Cell and molecular biology,Rastogi publication.

M.Sc.1st Semester

General Practical – ZOY 705

- Study the museum specimens of different invertebrate Phyla.
- Study the permanent slides of different phyla
- Study of permanent slide of larval stage of Helminthes to Echinodermetes.
- Study of mitosis from anion root tips
- Absorption spectrum of colored solution using spectrophotometer/ Colorimeter
- Separation & detection of dyes/ amino acids using paper chromatography.
- pH determination of unknown solution.
- Separation of Serum and tissue protein with the help of electrophoresis.
- .Biostatics; graphical representation of data(Mean, Median, Mode & standard deviation)

Marks distribution

Duration : 6 hours

• Colorimetric estimation of unknown solution/ Chromatography.	15
• Determination of pH/ separation of protein.	15
• Biostatics Problem	05
• Preparation of slide	05
• Spotting 1-10	20
• Record & Collection	10
• Viva-Voice	05
Total Marks	**75**

M.Sc. – 2nd Semester
General Paper- I – ZOY 801
Genetics

Course Objectives

Students are able to understand and learn

- Structure and functions of Chromosomes
- Various laws of Mendel related to genetics
- Genetic mapping, genomic imprinting and types of chromosomes
- Gene mutation its types and genetic disorders

Unit - 1

- Mendalian principle : Dominance, segregation and independent assortment
- Concept of gene : Allele, multiple allele, pseudoallele
- Extra chromosomal/Cytoplasmic inheritance

Unit - 2

- Co-dominance, incomplete dominance, epistasis, gene interaction, pleiotropy.
- Genomic imprinting, anticipation ,peneterance and expressivity, phenocopy.
- Linkage and crossing over
- Genetic maping : Two points and three points cross.

Unit - 3

- Molecular anatomy of eukaryotic chromosome and telomere.
- Giant chromosome : Polytene and lampbrush chromosome.
- DNA packaging upto metaphase chromosome.
- Chromosome banding, karyotype, patterns of inheritance and pedigree analysis.

Unit -4

- Gene Mutation : Kinds of mutation.
- Mutagens.
- Structural alteration in chromosome.
- Numerical alteration in chromosome.

Unit – 5

- Mendalian and gentic disorders.
- Eugenics, Euthenics and genetic counselling.
- Oncogene and tumor repressor gene,
- Chromosomal abnormalty in malignancy (chronic myloid leukemia,burkirtt's lymphoma, retinoblastoma and wilm's tumor.

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. P.K.Gupta : Genetics and molecular biology. Rastogi publication.
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Pierce B. Genetics. Freeman (2004).

8. Veer bala rastogi : Genetics, Meditech publication.

M.Sc. – 2nd Semester

General Paper- II – ZOY 802
Taxonomy and Evolution

Course Objectives

Students are able to understand and learn

- Understand basic concept of taxonomy & Systematic
- Able to understand various types of Taxonomy
- Able to know various procedure to study taxonomy
- Able to differentiate between taxonomy and systematic
- Various theories of evolution and concept of species

Unit – 1

- Definition and basic concepts of taxonomy.
- Scope and levels (α, β and γ) of taxonomy, phonetics, cladistics.
- Trends in biosystematics: Chemo, cyto and molecular taxonomy.
- Taxonomic procedures: Taxonomic collection and preservation, curetting , process of identification.
- Taxonomic keys, zoological nomenclature (As amended till date), international code of zoological nomenclature (ICZN), role of zoological survey of India.

Unit – 2

- Lamarkism
- Theory of natural selection, Darwin Wallace theory of evolution, neodarwinism.
- Modern synthetic theory.
- Mutation theory.

Unit – 3

- Historical concepts regarding origin of life.
- Modern theory regarding origin of life.
- Theories of chemical and spontaneous origin of life at molecular level.
- The evolution of protein, examples of protein evolution and neutral theory of protein evolution.

Unit – 4

- Species , rece and deme, nature of speciation.
- Instantaneous speciation : Through mutation , through macrogenesis, through chromosomal aberration.
- Gradual speciation : Allopatric and sympatric.
- Micro, macro and megaevolution , hypothesis of punctuated equilibria.
- Isolation : Types of isolation, premating and postmating isolating mechanism.

Unit – 5

- The Hardy – Weinberg principle and analysis of gene frequencies in natural population.
- Major factors influencing gene frequencies (Migration, inbreeding), effects of selection and mutation on gene frequencies,Genetic polymorphism
- Fossils ,Geological time scale, zoogeographical distribution of animals.
- Evolution of horse and man.

Suggested books :

- G.G. Simpson, **Principle of animal taxonomy**. Oxford IBH Publishing company.
- V.C. Kapoor. **Theory and Practice of Animal Taxonomy**. Oxford & IBH Publishing Co.
- Strikberger, M.W. **Evolution** Jones and Barlett Publishers. Boston London.
- Dobzhansky, Th.,**Genetics and Origin of Species**. Columbia Unvieristy Press. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. **Evolution**. Surjeet Publication, Delhi.
- Futuyama, D.J. **Evolutinary Biology**, Suinuaer Associates, INC Publishers, Dunderland.
- Rastogi, V. B., Organic Evolution, Medtech Science Press, Delhi.

M.Sc.2nd Semester
General Paper-III – ZOY 803
Biochemistry

Course Objectives

Students are able to understand

- Structure and function of various Biomolecules including protein, Nucleic acid etc.
- Basic concept of metabolism of carbohydrates, Protein and fats.
- Biosynthesis of Amino acids, nucleotides.
- Basic structure & function of enzyme & mechanism of action.

Unit-I

- Energetics : IInd law of thermodynamics, free energy, standard free energy change
- Reducing power and redox reaction, Ernst equation
- Synthesis of ATP
- Cellular energy resources

Unit-II

- Biosynthesis of Amino acid
- Protein structure ,classification folding and denaturation
- Ramachandran plot and chaperons.
- Structure of nucleic acid (DNA and RNA)
- Biosynthesis of nucleotides

Unit-III

- Nomenclature & classification of enzyme, Co-enzyme & Iso-enzyme
- Mechanism and regulation of enzyme action
- Enzyme kinetics: Michaelis-Menten equation, concept of K_m & V max
- Factors affecting rate of enzyme reaction
- Enzyme inhibition and Allosteric enzyme

Unit-IV

- Structure and classification of Carbohydrates
- Glycolysis, citric Acid cycle,HMP shunt
- Glycogenesis ,Gluconeogenesis, Glycogenolysis
- Oxidative phosphorylation

Unit-V

- Structure and classification of lipids
- Fatty acid metabolism; synthesis & degradation
- Biosynthesis of membrane lipid.
- Biosynthesis of steroids and cholesterol.

Suggested Readings:

1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000)
2. Zubayet al: Principles of Biochemistry: WCB (1995)
3. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
4. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. (2006).
5. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
6. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).

7.Jain and Jain : Bio chemistry, S Chand publication.

M.Sc.2nd Semester
General Paper-IV – ZOY 804
Ecology and animal behavior

Course Objectives

Students are able to understand

- Ethology as a branch of zoology to study animal behaviour
- Various types of animal behaviour
- Neural and hormonal control of Behaviour
- Motivation, Learning & various type of communications
- Various ecological aspects of behaviour, rhythms, orientation and migration

Unit – 1

- Concept of ecosystem, trophic structure of ecosystem, types of ecosystem, productivity of ecosystem.
- Concept of limiting factors ,Liebig Blackman law of limiting factor, Shelford's Law of tolerance.
- Types of interaction: Commensalism, mutualism, predation grazing , parasitism, allelopathy
- Ecological succession, Ecological niche and key stone species.

Unit – 2

- Population and its characteristics, patterns of population growth
- Survival ship curve, population dispersion and its regulations.
- Adaptation in terrestrial environment and parasitic habitat.
- Biogeochemical cycles.

Unit – 3

- Biodiversity and its significance
- Causes of biodiversity loss : habitat destruction , over exploitation, introduction of exotic spp., diseases and shifting or Jhum cultivation
- Conservation : IUCN red data book, Ex- situ conservation and In- situ conservation, germ plasm banks.
- Pollution : Urban, agricultural and atmospheric (Global climate change)

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Unit – 4

- Ethology and its scope, branches of ethology
- Patterns of behavior, components of behavior
- Role of hypothalamus : In feeding and drinking, in reproductive behavior, in fighting and fleeing , in sleeping and walking
- Reflexes and complex behavior, reflex arch
- Pheromones : Functions and effects

Unit – 5

- Concept of fixed action pattern and its properties
- Concept of sign or key stimulus, stimulus filtering, super normal stimulus, innate releasing mechanism
- Learning and memory : Conditioning, habituation, insight learning, association learning, reasoning
- Biological clocks : Circadian and circannual clocks
- Mimicry, altruistic behavior and kin selection

Suggested reading :

- Ecology and environment science by HR Singh, vishal publication.

- Animal behavior by Mannings.
- Animal behavior by Gundavia.
- Animal behavior by Fatik.
- Alcock ,JAnimal behavior : an evolutionary approach Sinauer Assoc.Sunderland,Mass USA.
- Bradbury , J.W and S.L. Vehrencamp: principles of animal communication Sinauer Assoc.Sunderland,Mass USA.

M.Sc.IInd Semester
General Practical – ZOY 805

- Preparation of human karyotype and study the chromosomal aberration from the pictures provided
- Study of sex chromatin (Barr body) in buccal smear and hair bud
- Extraction of DNA from animal/plant tissue
- Preparation of Polytene chromosome
- Solve genetic problems by punnett diagram
- Recoding of blood pressure by sphygmomanometer
- Recoding of blood sugar by gulucometer
- Estimation of clotting & bleeding time, Hb%
- Preparation of haemein crystals
- Identification of Carbohydrate, Protein , Lipids and amino acids
- Quantitative determination of biological components (protein, glycogen. RNA & DNA)
- Demonstration of reflex action.
- Problems related to evolution , population genetics etc(H.W. Principle, natural selection , adaptation, trends and genetic polymorphism

Marks Distribution **Duration:- 6 hours**

• Dissection of fish, amphibian & mammals (Virtual)	10
• Blood sugar / blood pressure/ reflex action	10
• Any two blood experiment(Bleeding, Clotting, haemin crystal, Hb%)	10
• Quantitative determination of biological components/problems related to evolution	10
Identification of foodstuff	10
• Spotting 1-10	15
• Record and Collection	05
• Viva-voice	05
Total	**75**

M.Sc. 3rd Semester
General Paper-I - ZOY 901
Comparative anatomy and physiology of Vertebrate

Course Objectives

Students are able to understand

- To understand the Physiology and Anatomy of Vertebrates
- To acquire idea of respiratory pigments & various animals
- To understand process of respiration communication & hormonal regulation
- To understand comparative & Evolutionary aspects of physiology in various vertebrates.

Unit-I

- Characteristic features & classification of Protochordata. .
- Origin, Classification and characteristics of vertebrates.
- Structure & development of integument and its derivatives.

Unit-II

- Respiratory organs in different vertebrates.
- Transport of gases.
- Neuronal and chemical regulation of respiration.
- Digestive system of mammals.

Unit-III

- Evolution of Heart and aortic-arches
- Cardiac cycle and blood pressure
- Anatomy of excretory organ in vertebrates.
- Physiology of excretion : Urine formation, micturition, waste elimination, water balance, electrolyte balance and acid base balance

Unit-IV

- Comparative account of CNS & PNS
- Conduction of nerve impulse
- Sense organs : Vision, hearing and tactile response

Unit-V

- Endocrine glands & their secretions
- Basic mechanism of hormonal action
- Hypothalamo-hyperphysial portal system & neural control of pituitary gland
- Hormonal disorders

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002,Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGrHill
5. R.L.Kotepal, text book of vertebrate zoology, Rastogi publication
6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS

M.Sc.3rd Semester

General Paper-II – ZOY 902
Molecular Cytogenetic

Course Objectives

Students are able to understand

- The structure of Eukaryotic chromosome along with to various types.
- About human karyotype & chromosomal abnormalities.
- About prokaryotic & Eukaryotic transcription & translation.
- Post transcriptional modification
- About genetic code & mechanism of Translation

Unit-I

- Enzymes and proteins involved in replication
- DNA replication in prokaryotes
- DNA replication in Eukaryotes
- DNA repair

Unit-II

- RNA polymerases, General transcription factors
- Transcription in prokaryotes
- Transcription in Eukaryotes

Unit-III

- Post transcriptional modification, capping & Polyadenylation
- Splicing and RNA editing
- Export & stability of mRNA

Unit-IV

- Genetic code & wobble hypothesis
- Factors involving in translation.
- Translation in prokaryotes
- Translation in eukaryotes

Unit-V

- Regulation of gene expression in prokaryotes; Lac Operon and trp-operon in E-coli,
- Regulation of gene expression in Eukaryotes; Role of chromatin, methylation ,Phosphorylation,acetylation, Epigenetic regulation

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002).
5. Watson et al. Molecular Biology of the Gene. Pearson (2004).
6. Lewin. Genes VIII. Pearson (2004).
7. P.K Gupta, Cell and molecular biology,Rastogi publication.

M.Sc.3rd Semester
General Practical – ZOY 915

- Virtual dissection of cranial nerves,afferent and efferent branchial arteries of fishes.
- Study of museum specimens of various Vertebrates.
- Study of permanent slides of Vertebrates.
- Study of Axial & appendicular skeleton of birds & mammals
- Study of Microtomy : Section cutting and preparation of permanent slides
- Study of different models (Cell organelles and nucleic acids)

Marks Distribution	**Duration:- 6 hours**
1-Dissection	05
2-Microtomy	10
3-Spotting (1-10)	15
4-Record	05
5-Viva	05
	Total 40

M.Sc. 4th Semester
General Paper-I- ZOY 1001
Infection Biology and Immunology

Course Objectives

Students are able to understand

- Concept of parasitism, Host parasite relationship various type of parasite
- Structure & types of Immunoglobulin
- About nature of immune response, MHC cytokines etc.
- Antigen antibody interaction & mechanism

Unit-I

- Introduction to Parasitology, types of host and parasites.
- Parasitic adaptation in helminth parasites, parasitoids.
- Application of molecular biology in parasitic diseases.
- Biochemical and molecular mechanism of drug resistance in parasites.

Unit-II

- Innate & Acquired immunity
- Cells & organs of immune system
- Antigen & immunogenicity
- Anti body structure, function and diversity.
- Clonal selection theory.

Unit-III

- Humoral & cell mediated immune response.
- Maturation, Activation of lymphocytes (T & B cells), cytotoxic T-cells, NK cells, T-helper cells
- Major Histocompatibility Complex, antigen processing and presentation.
- Complete system
- Mammalian tole like receptors.

Unit-IV

- Monoclonal antibodies
- Antigen, antibody reaction (Precipitation and agglutination)
- Immunological technique (ELISA-Radio immunoassay,Immunohistochemistry ,Immunoelectrophoresis)

Unit-V

- Tumor immunology and Immunity to cancer.
- Transplant immunology and immunological tolerance
- Congenital & acquired immunodeficiencies.

Suggested Readings:

1. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).

2. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).

3. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)
4. Januway et.al. ,immunobiology- the immune system in health and diseases, Garland publishing U.S.A.
5. D.M.Weir and John Stewart: Immunology.
6.Kuby Immunology 8Ed. Macmillan publication.

M.Sc. 4th Semester
General Paper-II – ZOY 1002
Developmental Biology

Course Objectives

Students are able to understand

- Basic concept of embryology, development and sex determination
- Early development of mammalian embryo
- Late embryonic development
- Post embryonic development

Unit-I - Historical perspective and basic concepts

- Historical review and theories of embryology
- Cell division and cell differentiation
- Developmental biology and human welfare
- Sex determination in birds and mammals

Unit-II - Early embryonic development in mammals

- Male gonads and spermatogenesis
- Female gonads and oogenesis
- Semination, Ovulation and transport of gametes
- Reproduction cycle ; estrous and menstrual cycle
- Fertilization and cleavage
- Blastulation and Gastrulation

Unit-III - Late Embryonic Development

- Morphogenesis; formation of neural tube, cell migration
- Fat map of germinal layers, extra embryonic membranes.
- Implantation in mammals
- Placentation in mammals
- Axis and pattering in Drosophila

Unit-IV - Post embryonic Development

- Metamorphosis in amphibian
- Regeneration epimorphic regeneration in reptile
- Ageing ; concept & theories
- Stem cells

Unit-V - Implication of developmental Biology

- Tretogenesis- teratological agents and their effect on embryonic development
- Amniocentesis
- Assisted reproductive techniques IVF, ICSE, GIFT etc

Suggested Books

- Gilbert, S.F. (2010) Developmental Biology, Sinauer Publisher

- Balinsky, B.I. and Fabian B.C. (1981) Introduction of Embryology
- Carlson, R.F. Patter's Foundation of Embryology
- Kalthoff. (2008) Analysis of Biologycal Development, Hill Publishers
- Lewis Wolpert (2002) Principales of Development Oxford University Press.
- Chordate embryology Verma and Agarwal. S.Chand Publication Recent edition

M.Sc. 3rd Semester

Special Paper-I – ZOY 903 (Fish- A)
Taxonomy, Ecology and behavior

Course Objectives

Students are able to understand

- Classification of fish by berg
- Various types of fishes according to habitat and habits
- Physiochemical factors affecting fish in food chain
- Behaviour and distribution of fishes

Unit – 1

- Outline Classification of fishes as proposed by Berg.
- Classification of placodermii, elasmobranchii and holocephalli.
- Classification of dipnoii and ostrichthyes .

Unit – 2

- Riverine and cold water fisheries.
- Lacustrine and estuarine fisheries.
- Coastal , offshore and deep sea fisheries.
- Systematic survey with particular references of fishes of Bundelkhand region.
- Adaptation in hill stream and deep sea fishes.

Unit – 3

- Trophic levels of fish in the food chain.
- Primary productivity of fish pond and its importance.
- Common aquatic weeds of fish ponds and their control.
- Larvicidal and predatory fishes and their importance in fish culture.
- Exotic fishes and their importance.

Unit – 4

- Courtship and parental care.
- Fish migration.
- Fish schooling behavior
- Shoaling behavior.

Unit – 5

- Diseases of aquaculture : Prevention, prophylaxis and treatment of bacterial, viral and fungul diseases.
- Protozoan and helminth diseases of fishes.
- Immune protection in fishes.
- Types and sources of aquatic pollution and its impact on fish health.

Suggested Books

- Biology of fishes ;Bone Q andMoore R. Talyor and Francis groups CRC press U. K.
- .The diversity of fishes G.S.Helfman, B.B.Collette and d.f.Facey Blackwell science USA.
- Reading in Ichthyology M.S.Love and G.M.Cailliet.Prentice-hall of India
- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Fish and fisheries of India :Jhingran,V.G. Hindustan publishing corporation New Delhi.

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M.Sc. 3rd Semester

Special Paper-I I – ZOY 909 (Fish- B)
Fish anatomy and physiology

Course Objectives

Students are able to understand

- Structure and function of skin and its derivatives including chromatophores and scales
- Various physiological functions including digestion , respiration etc
- Various sense organs structure and functions
- Fish reproductions and developments

Unit – 1

- Structure and function of skin and its derivatives.
- Structure , types and fuction of scales.
- Chromatophores : Structure ,classification and colour change mechanism.
- Determination of age growth and its relationship with scales.
- Fins : Origin ,types and their modification, locomotion in fishes.

Unit – 2

- Digestive system : Anatomy and physiology of Alimentary canal.
- Respiratory organ : Structure of gills and physiology of aqueous breathing .
- Swim bladder and webarian ossicles : Structure and function.

Unit – 3

- Circulatory system : Structure of heart and arterial system(Afferent and Efferent arteries).
- Excretory system : Structure and physiology of kidney.
- Osmoregulatory mechanism, balance of ions in fresh water and marine fishes.

Unit – 4

- Nervous system : Structure of brain and cranial nerves.
- Lateral line system : Structure, modification and significance.
- Organs of olfaction and taste.
- Electric organ, bioluminescent organ and sound producing organs.

Unit – 5

- Male and female reproductive organs.
- Reproductive cycle and maturation.
- Structure and fuctions of endocrine glands : Pituitory, thyroid, ultimobranchials, pancreas, adrenal, corpuscles of stannous, urophysis and pineal.
- Environmental and hormonal control of reproduction.

Suggested books

- Encyclopedia of fish physiology.2011 Anthony P. et all 2011 Academic press UK
- Fish physiology . (series)W.S. Hoar and.J. Randall Academic press UK

- The physiology of fishes.2013 Evans,D H and Claiborne,J.D.Taylor and Francis grp CRC press UK
- Introduction to fish physiology ;Dr. Lynwood S. Smith Narendra publishing house India.
- An introduction to fishes:G. S. Sandhu,Campus book international.
- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Fish and fisheries of India :Jhingran,V.G. Hindustan publishing corporation New Delhi.

M.Sc. 3rd Semester

Special paper practical – ZOY 916(Fish and Fisheries)

- Virtual dissection of bony and cartilaginous fishes.
- Study of electric organ of fishes.
- Determination of age through the scale of fishes.
- Study of museum specimens of fishes.
- Study of permanent slides.
- Study of bones of fishes.

Marks Distribution: **Duration:-6 hours**

• Dissection of fishes	10
• Determination of age/study of electric organ	05
• Spotting	10
• Preparation of permanent slide	05
• Viva – Voce	05
• Record and collection	05
Total	**40**

M.Sc. 4th Semester
Special Paper-I – ZOY 1003 (Fish- A)
Pisciculture

Course Objectives

Students are able to understand

- Collection of fish seed from natural resources
- Various type of bundh for fish culture
- Various instruments used for fish culture
- Fish preservation and transportation

Unit – 1

- Construction and layout of different types of ponds.
- Physiochemical properties of pond water and soil.
- Pre and post management of stocking ponds.
- Management of hatcheries, nurseries and rearing ponds.
- Management of fish germ plasm.

Unit – 2

- Dams and their impact on riverine fisheries.
- Culturable fish species of inland water .
- Planktons and their importance in fish culture.
- Construction and maintenance of fish aquaria and important aquarium fishes.

Unit – 3

- Fishing crafts and gears.
- Remote sensing technique used in fish culture.
- Fishways and screens.
- Fish feed: Natural, artificial and commercial .

Unit – 4

- Brakish water fish culture.
- Sewage fed fish culture.
- Biofloc fish farming .
- Recirculating aquaculture system.

Unit – 5

- Methods of fish preservation.
- Problem associated with fish preservation.
- Fish spoilage, rigor mortis, rancidity and enzyme spoilage.
- Transportation and marketing of fish.

Suggested books

- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Hand book of Fisheries and aquaculture.2013 Indian Council of Agricultural Research

ICAR New Delhi India

- Fish and fisheries of India : Jhingran,V.G. Hindustan publishing corporation New Delhi.
- Santhanam, R. Fisheries science Daya publishing house
- Lagler,K.Fet al.; Ichthyology, John Wiley
- C.I.F.R.I; Prawn Fisheries Bulletin no 10 1977.
- Huet M.;Text book of fish culture, breeding and cultivation of fish ,fishing news(books) LTD
- Ribelin, W .E.& Migeki, G.: the pathology of fishes,the university of Wisconsin press , 1975.

M.Sc. 4th Semester
Special Paper-I I – ZOY 1009 (Fish- B)
Aquaculture and economic importance of fishes

Course Objectives

Students are able to understand

- Various types of fish culture
- Genetic modification and its importance
- New techniques involved in aquaculture
- Fish by products and economic importance

Unit – 1

- Cage or pen culture.
- Prawn and shrimp culture.
- Pearl culture.
- Fish culture in swamps and marshes.

Unit – 2

- Integrated and composite fish culture.
- Rice field aquaculture .
- Induced breeding and bandh breeding

Unit – 3

- Fish as a model organism.
- Genetically modified fishes and their importance.
- Chromosome manipulation (Gynogenesis, androgenesis and polyploidy).
- DNA polymorphism in fishes.

Unit – 4

- Biosensors used in aquaculture.
- Fishes as biofactories.
- Extension services : Basic principles and immerging issues of extension.
- Role of information and communication technology(ICT) in fisheries extension.

Unit – 5

- Fish by products : Fish skin, scales, fish manure, fish isinglass, fish flour, fish sausage and fish silage.
- Economic importance of fish liver oil, fish body oil.
- Chemical composition of fish liver oil.
- Shark liver oil industry in India

Suggested books

- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Hand book of Fisheries and aquaculture.2013 Indian Council of Agricultural

Research ICAR New Delhi India

- Fish and fisheries of India :Jhingran,V.G. Hindustan publishing corporation New Delhi.
- Santhanam, R. Fisheries science Daya publishing house
- Lagler,K.Fet al.; Ichthyology, John Wiley
- Srivastava , C.B.L: a Textbook of fishery science and Indian fisheries, Kitaab Mahal 1985.

M.Sc. 4th Semester
Special paper practical – ZOY1015
(Fish and fisheries)

- Pituitary gland collection from fishes
- Study of different types of nets and gears.
- Fish skeletal preparation.
- Identification of fish parasites , their fixation and permanent slide preparation .
- Microtomy of fish organs (Block making , section cutting and slide preparation).
- Testing of Physiochemical parameters of water.
- Identification of fishes through keys.
- Identification of different weeds.
- Representation of catchment of fishes through histogram and pie diagram.
- Study of museum specimens and histological slides.

Marks distribution : **Duration:- 6 hours**

• Dissection of pituitary gland	10
• Study of nets / gear	10
• Microtomy	15
• Water testing	05
• Spotting	10
• Submission of skeleton of fish already prepared	10
• Slide preparation	05
• Identification of fish	05
• Viva and record	05
Total Marks	**75**

M.Sc. 3rd Semester

Special Paper-I – ZOY 907 (Applied zoology - A)
Aquaculture

Course Objectives

Students are able to understand

- Various types of Aquaculture
- Different types of pond and their managements
- Economic importance of aquaculture
- Fish breeding and maintenance of aquarium

Unit – 1

- Scope and significance of various streams of applied zoology
- Scope, importance and problems of aquaculture.
- Physiochemical properties of pond water
- Types and qualities of culturable fishes

Unit – 2

- Construction and lay out of different types of ponds
- Management of hatcheries, nurseries and rearing ponds.
- Pre and post management of stocking ponds.

Unit – 3

- Fresh water prawn culture
- Pearl culture
- Fin fish culture
- Integrated fish cum duck farming.
- Sewage fed fish culture.

Unit – 4

- Construction and maintenance of fish aquaria and important aquarium fishes.
- Cage culture.
- Brackish water fish culture.
- Biofloc fish farming.

Unit – 5

- Breeding habits of carps : Bandh breeding and induced breeding
- Fish byproducts and marketing .
- Fish preservation and transportation.

Suggested books

- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Hand book of Fisheries and aquaculture.2013 Indian Council of Agricultural Research ICAR New Delhi India
- Fish and fisheries of India :Jhingran,V.G. Hindustan publishing corporation New Delhi.
- Santhanam, R. Fisheries science Daya publishing house
- Lagler,K.Fet al.; Ichthyology, John Wiley

M.Sc. 3rd Semester

Special Paper-II – ZOY 913 (Applied zoology - B)
Human diseases, disorders and diagnostics

Course Objectives

Students are able to understand

- Types of parasites, host and their relationship
- Causes, diagnosis and prevention of common diseases
- Cancer and its types
- Methods of pathological analysis

Unit – 1

- Types of parasites and hosts
- Brief introduction to pathogenic microbes: Viruses and bacteria.
- Host parasite relationship

Unit – 2

- Causes , types, symptoms, diagnosis and prevention of : Tuberculosis ,Hepatitis, Diabetes and Hypertension.
- Causes, types, symptoms, diagnosis and prevention of epidemic and pandemic diseases : Typhoid, cholera, small pox, plague and covid-19.

Unit – 3

- Types of tumors : Benign, malignant
- Tumor associated antigen
- Immuno diagnosis and immunotherapy in cancer

Unit – 4

- Methods used for analysis of : Blood and Urine
- Medical imaging : X-Ray, MRI and CT scan

Unit – 5

- Hybridoma technology
- Gene therapy
- Development of recombinant vaccine
- Production of recombinant protein : Insulin and growth hormone

Suggested books

- Introduction to parasitology: J.D Smith
- Parasitology – T.C.Cheng
- Biology of parasites – E.J.W.Soulsbey
- Medical parasitology-K.D.Chaterjee
- Noble and Noble , Parasitology, Lea and Febiger 1973

M.Sc. 4th Semester

Special Paper-I – ZOY 1007 (Applied zoology - A)
Applied Entomology

Course Objectives

Students are able to understand

- Various types of insect culture
- Management of insect pest
- Use of pesticide and prevention
- Pest of serials, pulses and other stored grains.

Unit - 1

- Apiculture
- Sericulture
- Lac culture

Unit – 2

- Characteristic features, biology, nature of damage and management measures of :
    - Insect pests of sugar cane : Scirpophaga, Chilotraea, Pyrilla, Aleurolobus.
    - Insect pests of cotton : Sylepta, Erias, Pectinophora, Dysdercus.
    - Insect pests of oil seeds : Mustard aphid, Sawfly, Castor Semi-looper

Unit – 3

- Characteristic features, nature of damage and management measures of:
    - Important insect pests of cereals and pulses
    - Important insect pests of stored grains
    - Polyphagus insects
    - Important general pests : Grasshoppers, locusts, termite, aphids

Unit – 4

- Characteristic features, nature of damage and control measures of :
    - house hold pests : Cockroaches, crickets, ants, wasps, silverfish, cloth and carpet beetle, furniture beetle
    - Role of insects as vectors of human diseases.
    - Pest management including mechanical, physical, cultural ,chemical , legal biological and recent trends of management

Unit – 5

- Mode of action of pesticides : Organophosphorous, organochlorine, carbamate, pyrethroids and neem products.
- Forest entomology : Its pests and control
- Forensic entomology and its importance
- Veterinary insects and their control

Suggested books

- O.W.Richards and R.G .Davies, Imms textbook of Entomology. Methuen and Co. London.
- R.E .Snodgreass, Principles of insect morphology. Tata MacGraw Hill, Bombay.
- R.M.Fox and J.W.Fox, Introduction to comparative entomology. Reinhold Publ.Corp, New York.

- R.F.Chapman. The insects structure and function(ELBS,London)
- K.K.Nayar, T.N. Ananthakrishnan and B.V.David, General and Applied Entomology. Tata MacGrow Hill, New Delhi.
- K.G.V. Smith, Insects and other arthropods of medical importance.
- H.H.Ross. A Textbook of Entomology, John Wiley and sons, New York.

M.Sc. 4th Semester
Special Paper-I – ZOY 1013 (Applied zoology - B)
Parasitology and immunology

Course Objectives

Students are able to understand

- Types of parasites, host and their relationship
- Causes, diagnosis and prevention of common diseases
- Cancer and its types
- Methods of pathological analysis

Unit – 1

- Morphology, life cycle, physiology ,pathogenicity , epidemiology and treatment of :
  1- Sarcodina: Entamoeba spp.,Naegleria sp
  2- Sporozoa : Toxoplasma spp., Eimeria spp.,plasmodium spp.
  3- Ciliata : Balantidium spp., Nyctotherus spp.,

Unit – 2

- Morphology, life cycle, physiology pathogenicity , epidemiology and treatment of :
  1- Homoflagellate : Trypanosoma spp.and leishmania spp.
  2- Intestinal flagellate : Giardia and trichomonas spp.
  - Opalinids : Opalina spp.

Unit – 3

- Protozoan diseases of fish : Costiasis, White spot diseases, Pimple disease
- Helminth diseases of fish : Yellow grab, white grab, blood flukes, tape worms, gyrodactylus.
- Bacterial diseases of fish : Cotton wool disease, tail and fin rot, dropsy, furunculosis.
- Viral diseases : Lymphocystis, pox disease

Unit – 4

- Application of molecular biology in parasitic diseases
- Biochemical and molecular mechanism of drug resistance in protozoan parasites
- Drug target identifications in protozoan parasites

Unit -5

- Components of immune system
- Innate and adaptive immunity to infection
- Structure and function of antigen and antibody
- Complement system

Suggested books

- Introduction to parasitology: J.D Smith
- Parasitology – T.C.Cheng
- Biology of parasites – E.J.W.Soulsbey
- Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)
- Januway et.al. ,Immunobiology- the immune system in health and diseases, Garland publishing U.S.A.

M.Sc. 3rd Semester

Special Paper-I – ZOY 905 (Environmental Biology-A)
Fundamentals of Environmental Biology

Course Objectives

Students are able to understand

- Scope of Environmental Biology
- Ecosystem and its functioning
- Population ecology
- Various types of Environmental Pollution

Unit- I: Definition, Principles and scope of Environmental Biology

Man and Environment, Components of atmosphere and biosphere, Physicochemical and biological factors in the Environment, Structure and composition of Biosphere. Biomes and Climates

Unit- II: Nature of ecosystem

Ecosystem structure and functions, types of ecosystems, Abiotic and biotic components, Terrestrial and aquatic ecosystems, Productivity, Food chain, food web, energy flow through ecosystem, biogeochemical cycles, Ecological Pyramids Basics of Ecosystem restoration

Unit- III: Population ecology

Density, natality, mortality, growth curves, Commensalism, Mutualism,
Parasitism, Predator- Prey relations, Population dynamics, Ecological succession, Ecological Models

Unit- IV :Environmental Pollution

Classification of pollutants, Nuclear hazards and human health risks, Sources, Effects and control of Air, water, soil and noise pollution Ganga Action plan (GAP), public health issues, Plastic waste management rules, Bhopal gas tragedy, etc

UNIT – V: Environmental Microbiology and Toxicology

Introduction to toxicology, dose-response relation, additive-synergistic and antagonistic effects, factors affecting toxic responses, route of administration, toxicity testing, types of toxicity, Pesticides ,metals, solvents and vapours, radiation and radioactive materials, chemical carcinogens, food additives, fluorosis and arsenic poisoning.

Microbiology- organisms in nature & their importance, Biotransformation, bioconversion, phytoremediation and bioremediation, microbiology of water, air and soil ,microbes as pathological agent in plant, animal and man.

Reference Books-

1. Environmental chemistry - Sodhi
2. Principals of Environmental chemistry - Manhan
3. Environmental hazards & human health R.B. Philip
4. Toxicology - principles & applications - Niesink & Jon devries
5. Principles of microbiology - Pelzar
6. Microbial bio technology - A.N. Glazer
7. Microbial ecology - R.M. Atlas

M.Sc. 3rd Semester
Special Paper-I I – ZOY 911 (Environmental Biology-B)
Biodiversity and Energy Conservation

Course Objectives

Students are able to understand

- Concept of Biodiversity and conservation
- Uses of Biodiversity
- Energy resources and conservation
- Natural resources and various movements to conserve it

Unit- I: Biodiversity Conservation

Introduction to biodiversity concepts, significance and distribution, Levels of biological diversity, Threats to biodiversity, principles of biodiversity conservation in-situ and ex-situ conservation, acceleration of ecological succession, Mega biodiversity zones and Hot spots. Man and biosphere programme

Unit- II: Uses of biodiversity

Sources of food, medicines, raw material, aesthetic, cultural and ecosystem services, strategies for sustainable exploitation of biodiversity.

Unit- III: Energy Resources and Conservation

Renewable and non-renewable energy resources, sun as source of energy, solar radiation and its spectral characteristics, fossil fuels classification, composition.

Physiochemical characteristics and energy content of coal, petroleum and natural gas. Principle of generation and conservation of conventional and non-conventional energy.

Energy from biomass and biogas, energy conservation policies.

Unit- IV: Natural Resources and Movements

Land resources, Causes of deforestation; Impacts of mining and dam building on environment.

Water resources: Over exploitation of water resources; Floods, droughts, and international & interstate conflicts over water

Contemporary Indian issues related to mining, dams, forests, energy etc (e.g., National Solar Mission, Cauvery River water conflict, Sardar Sarovar dam, Chipko movement, Appiko movement, Tarun Bharat Sangh, Bishnois of Rajasthan, Narmada Bachao Andolan, etc) Environmental justice: National Green Tribunal and its importance.

Unit- V:Wetlands-

Concept, classification, importance, uses and threats to the wetlands, Productivity and development of Wetlands ,Important wetlands of India. Ramsar convention and National Wetland Policy.

References

1. Living in the environmental - T.J. Miller.
2. Natural resource conservation - Owen & Chiras.
3. Encyclopedia Energy - I & II.
4. Global Biodiversity - W.R. L.IUCN
5. Ecology of natural resource - Ramade
6. Ecology - P.D. Sharma
7. Keddy P.A (2000). Wetland Ecology: Principles and Conservation.
8. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science andConservation. S. Chand Publishing, New Delhi.

M.Sc. 4th Semester

Special Paper-I – ZOY 1005 (Envi. Biol. - A)
Environmental Management

Course Objectives

Students are able to understand

- Basic concept of sustainable development
- Various types of pollution and their management
- Disaster management
- Effect of pollution on health

Unit- I: Environmental Management

Introduction and scope of environmental management, basic concepts of sustainable development, Role of natural products, Environmental Impact Assessment (EIA),environmental management plan (EMP), international organization for standardization (ISO), environmental safety, Remote sensing, GIS technology and its uses, environmental monitoring.

Unit- II: Water Pollution Management

Water quality standard, physico-chemical and biological properties of sewage, effects of water pollutants on phytoplankton productivity, bio-indicators of water pollution., Biological treatment of waste waters, chemical and other methods for disinfection. , Water management strategies, rain water harvesting, recharging of ground water, Treatment of Industrial effluents.

Unit- III: Air Pollution Management

National air monitoring programme, effects of air pollution on human health, Vehicular pollution monitoring, Air pollution control equipments, control of sulphur dioxide and control of NO2. Hazardous air pollutants and their management, scope of green belt development

Unit- IV: Waste and Disaster Management

Solid waste management methods - Sanitary land filling, Recycling, Vermi composting, energy recovery from organic waste, Hospital Waste Management, Control measures for various types of urban, industrial lwaste, Hazardous waste, E-waste, etc; Waste segregation and disposal, Disaster Management.

Unit- V:Environmental Health Management

Effects of mercury, lead, chromium, cadmium, arsenic and nitrate on human health, Prevention and protection of community health from water borne diseases, Prevention of Air borne disease, Effects of weather and climate on diseases

References :

1. Solid Waste Management CPCB. New Delhi.
2. Ecotechnology for pollution control & environmental management
   - By R.K. Trivedi & Arvind Kr.
3. Basic Environmental Technology - J.A. Nathanson

M.Sc. 4th Semester
Special Paper-II – ZOY 1011 (Envi. Biol. - B)
Environmental issues and legislation

Course Objectives

Students are able to understand

- Basic concept of Global warming its causes and effect
- Wild life conservation
- Global convention and protocol
- Environmental policies and rules

Unit- I: Climate Change

Global warming, Greenhouse effect, Acid rain, Ozone Depletion, El-Nino effect, Impact of Climate change, Carbon sink, Carbon credit, Soil erosion, Deforestation, National action plan on Climate change, Green Economy

Development without destruction: Eco-transport, Eco farming, green belts

Unit- II: **Wild Life Conservation**

Endemic and endangered species of India, major causes of extinctions of wild life, threats to wildlife, IUCN threat categories, Red data book, Birds and wildlife census, Wild life conservation, National parks and sanctuaries, Biosphere reserves, Contemporary Indian wildlife and biodiversity issues, movements, and projects (e.g., Project Tiger, Project Elephant, Vulture breeding program, Project Great Indian Bustard, Crocodile conservation project, Silent Valley movement, Save Western Ghats movement, etc)

Unit- III: Global conventions and Protocols

Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity(CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc

Unit- IV: Environmental legislation

Wildlife Protection Act 1972, The Water (Prevention and Control of Pollution) Act 1974. Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981, Environment (protection) Act 1986, Biological Diversity Act, 2002, Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 and new legislations related to environment.

Unit- V: Environmental Policies and Rules

National Forest policy, Hazardous waste (Management and Handling) Rules, 1989, Bio-Medical Waste (Management and Handling) Rules, 1998, E- Waste Management Rules, 2016, Plastic Waste Management Rules, 2016, National Wetland Policy

References-

1.Divan, S. and Rosencranz, A. (2002). *Environmental Law and Policy in India: Cases, Material & Statutes*, 2nd Edition. Oxford University Press, India.

2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA.

3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi

4. Primack, R.B. (2014). *Essentials of Conservation Biology*, Oxford University Press, USA

M.Sc. 3rd Semester
SPECIAL PAPER PRACTICAL 1– ZOY 916 (Environmental Biology)
Biodiversity, Ecological Studies and Toxicological Studies

- Monitoring Flora and fauna and other Environmental Components.

Collection of Zooplankton and Phytoplankton

- Analysis of soil micro flora by dilution plate method, study of rhizospheric and rhizoplane microbes
- Study of anatomical changes in plants to detect effect of pollution.
- Study of pond ecosystem
- Birds and Wildlife census.

- Biodiversity index
- Analysis of water : Dissolved Oxygen ,Biological Oxygen Demand, Chloride estimation. Dissolved Solids, Hardness of water ,Alkalinity, Acidity, Ph
- Testing of presence of bacteria : Gram + and Gram – Bacteria
- Toxicity analysis

Books/ Manuals Recommended:

- APHA, AWWA, WEF (1998). Standard Methods of water and waste water. APHA (20th Edition
- Booth C. (1971). Methods in microbiology Volume 4 Academic press
- Pelczar M.J, Chan E.C.S and Krieg N.R. (1993). Microbiology Tata Mecgrahill New Delhi

M.Sc. 4th Semester

SPECIAL PAPER PRACTICAL 2– ZOY 1015 (Environmental Biology)

Pollution Monitoring, Analysis and Waste Management

Course Objectives

Students are able to understand

- Basic concept of pollution
- Various types of pollution and their management
- GIS analysis and GPS
- Solid waste management

Air pollution indices. Air Pollutant analysis, Auto – exhaust monitoring. High Volume Sampler and Stack Gas analysis kit, Estimation of the amount of oxides of Sulphur, oxides of Nitrogen in the ambient air, Estimation of the amount of in the ambient air, Air Pollution Tolerance Index, Indicator plants for Air pollution

Noise Pollution monitoring studies

Quantitative analysis - Gas chromatographic techniques, Titrimetric methods , Colorimetric methods, AA Spectro photometric analysis , HPLC techniques , Ion exchange chromatography, Electrophoresis methods, PCR technique

Environmental monitoring using remote sensing - Remote Sensing – Raster Analysis, Remote Sensing – Vector Analysis, GIS Analysis, GPS in Remote Sensing Analysis, Modelling

Sampling methods of soil and solid waste - Analysis of Moisture content, Organic Matter, Organic Carbon, Analysis of Sodium and Potassium, Nitrogen content, Potassium, Phosphorus, Preparation of Compost

Chemical toxicity tests in wastewater (Industrial), Heavy metal analysis, Predicting techniques (impact prediction).

Biological analysis of Municipal Solid waste, Waste water treatment methods

Books Recommended:

- Stern A. C.,(1977), Air Pollution, Academic Press, New York
- Park- Air Pollution- Analysis.
- Aery. N.C (2002), Manual of Environmental Analysis, Ane Books Pvt. Ltd.

M.Sc.3rd Semester
Special Paper-I – ZOY 908 (Entomology- A)
General Entomology & Insect Morphology

Course Objectives

Students are able to understand

- Basic concept of Insect diversity
- Mouth parts and feeding habits of insects
- Coloration and mimicry
- Interdependence of insect and biotic components

Unit – 1

- Insect diversity and their outline classification.
- Collection, preservation and culture of Insects.
- General organization of insect body: Head, thorax, abdomen and their appendages.

Unit – 2

- Mouthparts and relationship with feeding habits of insects.
- Wings: Origin, structure and venation.
- Structure of flight muscles and flight mechanisms in insects.

Unit – 3

- Coloration and mimicry in insects.
- Light producing organ and its mechanism.
- Sound producing organ and its mechanism.

Unit – 4

- Phase theory of locusts.
- Polymorphism in insects.
- Methods of insect communication.

Unit – 5

- Insect and Abiotic environment.
- Insect and biotic environment.
- Insects and humans.

Suggested books

- O.W.Richards and R.G.Davies, Imms textbook of Entomology. Methuen and Co. London.
- R.E.Snodgreass, Principles of insect morphology. Tata MacGraw.Hill, Bombay.
- R.M.Fox and J.W.Fox, Introduction to comparative entomology. Reinhold Publ.Corp, New York.
- R.F.Chapman. The insects structure and function(ELBS,London)
- K.K.Nayar, T.N. Ananthakrishnan and B.V.David, General and Applied Entomology. Tata MacGrow Hill, New Delhi.
- K.G.V. Smith, Insects and other arthropods of medical importance.
- H.H.Ross. A Textbook of Entomology, John Wiley and sons, New York.

M.Sc.3rd Semester

Special Paper – II ZOY- 914 (Entomology – B)
Insect Anatomy & Physiology

Course Objectives

Students are able to understand

- Basic concept of Insect morphology
- Various physiological function of insect
- Parasites of insects
- Insect managements

Unit – 1

- Structure and function of insect integument.
- Head and its Appendages.
- The digestive system.

Unit – 2

- Respiratory system.
- Circulatory system.
- Excretory system.

Unit – 3

- Nervous system.
- Endocrine system.
- Reproductive system.

Unit – 4

- The Development.
- Sense organs.
- Visual organs.

Unit – 5

- Insect Parasitism.
- Dispersal and migration in insects.
- Behaviour : Orientation, innate and parental.\

Suggested books

- Chapmn : the insects: structure and function 4th edition.
- Pedigo : entomology and pest management , prentice hall , New delhi 1989.
- Gullan & Cranston:the insects : an outline of entomology 2nd edition Blackwell science 2000.
- Dhaliwal and Arora : principles of insect pest management,national agriculture technology information centre Ludhiana.
- Atwaal : agriculture pest of India and south east asia , kalyaani publication New Delhi.
- Klowden : physiological systems in insects, academic press 2002.

M.Sc.3rd Semester
Special Paper Practical ZOY - 916

General Entomology

- Dissection of various organ systems (nervous, digestive, reproductive, neuroendocrine etc.) in available insects like grasshopper, cricket, cockroach, beetle, bug, wasp, honey bee, butterfly, moth, dragonfly etc.
- Preparation of permanent stained mounts of insects, their body parts and dissected organs.
- Study of permanent slides of insects, their body parts, organs and histological preparations.
- Study of insect specimens showing colouration, mimicry, light production, polymorphism, sound production and reception and other morphological modification.
- Physiological / Biochemical experiments in insects like extirpation and implantation of endocrine organs, parabiosis, ligation of dipteran/ lepidopteran larvae, preparation of isolated abdomen demonstration of digestive enzymes, excretory products, Chitin and cuticular lipids etc.
- Microtomy of insect material.

MARKS DISTRIBUTION **Duration: 6 hrs.**

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• Dissection with display and diagram..	10	
• Mounting with identification, diagram and comments.		05
• Spotting		10
• Physiological/Biochemical Experiments		05
• Viva – Voce		05
• Practical record		05
Total	**40**	

M.Sc.4th Semester
Special Paper - II - ZOY – 1012 (Cell Biology – B)
Neurobiology, Ageing and immunology

Course Objectives

Students are able to understand

- Basic concept of Neurobiology
- Concept of ageing and its theories
- Apoptosis and cell death
- MHC complex

Unit – 1

- Neuron, General organization and function of nerve fibers.
- Chemical synaptic transmission, Neurotransmitters and role of synaptic vesicles in nerve transmission.
- Voltage gated channels in electrically excitable membrane.
- C- AMP and calcium as second messenger and their role in cellular regulatory mechanism.

Unit – 2

- Chromatophores : Types, structure, composition and functional significance.
- Autonomic neural regulation of melanophores and colour change.
- Ageing : Theories of ageing and the current concept.
- Free radicals and age pigments (Lipofuschin and ceroids) and their significance in cellular sequence.

Unit – 3

- Apoptosis and cell death, the current concept and sequence in cellular sequence and ageing .
- Age associated neurodegenerative diseases, Alzheimer's and Parkinson's disease.
- Change of chromatin organization and enzyme activities during ageing.

Unit – 4

- Introductory ideas of innate and adaptive immunity.
- Cells and Tissues of immune system: General organization and functions.
- General structure of immunoglobulin (antibody) molecule.
- Antibody diversity (rearrangement, recombination in immunoglobulin genes).

Unit - 5

- Major histocompatibility (MHC) complex.
- Concept of humoral and cell mediated immune responses.
- Allergy, autoimmunity, Immune response genes and AIDS.
- Auto immune diseases.

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. D.M.Weir and John Stiwart: Immunology.
6. Kuby Immunology 8Ed. Macmillan publication.

M.Sc.4th Semester
Special Paper - I - ZOY – 1008 (Entomology – A)
Insect Taxonomy, Ecology and Development

Course Objectives

Students are able to understand

- Basic concept of Insect diversity
- Classification of Insect
- Social organization of insect
- Development of insect

Unit – 1

- Classification of Apterygota with distinctive feature, economic importance and example of various orders and their sub divisions.
- Classification of Pterygota up to orders with distinguishing characters and examples.
- Classification of Exopterygota up to orders with distinguishing characters and examples.
- Classification of Endopterygota up to orders with distinguishing characters and examples.

Unit – 2

- Classification of the Dictyoptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Orthoptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Hemiptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Isoptera up to families with distinguishing characters, economic importance and examples.

Unit – 3

- Classification of the Lepidoptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Diptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Hymenoptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Coleoptera up to families with distinguishing characters, economic importance and examples.

Unit – 4

- Social organization in insects (honey bees, termite, Ant etc.)
- Influence of climatic factors on insect populations.
- Adaptation of insects to their surroundings (aquatic, terrestrial and parasitic)
- Insects – host plant relationship.

Unit – 5

- Biotechnological methods for the control of pest and diseases.
- Insects as human food.

- Types of insect larvae, pupae and metamorphosis.
- Insect diapauses.

Suggested study material:

- O.W.Richards and R.G.Davies, Imms textbook of Entomology. Methuen and Co. London.
- H.H.Ross. A Textbook of Entomology, John Wiley and sons, New York.
- M.S.Mani. General Entomology.

M.Sc.4th Semester
Special Paper -II - ZOY – 1014(Entomology – B)
Applied Entomology

Course Objectives

Students are able to understand

- Basic concept of Insect diversity
- Mouth parts and feeding habits of insects
- Coloration and mimicry
- Interdependence of insect and biotic components

Unit – 1

- Structure life history, significance nature of damage and control methods of following pests of sugarcane :
  - Scirpophaga (b) Chilotracea (c) Pyrilla (d) Aleurolobus.
- Structure life history, significance nature of damage and control methods of following cotton pests :
  - Sylepta (b) Erias (c) Pectinophora (d) Dysdercus.
- Structure life history, significance nature of damage and control measures of following oil seed pests :
  - Mustard aphid (b) saw fly (c) Castor semilooper (d) linseed gall midge.
- Structure life history, significance nature of damage and control measures of following stored grain pests :
  - Sitophilus (b) Trogoderma (c) Rhizopertha (d) Tribolium (e) Bruchus (f) Sitotroga (g)Ephestia.
- Significance, life history and control measures of following general pests.
  - Grasshoppers (b) Locusts (c) Termites (d) Aphids (e) Hairy caterpillars.

Unit – 2

- Household pests (Cockroaches, Crickets, Ants, Wasps, Silverfish, Cloth with carpet beetle, furniture beetle, book lice, cigarette beetles and their control.
- Role of insect as vectors of human diseases.
- Mosquitoes as pests of public health importance and their control.
- Housefly : A human health hazard and its control.
- Live-stocks pests and their control.

Unit – 3

- Beneficial activities of insects.
- Apiculture
- Lac Culture
- Sericulture
- Types and significance of entomophagous Insects.

Unit-4

- Detailed information and classification of insecticide and their mode of action.
- Merits and demerits of chemical insecticides and development of resistance against them.
- Biological pest control.
- Different measures of insect pest control and integrated pest management.

Unit – 5

- Forest entomology and its pests and control measures.
- Forensic entomology and its importance.
- Veterinary insects and its control.
- Medical entomology.

Suggested study material:

1.O.W.Richards and R.G.Davies, Imms textbook of Entomology. Methuen and Co. London.
2.R.E.Snodgreass, Principles of insect morphology. Tata MacGraw.Hill, Bombay3.R.M.Fox and J.W.Fox, Introduction to comparative entomology. Reinhold Publ.Corp, New York.

- K.G.V. Smith, Insects and other arthropods of medical importance.
- H.H.Ross. A Textbook of Entomology, John Wiley and sons, New York.
- M.S.Mani. General Entomology.

M.Sc.4th Semester

Special Paper practical- ZOY-1015 (Entomology)

- Insect Collection and preservation for systematic studies.
- Identification of different insect up to orders.
- Identification of insect up to families of economically important orders as studied in theory course.
- Identification of insect up to species: Mosquitoes, honeybees and stored grain beetles..
- Field studies of insects to understand their habit, habitat environmental impact, beneficial and harmful activities etc.
- Study of beneficial insects, benefits derived from them and useful products.
- Study of destructive insects, damage caused by them and damaged products.
- Study of insecticidal formulatives and insect control appliances.
- Simple experiments on insect control like LC-50, knock down and recovery effect, repellency / antifeedance tests, percentage damage tests for leaf eating insects, and stored grain pests.

Scheme of Examination Duration : 6 Hours

• Identification of insects (10) upto orders	10
• Identification of insects (5) upto families	10
• Identification of insects of special upto species	10
• Spotting related to applied entomology	10
• Experiment on insect control	10
• Viva-voce	05
• Record/collection	05
• Seminar / Excursion/Field Trip	15
Total	**75**

M.Sc.4th Semester
Special Paper - I ZOY- 1006 (Cell Biology – A)
Chromosomes, genes and genetic engineering

Students are able to understand

- Various types of Eukaryotic chromosomes
- Organization of eukaryotic transcriptional machinery
- Gene family organization and evolution
- DNA rearrangement and genetic mapping

Unit – 1

- Molecular organization of eukaryotic chromatin, nucleosome and higher order compaction of mitotic chromosomes.
- Genes, gene mutations and molecular mechanism of occurrence of mutations.
- Organization and significance of hetero-chromatin.

Unit – 2

- Organization of eukaryotic transcriptional machinery, promoter obstructers, enhancers, transcription factors and polymerases.
- DNA binding domains of transcription apparatus, zinc finger, steroid receptors homeo domains, Halix-loop-Helix and Leucine Zipper.
- Structural organization of eukaryotic genes : Interrupted genes and overlapping genes and their evolution.
- DNA methylation and DNAs sensitivity in relation to gene activity and chromatin organization.

Unit – 3

- Gene families : Organization, evolution and significance.
- Environmental modulation of gene activity (stress responses) : Stress genes and stress proteins.
- Molecular basis of Thalassemia, Muscular dystrophy and Cystic fibrosis.

Unit – 4

- DNA rearrangement and amplification during development with special reference to ciliates, chorion gene and ssRNA genes.
- General plan of embryonic development of Drosophila embryo, transdetermination.
- Basic idea of organization and evolutionary significance of homeoboxes.
- Basic idea of homeotic genes and homeotic mutation.

Unit – 5

- Genetic and cytological mapping of chromosome.
- Transposable elements : Charateristics and types.
- Single nucleotide polymorphisms and its significance.

Suggested reading Material :

- DeRobertis, Alberts et al.: Cell and molecular biology.
- J.D. Watson, Molecular biology of the gene.
- Gerald Karp, Cell biology.
- Lewin, Genes Vol. VIII.

M.Sc. 3rd Semester
Special paper – I ZOY- 906 (Cell Biology – A)
Methods in cell and molecular biology

Course Objectives

Students are able to understand and learn

- Various types of tools used is scientific study
- Learn and understand various techniques to perform scientific study
- Understands culture techniques to perform microbial study
- Understand working various qualitative and qualitative analysis by using Sophisticated instruments

Unit – 1

- Microscopy : Light, Phase contrast and electron microscope.
- Basic principle and application micro-photometry.
- Tissue culture : Media, sterilization, monolayer and suspension culture, cell counting and infection.

Unit – 2

- Centrifugation : Principle and applications : Types of rotors, clinical, high speed and ultracentrifuges.
- Autoradiography: Principle, methods and applications.
- Radio immune assay.

Unit – 3

- Electrophoresis: Types, principles, methods and applications.
- Spectro photometry : Principles and applications.
- FT – IR (Fourier transform infrared) and NMR (Nuclear magnetic resonance) spectroscope.

Unit – 4

- Preparation of recombinant DNA (Gene cloning). Restriction enzymes and modifying enzymes.
- Preparation of genomic and c-DNA libraries. General idea of expression library : Screening of gene libraries.
- Methods in gene analysis : Hybridization technique (Southern, Northern, Western Blotting.
- PCR ,RAPD, RFLP, AFLP (Genetic analysis techniques) and its applications.

Unit – 5

- Methods of protein purification.
- DNA foot printing.
- Chromosome banding: Principle, methods and applications.
- RNA silencing.

Suggested Readings:

1. Karp: Cell and Molecular Biology: Wiley (2002).
2. Watson et al. Molecular Biology of the Gene. Pearson (2004).
3. Lewin. Genes VIII. Pearson (2004).
4. Primrose. Molecular Biotechnology. Panima (2001).
5. Clark & Switzer. Experimental Biochemistry. Freeman (2000).

M.Sc.4th Semester
Special Paper Practical ZOY – 1015(Cell Biology)

- Preparation of mitotic chromosomes from rat bone marrow.
- Study of inversion/ inversion frequency from polytene chromosome of Drosophila larvae.
- Study on antigen antibody reactions : Blood group and Rh factor.
- Study of Monohybrid and Dihybrid crosses / sex linkage in Drosophila.
- Study of development (homeotic) and other phenotypic mutants of Drosophila.
- Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
- Demonstration of DNA extraction from blood or tissue samples.
- To estimate amount of DNA using spectrophotometer.
- To calculate molecular weight of unknown DNA and protein fragments from gel pictures.

Marks Distribution: Duration : 6 hours

• Preparation mitotic chromosome from rat bone marrow	10
• Preparation of polytene chromosomes to study inversions	10
• Analysis of Mono / Dihybrid / sex linkage crosses in Drosophila	10
• Experimental in immunology	10
• Calculation molecular weight of DNA from gel picture/ extraction of DNA	20
• Permanent slides preparations	05
• Viva-voce	05
• Record	05
Total	**75**

M.Sc.3rd Semester
Special Paper Practical ZOY – 916(Cell Biology)

- Histochemical demonstration of lipids, proteins (including enzymes), carbohydrate and nucleic acids (DNA/RNA).
- Chromosome staining of grasshopper testis and polytene chromosomes from salivary glands of Drosophila.
- Gel electrophoresis of nucleic acid (DNA/RNA). Isolation and detection of DNA/RNA on agarose gel.
- Study of permanent slides of meiosis.

Marks Distribution : Duration: 6 hours

• Histology and Histochemistry	10
• Demonstration of Biomolecules / meiotic slides	10
• Chromosome staining of grasshopper testis /Polytene Chromosome	05
• Gel Electrophoresis of DNA	05
• Viva – Voce	05
• Record	05
Total	**40**

M.Sc.3rd Semester

Special Paper - II ZOY – 912 (Cell Biology - B)
Cell Structure and molecular organization

Course Objectives

Students are able to understand and learn

Students are able to understand and learn

- Structure and functions of Biomembranes
- Various cytoskeleton structure and their functions
- Cell- cell interaction signaling
- Adhesion molecular and their Regulation & functions

Unit – 1

- Chemical composition of cell membrane.
- Membrane protein : Spectrin, glycophorin and band 3.
- Structure and functions of lysosomes and peroxisomes.

Unit – 2

- Structure and chemical composition of mitochondria.
- Molecular organization of respiratory assemblies, ATP/ADP, translocase and Fo.F1 ATPase., ATP synthesis.
- Mitochondrial DNA : Structure expression and variability from genomic DNA.
- C-Value paradox, Cot value and its significance.

Unit – 3

- Structure and function of endoplasmic reticulum (ER).
- Structure, function and biogenesis of ribosomes.
- Cytochemistry of Golgi complex and its role in protein trafficking.

Unit – 4

- Cell nucleus: Nuclear envelop, nuclear pore complex and nucleolus.
- Nucleocytoplasmic transport : Import and export of protein and RNAs.
- Structure of chromosome, kinetochores and telomere.

Unit -5.

- General idea of oncogene and cancer : Transforming agent, proto-oncogenes and oncoproteins.
- Differences between normal cell and cancer cell : Biochemical, cytoskeletal cell surface changes, hormones in relation to cancer cells.
- Human cancer : Genetic basis and chromosomal abnormalities.
- Evolutionary origin of cancer

Book recommended:

- Cell and Mol. Biology – Gerald Karp.
- Genes VIII. B Lewin.
- Principle of Genetics – Snustad and Simmons.

M.Sc.3rd Semester
Special Paper Practical –ZOY-916 (Applied Zoology)

- Study of specimens of fresh water fishes and aquaculture animals.
- Study of specimens of helminths and arthropods.
- Study of slides of parasites of protozoan, helminths and arthropods.
- Counting of blood cells with haemocytometer.
- Identification of fish scales.
- Haematological experiments.

MARKS DISTRIBUTION Duration: 6 hours

• Haematological experiments.	10
• Spotting	10
• Permanent slide preparation	10
• Record and collection	05
• Viva voce	05
TOTAL	40

M.Sc.4TH Semester
Special Paper Practical ZOY – 1015(Applied Zoology)

- Insect collection and preservation for systematic studies.
- Identification of insects.
- Field studies of insects to understand their habit, habitat environment impact.
- Beneficial and harmful activities etc.
- Study of beneficial insects, benefits derived from them and useful products.
- Study of destructive insects, damage caused by them and damaged products.
- Study of insecticidal formulatives and insect control appliances.
- Simple experiments on insect control like C-50/LD-50, knock down and recovery.
- Effect, repellency / antifeedance tests, percentage damage tests for leaf eating.
- Study of ABO blood group.
- Study of prepared slides of protozoa , helminthes and arthropoda

MARKS DISTRIBUTION Duration: 6 hours

• Identification of insects (5) upto orders	10
• Identification of insects (2) upto families	10
• Blood group testing	10
• Spotting	20
• Experiment on insect control	10
• Preparation of slide of parasite	05
• Record	05
• Viva voce	05
TOTAL	**75**

MASTER OF SCIENCE
IN
ZOOLOGY

TWO YEARS FULL TIME PROGRAM

COURSE CONTENT OF VII, VIII, IX AND X SEMESTER

2022 JUNE

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ORDINANCE FOR POSTGRADUATE (SEMESTER SYSTEM) PROGRAMME ARTS, SCIENCE & COMMERCE FACULITIES (2022 onward)

1. INTRODUCTION

1.1 Preamble

This ordinance governs all the rules and regulations as per the NEP 2020 for the traditional post graduate programs (M.A., M.Sc., M.Com, Management courses,. etc) which are not covered by any regulatory bodies (AICTE, BAR Council, PCI, NCTE etc) running in the University campus or its affiliated colleges in Bundelkhand University, Jhansi. This ordinance supersedes all the previous relevant ordinances, rules and regulations.

1.2 Duration

Bundelkhand University has adopted the semester system in various Postgraduate coursesas per directives of Higher Education Department, Uttar Pradesh Government vide letter No 401/seventy-3-2022 dated 09-02-2022 to accelerate the teaching-learning process and enable vertical and horizontal mobility in learning from the academic session 2022- 23 onwards.

The duration of PG courses shall be two years comprising of four semesters. In case a student(s) exits from this programme after completion of the first year (2 semesters),he/she may take exit from the programme and shall be awarded the Degree of Bachelor in Research. After the successful completion of two years (4 semesters) a student shall be awarded the Master's degree in the concerned subject. The maximum duration to complete the course shall be four years.

1.3 Eligibility for Admission

- Candidate, who wishes to seek admission in a course of study prescribed for a post graduate degree of the University, shall be admitted to campus or an affiliated college unless he/ she has:

  -passed the three years Bachelor's degree course Examination of the University of Uttar Pradesh or any other Indian University incorporated by any law in force at the time of admission.
  or
  -passed any other equivalent examination recognized by the University as equivalent thereto.
  -passed any other equivalent examination recognized by a Foreign University as equivalent thereto

- The date of admission shall follow the University academic calendar.

1.4 Choice of Subject and Course Structure

i. University/ College shall admit students as per the eligibility criteria and availability of seats decided by the university.

ii. A student shall take admission to post graduation first year & fourth year of Higher Education program of NEP 2020 after successful completion of Graduate course from NEP 2020 or old course of Science/ Arts/ Commerce/

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Management, etc. He/she shall have to choose respective faculty courses as per guidelines of NEP 2020 depending on the number of seats available in concerned subject and eligibility criteria. In case a candidate is willing to change the faculty, the following condition is required

The candidate should have passed Bachelor degree in Science/ Commerce of NEP 2020 or old courses may take admission in some subjects of Arts faculty (excluding practical subjects like geography, psychology etc). Similarly, the Student from Commerce of NEP or old course of commerce may also be eligible to take admission in Arts subjects. Arts, Management and Commerce candidates cannot be admitted in Science subjects.

iii. Student(s) shall select subjects for Post graduation course from the major subjects that he / she had opted in the graduation course and shall continue with the same subjects in all the four semesters of the PG programme.

iv. The course structure shall be as follows:

There shall be four compulsory theory papers in the first semester. In the second and third semester there shall be two compulsory papers and one/two elective papers. The elective papers are the specialization papers.

Student(s) shall have to select one Minor Elective Course as **Minor subject** from any other faculty (except own faculty) or interdisciplinary subject in the first semester of the first year.

v. Student(s) shall take a Research Project /Survey/ Industrial /Field training program in both the years (Semester II and IV). No pre-requisite shall be required for this.

vi. List of Minor Elective Course: The candidate shall select any one subject from the following as minor subject infirst year of post graduate course.

S No	Science	Arts	Commerce	Interdisciplinary
1.	Mathematical Biology	Tribal Culture and Heritage	Customer Relation Management	Ancient Medical Sciences
2.	Conservation and Water Resource Management	Principle of Administration and Implications	House Keeping and Hospitality	Traditional Medical Therapy
3.	Natural Resources and Conservation	Socio-Economics and Social Security	Share Market and Banking	Vedic Mathematics
4.	Pollution: Causes and Mitigation	Archeological Sites and Monuments	Retail Management and Accounting	Bio Medical Instrumentation and Health
5.	Computational Resources	Indian Constitution	Insurance Policy and Finance	Disaster, Mitigation, & Management
6.	Organic and Natural Farming	Communication and Soft Skill		Mining Plan and Resource Mapping
7.	Computer Hardware Handling	Sanskrit Knowledge System		Water Treatment System
8.	Computer Software	Technical		Climate Change

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	Handling	Translation and Trans creation		and Environmental Degradation
9.	Solar and Non Conventional Energy	Urban Economics and Planning		Medicinal and Aromatic Plants Cultivation, extraction and nutraceutical Values
10.	Cyber Crime	Actuarial Economics		
11.	Bee Keeping, Aquaculture and Fish Farming	Social Sector and Gender Economics		Non Conventional Energy Resource
12.	Entrepreneurship in Microbial and Botanical Products	Environmental Economics		Soil and Water Testing
13.				

2. SEMESTER AND CREDIT DISTRIBUTION

An academic year for post graduate program is divided into four semesters. The Odd semester may be scheduled from July to December and Even semester from January to June.

Fourth Year

	VII Sem	Credits	VIII Sem	Credits
Major	Theory – 04 Papers	5 Credits each Total Credits=20	Theory – 04 Papers	5 Credits each Total Credits=20
	Or Theory – 04 Papers Practical -02	Or 4 Credits each Total Credits=16 2 Credit each Total Credits=4 **Total Credits=20**	Or Theory – 04 Papers Practical -02	Or 4 Credits each Total Credits=16 2 Credit each Total Credits=4 **Total Credits=20**
Minor	Minor Elective-1 paper of 04 credits	04 Credits **Total Credits=04**		
Research Project/ Industrial training/ Survey/ Field Training	One of each 04 Credits	04 Credits **Total Credits=04**	One of each 04 Credits	04 Credits **Total Credits=04**
Total Credits		28		24
Total in Both Semester				**52 Credit**

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Fifth Year

Semester	IX	Credits	X	Credits
Major	Theory – 04 Papers Or Theory – 04 Papers Practical -02	5 Credits each Total Credits=20 Or 4 Credits each Total Credits=16 2 Credit each Total Credits=4 **Total Credits=20**	Theory – 04 Papers Or Theory – 04 Papers Practical -02	5 Credits each Total Credits=20 Or 4 Credits each Total Credits=16 2 Credit each Total Credits=4 **Total Credits=20**
Research Project / Industrial training / Survey	One of each 04 Credits	04 Credits **Total Credits=04**	One of each 04 Credits	04 Credits **Total Credits=04**
Total Credits		24		24
Total in Both Semester	**48 Credit**			

3. ATTENDANCE

The expression "a regular course of study" wherever it is used in these Ordinances, means attendance of at least 75% of the lectures and other teaching in campus / affiliated college in the subject for the examination at which a candidate intends to appear and at such other practical work (such as work in a laboratory) as is required by any Statute, Ordinance or Regulation in force for the time being in the University.

A shortage up to 5% of the total number of lectures delivered or practical work done in each subject may be condoned by the Principal of the college/ Head of the Department (in case of University Campus) concerned.

A further shortage up to 10% may be condoned only by the Vice- Chancellor on the specific recommendation of the Principal of the college/Head of the Department concerned (in case of University Campus).

4. EXAMINATIONS

1. There shall be examinations at the end of each semester as, for odd and even semesters in accordance with the academic calendar of the university. A candidate who does not pass the examination in any course(s) shall be permitted to appear in such failed course(s) in the subsequent examinations upto the maximum duration of the course.

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2. A candidate should get enrolled/registered for the first semester examination and is mandatory. If enrolment/ registration is not possible owing to shortage of attendance / rules prescribed OR belated joining or on medical grounds, such students shall not be permitted to proceed to the next semester. Such students shall re-dothe first semester in the subsequent term of that semester as a regular student; however, a student of first semester shall be admitted in the second semester, if he/she has successfully completed the first semester.
3. It shall be mandatory for the student(s) to register for examination in each and every semester (i.e. to fill up the examination form with the requisite fee). If a student fails to register for the examination in any semester, he or she shall not be allowed to appear in that semester as a back paper student. Such student(s) shall appear in the (next) subsequent examination of that semester.

5.EVALUATION

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade point. Evaluation for each course shall be done by a Continuous Internal Assessment (CIA) by the concerned course teacher as well as by end semester examination and will be consolidated at the end of course. The evaluation must be continuous and holistic and should be based on following parameters:

i. Academic assessment
ii. Skill assessment
iii. Physical assessment
iv. Personality assessment
v. Extra-curricular assessment

5.1 THEORY PAPER

Semester Examinations shall be conducted by the university as mentioned in the academic calendar. The Question paper will be set by the examiners appointed by the Vice Chancellor based on the recommendation of the board of studies. The pattern of the question paper shall be as given in annexure II.

i. Internal Assessment(C.I.A.) –25%weightageofacourse

- Test/ Mid-Term Assessment - 10 marks
- Term paper/Presentation on given project/assignment - 10marks
- Attendance/activities – 05marks

ii. End Semester Exam (External examination)– 75% weightage of course

5.2 PRACTICAL PAPER

Practical examinations will be conducted by the examiners appointed by the Vice Chancellor on the recommendations of the Board of Studies. Each student has to present the practical records.

i. Internal Assessment(C.I.A.) –25%weightageofacourse

- Test/ Mid-Term Assessment - 10 marks
- Term paper/Presentation on given project/assignment - 10marks
- Attendance/activities – 05marks

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ii. End Semester Exam (External examination)– 75% weightage of a course

MINIMUM PASSING STANDARD

1. The minimum passing standard for combined external and internal examinations for each subject/paper shall be 45%,i.e. 45 out of 100 marks for theory and practical courses. The minimum passing standard for Aggregate in a semester end Examination shall be 45%.
2. Continuous Internal Assessment (CIA) shall be ensured by the Principal of the colleges / HODs for the Campuses courses. The Principal of the colleges / HODs of the Campus shall provide the marks of the same to the university and it shall be mandatory to maintain the records of the same till the maximum duration of that course.
3. The internal assessment, field training and practical examination awards of a student who fails in any semester examination shall be carried forward to the next examination.
4. It shall be mandatory for a student to secure minimum 45% marks (i.e. 34/75) in the theory and practical paper separately.

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PROVISION FOR BACK PAPERS AND EX-STUDENTS

A Back Paper (B.P.) candidate shall be promoted to next semester. The back paper facility in a semester provides promotion to the next semester and another opportunity to obtain a minimum of the pass marks assigned for an individual paper or in the aggregate. Following category of students of Bundelkhand University shall be eligible for back paper facility as under,

1. A student shall be required to pass in minimum two subject papers in each semester. However, at the end of each year, it shall be mandatory for a student to pass in at least two subjects papers and minor paper otherwise he/she shall be deemed as failed and will be treated as a year back / ex- student.
5. Students shall get the attempts to appear in the Back paper examination in the subsequent odd /even semester till the maximum duration of the said course.
6. Special back paper examination shall be held only for regular students of the final year of PG course.
7. The candidates who fail in more than three of the total papers, will be deemed as failed. These candidates can appear only in subsequent examination of that semester as Ex- Students.

8. PROMOTION RULES

8.1Semester Course & Examination:

The students who have taken admission in any post-graduation programme in a session and who have put in the minimum percentage of attendance for appearing at the Examination, presented himself/herself for internal assessment and have filled in the examination form in time for appearing at the End Semester Examination shall be allowed to appear at the respective examinations.

8.2Declaration of results

After appearing in the Examination of both the semesters in a particular year, the student can be put in the following categories in the context of declaration of the results of the Semester Examination:

Passed
Promoted with Back Paper(s)
Failed

8.3 Promotion to next Semester:

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All students under category Passed and promoted with back papers shall be promoted to the next Semester.

"Failed" students may clear their UNCLEARED courses in subsequent examinations as ex-students. Students promoted with back papers shall clear their back papers in subsequent examinations as ex-students.

A student who has failed in a course shall get two more chances to clear this course subject to the maximum duration for passing the course. Further, each candidate shall have to clear all the courses within the maximum period of seven years from the date of his/her latest admission.

A candidate who has qualified for the Degree shall be placed in the First / Second Division as per following table:

8. COMPUTATION OF SGP AND CGPA

The guidelines formulated by Bundelkhand University shall be followed in order to bring uniformity in evaluation system of every CBCS based Course and computation of the SGPA (Semester Grade Point Average) and CGPA(Cumulative Grade Point Average)based on students' performance in examination. The number of core, elective, open elective papers and foundation papers and the required credit for each paper shall be formulated by respective Board of Studies (BOS) and faculty board. For the purpose of computation of work load the UGC proposed mechanism is adopted i.e. one credit=1 Theory period of one hour duration, 1credit= 1Tutorial period of one hour duration, 1credit=1 Practical period of one hour duration. The credit(s) for each theory paper/practical/tutorial/dissertation will be as per the respective Board of Studies of departments.

Letter Grade	Numerical grade
O (outstanding)	10
A+ (Excellent)	9
A(very good)	8
B+(Good)	7
B(average)	6
F(Fail)	<5
Ab (Absent)	0

The minimum passing marks shall be 45%of the maximum marks as prescribed in the University Examination and 45%of marks in the aggregate marks in the subject including internal / sessional marks.i.e.Minimum Passing Grade is "B".

A student who obtains Grades "O"or"B" shall be considered as PASSED. If a student secures "F" grade, he/she shall be considered as FAILED and shall have to re appear in the examination. It is mandatory for a student to earn the required SGPA as in each semester. If a student is not able to secure 45% / B grade in any theory / practical / internal / sessional / viva-voce / internship / project examination, the awarded grade point shall be ZERO (0).

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9.1 The University, adopts absolute grading system where in the marks are converted to grades, and every semester results will be declared with semester grade point average(SGPA) and year result will be declared with year grade point average (YGPA). The Cumulative Grade Point Average (CGPA) will be calculated in end of final semester. The grading system except pharmacy department will be with following letter grades and grade points scale as given below:

Table A (For all courses except Pharmacy courses)

Level	Outstanding	Excellent	Very Good	Good	Average			Fail
Letter Grade	O	A+	A	B+	B			F
Grade Points	10	9	8	7	6			0
Score (Marks) Range (%)	≥90 (90-100)	<90, ≥80 (80-89.99)	<80, ≥70 (70-79.99)	<70, ≥60 (60-69.99)	<60, ≥45 (50-59.99)			<45 (0-35.99)

1.1 A student obtaining Grade "F" shall be considered failed and will be required to reappear in the examination. Such students after passing the failed subject in subsequent examination / will be awarded with grade respective of marks he/she scores in the subsequent examination/s.

1.2 The University has the right to scale/moderate the theory exam / practical exam / internal exam / sessional marks of any subject when ever required for converting of marks into letter grades on the basis of the result statistics of university as in usual practice, i.e. marks obtained in decimal will be converted in nearest integer.

9. **CONVERSION OF GRADES IN TO PERCENTAGE**

1.3 Conversion formula for the conversion of CGPA into Percentage is **CGPA Earnedx10= Percentage of marks scored.**

Illustration: CGPA Earned8.2 x10=82.0%

2. **AWARD OF DIVISION**

Division shall be awarded only after the final semester examination based on integrated performance of the student for all the semesters as per following details.

2.1 A student who qualifies for the award of the degree securing "B" or above grades in all subjects pertaining to all semesters, and in addition secure as a CGPA of 8.0 and above shall be declared to have passed the examination in **FIRST DIVISION WITH HONOURS.**

2.2 A student who qualifies for the award of the degree securing "B" or above grades in all subject pertaining to all semesters, and in addition secures a CGPA of 7.0 and above shall be declared to have passed the examination in **FIRST DIVISION.**

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DEPARTMENT OF ZOOLOGY
BUNDELKHAND UNIVERSITY JHANSI (U.P.)

SEMESTER-I

Paper	Paper Code	Paper Name	Internal Marks (10 +10+5)	Theory Marks	Total	Credit
1	ZOY - 701	Comparative Structure & Function of Invertebrates	25	75	100	4
2	ZOY- 702	Quantitative Biology	25	75	100	4
3	ZOY - 703	Instrumentation and Biotechnology	25	75	100	4
4	ZOY- 704	Molecular Cell Biology	25	75	100	4
5	ZOY- 705	Practical Related to 701 to 704	25-Internal 75-External		100	4
6	ZOY- 706	research project/industrial training/survey/field training	Submission of progress report		100	4
7	ZOY- 707	*Miner Subject/open elective paper from table	25	75	100	4
Total					700	28

*Student(s) shall have to select one elective course as minor subject from any other faculty (except own faculty) as prescribed in university ordinance for post graduate programme Table is attached herewith

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DEPARTMENT OF ZOOLOGY
BUNDELKHAND UNIVERSITY JHANSI (U.P.)

SEMESTER-II

Paper	Paper Code	Paper Name	Internal Marks	Theory marks	Total	Credit
1	ZOY -801	Genetics	25	75	100	4
2	ZOY-802	Taxonomy and Evolution	25	75	100	4
3	ZOY -803	Biochemistry	25	75	100	4
4	ZOY-804	Ecology and animal behavior	25	75	100	4
5	ZOY-805	Practical Related to 801 to 804	25-Internal 75-External		100	4
6	ZOY-806	research project/industrial training/survey/field training	Submission of research project		100	4
Total					600	

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DEPARTMENT OF ZOOLOGY
BUNDELKHAND UNIVERSITY JHANSI (U.P.)

SEMESTER-III

Paper	Paper Code	Paper Name	Internal Marks (10 +10+5)	Theory Marks	Total	Credit
1	ZOY - 901	Comparative Structure & Function in vertebrates	25	75	100	4
2	ZOY-902	Molecular cytogenetics	25	75	100	4
3	ZOY - 903/ 904/ 905/ 906/ 907/ 908	**Special A** (Fish & fisheries/ Endocrinology/ Environmental biology/ Cell biology/ Applied Zoology /Entomology)	25	75	100	4
4	ZOY- 909/ 910/ 911/ 912/ 913 / 914	**Special B** ((Fish & fisheries/ Endocrinology/ Environmental biology/ Cell biology/ Applied Zoology /Entomology	25	75	100	4
5	ZOY-915	Practical – 1(General) Related to SNO.1&2	10-Internal 40-External		50	2
6	ZOY - 916	Practical – 2(Special) Related to SNO. 3&4	10-Internal 40-External		50	2
7	ZOY- 917	*Dissertation (Research project)	Submission of progress report		100	4
Total					600	

* 4 credits will be allocated to students after the submission of dissertation progress report

DEPARTMENT OF ZOOLOGY
BUNDELKHAND UNIVERSITY JHANSI (U.P.)

SEMESTER-IV

Paper	Paper Code	Paper Name	Internal Marks	Theory marks	Total	Credit
1	ZOY -1001	Infection biology and immunology	25	75	100	4
2	ZOY-1002	Developmental biology	25	75	100	4
3	ZOY 1003/1004/1005/ 1006/1007/1008	**Special A** (Fish & fisheries/ Endocrinology/ Environmental biology/ Cell biology/ Applied Zoology /Entomology)	25	75	100	4
4	ZOY-1009/1010/1011/ 1012/1013/1014	**Special B** (Fish & fisheries/ Endocrinology/ Environmental biology/ Cell biology/ Applied Zoology /Entomology)	25	75	100	4
5	ZOY-1015	Practical Special Paper	25-Internal 75-External		100	2
6	ZOY- 1016	*Dissertation (Research project)	Submission of research project		100	4
Total					600	

GRAND TOTAL **2500**

*Marks distributed as: Submission of research project – 50, presentation – 25, publication-25

M.Sc.1st Semester
General Paper-I, ZOY-701
Comparative Structure & Function of Invertebrates

Unit – I

- Symmetry in animal organization : Asymmetry, radial, and bilateral symmertry and their Significance.
- Coelom : Evolution of coelom, Acoelomate, pseudocoelomate, coelomate groups: Protostomia and Deuterostomia.
- Organiztion of coelom: Enterocoelic, Schizocoelic and gonocoelic
- Metamerism : Evolution of metamerism – Pseudometamerism, cyclo metamerism. Corm theory.Embryological theory and Significance,

Unit – II

- Flagellar and ciliary movements in Protozoa
- Hydrostatic movement in Coelenterate, Annelid and Echinoderm
- Patterns of feeding and digestion in lower metazoan
- Filter feeding in Polychaeta, Mollusca and Echinodermata

Unit – III

- Different types of respiratory organs – Gills, lungs and trachea
- Respiratory pigments
- Mechanism of respiration
- Different types of excretory organs- coelomoducts, Nephridia and Malphigian tubules.
- Mechanisms of excretion and osmoregulation.

Unit – IV

- Primitive nervous system: Coelenterata and Echinodermata
- Advanced nervous system: Annelida, (Polychaeta and Oligochaeta), Arthopoda (Crustacea and Insecta) and Mollusca (Cephalopoda).
- Endocrine glands in crustaceans and Insects , Pheromones and Semiochemicals.

Unit – V

- Pattern of sexual and asexual reproduction.
- Larval forms of parasites and their phylogenic significance.
- Larval forms of annelida,crustacea, mollusca and echinodermata.
- General Characters and affinities of Minor phyla: Rotifera, Chaetogneatha, Phoronida and Sipunculida.

Suggested Readings:

1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17
2. Hunter: Life of Invertebrates (1979, Collier Macmillan)
3. Marshall; Parker &Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
4. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
5. Brusca and Brusca (2016) Invertebrates. Sinauer
6. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
7. R.L Kotepal, Text book of invertebrate, Rastogi publication.
8. EJW Barrington-Invertebrate structure and function.

M.Sc.1st Semester
General Paper-II – ZOY 702
Quantitative Biology

Unit – I

- Basic concepts of biostatistics.
- Significance & Applications of biostatistics.
- Classification & Graphical representation of data.
- Analysis of frequency & frequency distribution

Unit – II

- Measures of central tendency (Mean, Median, Mode)
- Measures of Dispersal (Mean deviation, Standard deviation)
- Probability distribution (bionomial, & normal)

Unit-III

- Sampling distribution
- Hypothesis testing
- Chi-square test
- Student's t-test

Unit-IV

- F-test & Analysis of Variance(ANOVA), ANCOVA
- Correlation
- Regression

Unit-V

- General application of computer
- M.S. Word, Excel and PowerPoint
- Hardware and software , statistical software ie. SPSS.
- Internet & E-mail

Note : Non scientific (Simple) calculator is allowed for students.

Suggested Reading:

- Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.
- Statistical Methods (Eighth Edition) by G. W. Snecdecor and W. G. Cochran, Willey Blackwell.
- Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
- Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners
- Introduction to biostatistics, Dr. P.K. Banerjee, S. Chand publication.
- Elements of biostatistics, S. Prasad, Rastogi publication.
- Biostatistics, P.N. Arora and P.K.Malhan, Himalaya publishing house.

M.Sc.1st Semester
General Paper-III – ZOY 703
Instrumentation and Biotechnology

Unit-I

- Principle and applications of microscopy, types of microscope : Light and compound microscope, flourscence microscope, phase contrast microscope.
- Electron microscope: SEM and TEM.
- pH meter : Principle and measurement of pH.

Unit-II

- Principle of centrifugation.
- Types of centrifuge and rotors.
- Princples of chromatography.
- Types to chromatography.

Unit-III

- Colorimeter and spectrophoto meter: Beer lambert law, absorption spectrum.
- Electrophoresis:Principle ,types and applications.
- Radio tracer techniques : Detection and measurement of radio isotopes used in biology,Incorporation of radio isotopes in tissue and cells, safety measures.

Unit-IV

- Concept of rDNA technology.
- DNA modifying enzymes.
- Cloning vectors.
- Preparation of genomic and cDNA liberary ,Molecular probes .
- Amplification of gene :Polymerase chain reaction (PCR),RAPD

Unit-V

- DNA finger printing.
- Detection of genetic diseases,Gene transfer techniques and gene therapy..
- Development of DNA drugs and vaccines.
- Live stock improvement

.Suggested Readings:

1. Karp: Cell and Molecular Biology: Wiley (2002).
2. Watson et al. Molecular Biology of the Gene. Pearson (2004).
3. Lewin. Genes VIII. Pearson (2004).
4. Pierce B. Genetics. Freeman (2004).
5. Sambrooket al .Molecular Cloning Vols I, II, III. CSHL (2001).
6. Primrose. Molecular Biotechnology. Panima (2001).
7. Clark & Switzer. Experimental Biochemistry. Freeman (2000).
8. L.Veera Kumari, Bio instrumentation MJP publishers
9. P.K. Bajpai - Biological Instrumentation & Methodology S.Chand & Co. New Delhi

M.Sc.1st Semester
General Paper-IV – ZOY 704
Molecular Cell Biology

Unit-I

- Transport across cell membrane :diffusion active transport & uniport, symport & antiport.
- Membrane potential
- Transport across epithelia.

Unit-II

- Microfilaments, microtubules, intermediate filament & their dynamics.
- Microtubules & mitosis
- Cell movement intracellular transport, role of kinesin & dynein.

Unit-III

- Signals transduction mechanism.
- Cell surface receptors
- Second messenger system
- MAP kinase pathway
- Signaling from plasma-membrane to nucleus

Unit-IV

- Ca^{++} dependent hemophilic cell-cell adhesion
- Ca^{++} independent hemophilic cell-cell adhesion
- Gap junction & connexins

Unit-V

- Itergrins, collagens and non collagen components.
- Cyclins & cyclin dependent kinases
- Regulation of CDK-cyclin activity
- Apoptosis and Necrosis.

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. P.K Gupta, Cell and molecular biology,Rastogi publication.

M.Sc.1st Semester
General Practical – ZOY 705

- Study the museum specimens of different invertebrate Phyla.
- Study the permanent slides of different phyla
- Study of permanent slide of larval stage of Helminthes to Echinodermata.
- Study of mitosis from anion root tips
- Absorption spectrum of colored solution using spectrophotometer/ Colorimeter
- Separation & detection of dyes/ amino acids using paper chromatography.
- pH determination of unknown solution.
- Separation of Serum and tissue protein with the help of electrophoresis.
- .Biostatics; graphical representation of data(Mean, Median, Mode & standard deviation)

Marks distribution **Duration : 6 hours**

• Colorimetric estimation of unknown solution/ Chromatography.	15
• Determination of pH/ separation of protein.	15
• Biostatics Problem	05
• Preparation of slide	05
• Spotting 1-10	20
• Record & Collection	10
• Viva-Voice	05
Total Marks	**75**

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ZOY – 707: Minor Elective Course

S.No.	Science	Arts	Commerce	Interdisciplinary
1.	Mathematical Biology	Tribal culture & Heritage	Customer relation management	Ancient medical sciences
2.	Conservation and water resource	Principle of administration and implication	House keeping and hospitality	Traditional medical therapy
3.	Management natural resources and conservation	Socio economics and social security	Share market and banking	Vedic mathematics
4.	Pollution: Causes and mitigation	Archeological sites and monuments	Retail management and accounting	Bio medical instrumentation and health
5.	Computational resources	Indian constitution	Insurance policy and finance	Disaster, mitigation and management
6.	Organic and natural farming	Communication and soft skill		Mining plan and resource mapping
7.	Computer hardware handling	Sanskrit knowledge system		Water treatment system
8.	Computer software handling	Technical translation and transcreation		Climate change and environmental degradation
9.	Solar and non conventional energy	Urban economics and planning		Medicinal and aromatic plants, cultivation, extraction and nutraceutical values
10.	Cyber crime	Actuarial economics		
11.	Bee keeping, aquaculture and fish farming	Social sector and gender economics		Non conventional energy resource
12.	Entrepreneurship in microbial and botanical products	Environmental economics		Soil and water testing

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M.Sc. – 2nd Semester
General Paper- I – ZOY 801
Genetics

Unit - 1

- Mendalian principle : Dominance, segregation and independent assortment
- Concept of gene : Allele, multiple allele, pseudoallele
- Extra chromosomal/Cytoplasmic inheritance

Unit - 2

- Co-dominance, incomplete dominance, epistasis, gene interaction, pleiotropy.
- Genomic imprinting, anticipation ,peneterance and expressivity, phenocopy.
- Linkage and crossing over
- Genetic maping : Two points and three points cross.

Unit - 3

- Molecular anatomy of eukaryotic chromosome and telomere.
- Giant chromosome : Polytene and lampbrush chromosome.
- DNA packaging upto metaphase chromosome.
- Chromosome banding, karyotype, patterns of inheritance and pedigree analysis.

Unit -4

- Gene Mutation : Kinds of mutation.
- Mutagens.
- Structural alteration in chromosome.
- Numerical alteration in chromosome.

Unit – 5

- Mendalian and gentic disorders.
- Eugenics, Euthenics and genetic counselling.
- Oncogene and tumor repressor gene,
- Chromosomal abnormalty in malignancy (chronic myloid leukemia,burkirtt's lymphoma, retinoblastoma and wilm's tumor.

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. P.K.Gupta : Genetics and molecular biology. Rastogi publication.
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Pierce B. Genetics. Freeman (2004).
8. Veer bala rastogi : Genetics, Meditech publication.

M.Sc. – 2nd Semester
General Paper- II – ZOY 802
Taxonomy and Evolution

Unit – 1

- Definition and basic concepts of taxonomy.
- Scope and levels (α, β and γ) of taxonomy, phonetics, cladistics.
- Trends in biosystematics : Chemo, cyto and molecular taxonomy.
- Taxonomic procedures : Taxonomic collection and preservation, curetting , process of identification.
- Taxonomic keys, zoological nomenclature (As amended till date), international code of zoological nomenclature (ICZN), role of zoological survey of India.

Unit – 2

- Lamarkism
- Theory of natural selection, Darwin Wallace theory of evolution, neodarwinism.
- Modern synthetic theory.
- Mutation theory.

Unit – 3

- Historical concepts regarding origin of life.
- Modern theory regarding origin of life.
- Theories of chemical and spontaneous origin of life at molecular level.
- The evolution of protein, examples of protein evolution and neutral theory of protein evolution.

Unit – 4

- Species , rece and deme, nature of speciation.
- Instantaneous speciation : Through mutation , through macrogenesis, through chromosomal aberration.
- Gradual speciation : Allopatric and sympatric.
- Micro, macro and megaevolution , hypothesis of punctuated equilibria.
- Isolation : Types of isolation, premating and postmating isolating mechanism.

Unit – 5

- The Hardy – Weinberg principle and analysis of gene frequencies in natural population.
- Major factors influencing gene frequencies (Migration, inbreeding), effects of selection and mutation on gene frequencies,Genetic polymorphism
- Fossils ,Geological time scale, zoogeographical distribution of animals.
- Evolution of horse and man.

Suggested books :

- G.G. Simpson, **Principle of animal taxonomy**. Oxford IBH Publishing company.
- V.C. Kapoor. **Theory and Practice of Animal Taxonomy**. Oxford & IBH Publishing Co.
- Strikberger, M.W. **Evolution** Jones and Barlett Publishers. Boston London.
- Dobzhansky, Th.,**Genetics and Origin of Species**. Columbia Unvieristy Press. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. **Evolution**. Surjeet Publication, Delhi.
- Futuyama, D.J. **Evolutinary Biology**, Suinuaer Associates, INC Publishers, Dunderland.
- Rastogi, V. B., Organic Evolution, Medtech Science Press, Delhi.

M.Sc.2nd Semester
General Paper-III – ZOY 803
Biochemistry

Unit-I

- Energetics : II[nd] law of thermodynamics, free energy, standard free energy change
- Reducing power and redox reaction, Ernst equation
- Synthesis of ATP
- Cellular energy resources

Unit-II

- Biosynthesis of Amino acid
- Protein structure ,classification folding and denaturation
- Ramachandran plot and chaperons.
- Structure of nucleic acid (DNA and RNA)
- Biosynthesis of nucleotides

Unit-III

- Nomenclature & classification of enzyme, Co-enzyme & Iso-enzyme
- Mechanism and regulation of enzyme action
- Enzyme kinetics: Michaelis-Menten equation, concept of K_m & V max
- Factors affecting rate of enzyme reaction
- Enzyme inhibition and Allosteric enzyme

Unit-IV

- Structure and classification of Carbohydrates
- Glycolysis, citric Acid cycle,HMP shunt
- Glycogenesis ,Gluconeogenesis, Glycogenolysis
- Oxidative phosphorylation

Unit-V

- Structure and classification of lipids
- Fatty acid metabolism; synthesis & degradation
- Biosynthesis of membrane lipid.
- Biosynthesis of steroids and cholesterol.

Suggested Readings:

1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000)
2. Zubayet al: Principles of Biochemistry: WCB (1995)
3. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
4. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. (2006).
5. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
6. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
7.Jain and Jain : Bio chemistry, S Chand publication.

M.Sc.2nd Semester
General Paper-IV – ZOY 804
Ecology and animal behavior

Unit – 1

- Concept of ecosystem, trophic structure of ecosystem, types of ecosystem, productivity of ecosystem.
- Concept of limiting factors ,Liebig Blackman law of limiting factor, Shelford's Law of tolerance.
- Types of interaction: Commensalism, mutualism, predation grazing , parasitism, allelopathy
- Ecological succession, Ecological niche and key stone species.

Unit – 2

- Population and its characteristics, patterns of population growth
- Survival ship curve, population dispersion and its regulations.
- Adaptation in terrestrial environment and parasitic habitat.
- Biogeochemical cycles.

Unit – 3

- Biodiversity and its significance
- Causes of biodiversity loss : habitat destruction , over exploitation, introduction of exotic spp., diseases and shifting or Jhum cultivation
- Conservation : IUCN red data book, Ex- situ conservation and In- situ conservation, germ plasm banks.
- Pollution : Urban, agricultural and atmospheric (Global climate change)

Unit – 4

- Ethology and its scope, branches of ethology
- Patterns of behavior, components of behavior
- Role of hypothalamus : In feeding and drinking, in reproductive behavior, in fighting and fleeing , in sleeping and walking
- Reflexes and complex behavior, reflex arch
- Pheromones : Functions and effects

Unit – 5

- Concept of fixed action pattern and its properties
- Concept of sign or key stimulus, stimulus filtering, super normal stimulus, innate releasing mechanism
- Learning and memory : Conditioning, habituation, insight learning, association learning, reasoning
- Biological clocks : Circadian and circannual clocks
- Mimicry, altruistic behavior and kin selection

Suggested reading :

- Ecology and environment science by HR Singh, vishal publication.
- Animal behavior by Mannings.
- Animal behavior by Gundavia.
- Animal behavior by Fatik.
- Alcock ,JAnimal behavior : an evolutionary approach Sinauer Assoc.Sunderland,Mass USA.
- Bradbury , J.W and S.L. Vehrencamp: principles of animal communication Sinauer Assoc.Sunderland,Mass USA.

M.Sc.II[nd] Semester
General Practical – ZOY 805

- Preparation of human karyotype and study the chromosomal aberration from the pictures provided
- Study of sex chromatin (Barr body) in buccal smear and hair bud
- Extraction of DNA from animal/plant tissue
- Preparation of polytene chromosome
- Solve genetic problems by punnett diagram
- Recoding of blood pressure by sphygmomanometer
- Recoding of blood sugar by gulucometer
- Estimation of clotting & bleeding time, Hb%
- Preparation of haemein crystals
- Identification of Carbohydrate, Protein , Lipids and amino acids
- Quantitative determination of biological components (protein,glycogen. RNA & DNA)
- Demonstration of reflex action.
- Problems related to evolution , population genetics etc(H.W. Principle, natural selection , adaptation, trends and genetic polymorphism

Marks Distribution **Duration:- 6 hours**

• Dissection of fish, amphibian & mammals (Virtual)	10
• Blood sugar / blood pressure/ reflex action	10
• Any two blood experiment(Bleeding, Clotting, haemin crystal, Hb%)	10
• Quantitative determination of biological components/problems related to evolution	
Identification of foodstuff	10
• Spotting 1-10	10
• Record and Collection	15
• Viva-voice	05
	05
75	**Total**

M.Sc. 3rd Semester
General Paper-I - ZOY 901
Comparative anatomy and physiology of Vertebrate

Unit-I

- Characteristic features & classification of Protochordata. .
- Origin , Classification and characteristics of vertebrates .
- Structure & development of integument and its derivatives .

Unit-II

- Respiratory organs in different vertebrates.
- Transport of gases.
- Neuronal and chemical regulation of respiration.
- Digestive system of mammals.

Unit-III

- Evolution of Heart and aortic-arches
- Cardiac cycle and blood pressure
- Anatomy of excretory organ in vertebrates.
- Physiology of excretion : Urine formation, micturition, waste elimination, water balance, electrolyte balance and acid base balance

Unit-IV

- Comparative account of CNS & PNS
- Conduction of nerve impulse
- Sense organs : Vision, hearing and tactile response

Unit-V

- Endocrine glands & their secretions
- Basic mechanism of hormonal action
- Hypothalamo-hyperphysial portal system & neural control of pituitary gland
- Hormonal disorders

Suggested Readings:

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002,Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGrHill
5. R.L.Kotepal, text book of vertebrate zoology, Rastogi publication
6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS

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M.Sc.3rd Semester
General Paper-II – ZOY 902
Molecular Cytogenetics

Unit-I

- Enzymes and proteins involved in replication
- DNA replication in prokaryotes
- DNA replication in Eukaryotes
- DNA repair

Unit-II

- RNA polymerases, General transcription factors
- Transcription in prokaryotes
- Transcription in Eukaryotes

Unit-III

- Post transcriptional modification, capping & Polyadenylation
- Splicing and RNA editing
- Export & stability of mRNA

Unit-IV

- Genetic code & wobble hypothesis
- Factors involving in translation.
- Translation in prokaryotes
- Translation in eukaryotes

Unit-V

- Regulation of gene expression in prokaryotes; Lac Operon and trp-operon in E-coli,
- Regulation of gene expression in Eukaryotes; Role of chromatin, methylation ,Phosphorylation,acetylation, Epigenetic regulation

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002).
5. Watson et al. Molecular Biology of the Gene. Pearson (2004).
6. Lewin. Genes VIII. Pearson (2004).
7. P.K Gupta, Cell and molecular biology,Rastogi publication.

M.Sc.3rd Semester
General Practical – ZOY 915

- Virtual dissection of cranial nerves,afferent and efferent branchial arteries of fishes.
- Study of museum specimens of various Vertebrates.
- Study of permanent slides of Vertebrates.
- Study of Axial & appendicular skeleton of birds & mammals
- Study of Microtomy : Section cutting and preparation of permanent slides
- Study of different models (Cell organelles and nucleic acids)

Marks Distribution	**Duration:- 6 hours**
1-Dissection	05
2-Microtomy	10
3-Spotting 1-10	15
4-Record	05
5-Viva	05
	Total 40

M.Sc. 3rd Semester

Special Paper-I – ZOY 903 (Fish- A)
Taxonomy, Ecology and behavior

Unit – 1

- Outline Classification of fishes as proposed by Berg.
- Classification of placodermii, elasmobranchii and holocephalli.
- Classification of dipnoii and ostrichthyes .

Unit – 2

- Riverine and cold water fisheries.
- Lacustrine and estuarine fisheries.
- Coastal , offshore and deep sea fisheries.
- Systematic survey with particular references of fishes of Bundelkhand region.
- Adaptation in hill stream and deep sea fishes.

Unit – 3

- Trophic levels of fish in the food chain.
- Primary productivity of fish pond and its importance.
- Common aquatic weeds of fish ponds and their control.
- Larvicidal and predatory fishes and their importance in fish culture.
- Exotic fishes and their importance.

Unit – 4

- Courtship and parental care.
- Fish migration.
- Fish schooling behavior
- Shoaling behavior.

Unit – 5

- Diseases of aquaculture : Prevention, prophylaxis and treatment of bacterial, viral and fungul diseases.
- Protozoan and helminth diseases of fishes.
- Immune protection in fishes.
- Types and sources of aquatic pollution and its impact on fish health.

Suggested Books

- Biology of fishes ;Bone Q andMoore R. Talyor and Francis groups CRC press U. K.
- .The diversity of fishes G.S.Helfman, B.B.Collette and d.f.Facey Blackwell science USA.
- Reading in Ichthyology M.S.Love and G.M.Cailliet.Prentice-hall of India
- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Fish and fisheries of India :Jhingran,V.G. Hindustan publishing corporation New Delhi.

M.Sc. 3rd Semester
Special Paper-I I – ZOY 909 (Fish- B)
Fish anatomy and physiology

Unit – 1

- Structure and function of skin and its derivatives.
- Structure , types and fuction of scales.
- Chromatophores : Structure ,classification and colour change mechanism.
- Determination of age growth and its relationship with scales.
- Fins : Origin ,types and their modification, locomotion in fishes.

Unit – 2

- Digestive system : Anatomy and physiology of Alimentary canal.
- Respiratory organ : Structure of gills and physiology of aqueous breathing .
- Swim bladder and webarian ossicles : Structure and function.

Unit – 3

- Circulatory system : Structure of heart and arterial system(Afferent and Efferent arteries).
- Excretory system : Structure and physiology of kidney.
- Osmoregulatory mechanism, balance of ions in fresh water and marine fishes.

Unit – 4

- Nervous system : Structure of brain and cranial nerves.
- Lateral line system : Structure, modification and significance.
- Organs of olfaction and taste.
- Electric organ, bioluminescent organ and sound producing organs.

Unit – 5

- Male and female reproductive organs.
- Reproductive cycle and maturation.
- Structure and fuctions of endocrine glands : Pituitory, thyroid, ultimobranchials, pancreas, adrenal, corpuscles of stannous, urophysis and pineal.
- Environmental and hormonal control of reproduction.

Suggested books

- Encyclopedia of fish physiology.2011 Anthony P. et all 2011 Academic press UK
- Fish physiology . (series)W.S. Hoar and.J. Randall Academic press UK
- The physiology of fishes.2013 Evans,D H and Claiborne,J.D.Taylor and Francis grp CRC press UK
- Introduction to fish physiology ;Dr. Lynwood S. Smith Narendra publishing house India.
- An introduction to fishes:G. S. Sandhu,Campus book international.
- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Fish and fisheries of India :Jhingran,V.G. Hindustan publishing corporation New Delhi.

M.Sc. 3rd Semester

Special paper practical – ZOY 916(Fish and Fisheries)

- Virtual dissection of bony and cartilaginous fishes.
- Study of electric organ of fishes.
- Determination of age through the scale of fishes.
- Study of museum specimens of fishes.
- Study of permanent slides.
- Study of bones of fishes.

Marks Distribution:	**Duration:-6 hours**
• Dissection of fishes	10
• Determination of age/study of electric organ	05
• Spotting	10
• Preparation of permanent slide	05
• Viva – Voce	05
• Record and collection	05
Total	**40**

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M.Sc.3rd Semester
Special paper 1-ZOY 904 (Endo-A)
Comparative Endocrinology

Unit-I

1. History and scope of endocrinology
2. Endocrine methodologies.
3. Mechanism of hormone action
4. General and comparative structure of pituitary gland
5. Structure of Pineal gland

Unit-II

1. General & comparative structure of thyroid gland
2. General and comparative structure of parathyroid gland.
3. General and comparative structure of pancreas
4. General and comparative structure of adrenal medulla and chromaffin tissue
5. General and comparative structure of adrenal cortex and inter renal tissue.

Unit-III

1. Neuroendocrine concept & mechanism in invertebrates
2. Neuroendocrine system in coelenterates
3. Neuroendocrine system in Helminthes
4. Neuroendocrine mechanism in Annelida.
5. Neuroendocrine system in Mollusca

Unit-IV

1. Caudal neurosecretory system in fish
2. General structure of thymus in mammal
3. Ultibranchial bodies in Vertebrates.
4. Structure of ovary in mammals
5. Structure of testis in mammals

Unit-V

1. Hormones and environment
2. Care and Breeding of laboratory animals rat mice.
3. Hormones, hormones like substances and their evolution.

Suggested Reading Books

1. C.D. turner and J.P. Bagnara, General Endocrinology W.B. Saunnder's Publication
2. Mc.E.Hadkey, Endocrinology Printice Hall
3. P.J.Bently, Comparative Vertebrate Endocrinology Cambridge University Press.
4. Gorbmen and Bern, Comparative endocrinology Wiley Eastern University Edition.
5. David.O.Norris, Vertebrate Endocrinology Academic Press.

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M.Sc.3rd Semester

SPECIAL PAPER 2-ZOY 910(ENDO-B)
Endocrinology Physiology

Unit-I

1. Role of hypothalamus and neuroendocrine intergration in mammals.
2. Hormones of anterior pituitary and their functional significance.
3. Growth hormone and its physiological significance.
4. Hormones of neurohypophysis and their functional significance in mammals.
5. Hormones of pars-intermedia and control of pigmentary function in vertebrates.

Unit-II

1. Evolution of thyroid function and synthesis of thyroid hormones.
2. Regulation of thyroxine secretion and its physiological significance.
3. Thyroxine and its influence of development and metamorphosis.
4. Parathyroid hormones and its physiological significance.
5. Calcitonin, thyrocalcitonin and their functional significance.

Unit-III

1. Catecholamines (Epinephrine and non-epinephrine) their biosynthesis and physiological influence on metabolism.
2. Biosynthesis and metabolism of adrenal glands.
3. Physiological significance of mineralcorticoid.
4. Physiological significance of glucocorticoids.

Unit-IV

1. Gastrointestinal hormone and their physiological significance and its dysfunction
2. Physiological significance of insulin in carbohydrates metabolism
3. Physiological significance of glucagon in carbohydrates metabolism.
4. Insulin and insulin like peptides and their role in early mammalian development.

Unit-V

1. Neuroendocrine system in insects
2. Synthesis and functions Brain hormones in insects
3. Gonadal hormone in insects
4. Neuro secretion in crustacean.

Suggested Reading Books

1. C.D. turner and J.P. Bagnara, General Endocrinology W.B. Saunnder's Publication
2. Mc.E.Hadkey, Endocrinology Printice Hall
3. P.J.Bently, Comparative Vertebrate Endocrinology Cambridge University Press.
4. Gorbmen and Bern, Comparative endocrinology Wiley Eastern University Edition.
5. David.O.Norris, Vertebrate Endocrinology Academic Press.

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M.Sc.3rd Semester
Special Paper Practical –ZOY 916(Endocrinology)

General and comparative Endocrinology

1. Virtual dissection of endocrine gland in vertebrate and invertebrates (Cockroach, Grasshopper and Butterfly).
2. Determination of protein and glycogen in the endocrine material using colorimeter.
3. Microtomy of endocrine material (Preparation of paraffin blocks, sectioning and staining)
4. Identification of endocrine gland.
5. Identification of chemical structure of peptides and steroid hormones.
6. Determination of blood sugar level.

Scheme of Practical Examination

1. Dissection of endocrine glands in Vertebrate / Invertebrates with display and Diagram	10
2. Biochemical estimation of protein, glycogen in endocrine tissue/ Determination of blood sugar level	05
3. Microtomy of endocrine material	10
4. Identification and comments of spotting (Slides-3, Molecular structure of hormones-2)	10
5. Viva-voce/Practical record	05
Total	**40**

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M.Sc. 3rd Semester
Special Paper-I – ZOY 905 (Environmental Biology-A)
Fundamentals of Environmental Biology

Unit- I: Definition, Principles and scope of Environmental Biology
Man and Environment, Components of atmosphereand biosphere, Physicochemical and biological factors in the Environment, Structure and composition of Biosphere. Biomes and Climates

Unit- II: Nature of ecosystem
Ecosystem structure and functions, types of ecosystems, Abiotic and biotic components, Terrestrial and aquatic ecosystems, Productivity, Food chain, food web, energy flow through ecosystem, biogeochemical cycles, Ecological Pyramids Basics of Ecosystem restoration

Unit- III: Population ecology
Density, natality, mortality, growth curves, Commensalism, Mutualism,
Parasitism, Predator- Prey relations, Population dynamics, Ecological succession, Ecological Models

Unit- IV :Environmental Pollution
Classification of pollutants, Nuclear hazards and human health risks, Sources, Effects and control of Air, water, soil and noise pollution Ganga Action plan (GAP), public health issues, Plastic waste management rules, Bhopal gas tragedy, etc

UNIT – V: Environmental Microbiology and Toxicology
Introduction to toxicology, dose-response relation, additive-synergistic and antagonistic effects, factors affecting toxic responses, route of administration, toxicity testing, types of toxicity, Pesticides ,metals, solvents and vapours, radiation and radioactive materials, chemical carcinogens, food additives, fluorosis and arsenic poisoning.

Microbiology- organisms in nature & their importance, Biotransformation, bioconversion, phytoremediation and bioremediation, microbiology of water, air and soil ,microbes as pathological agent in plant, animal and man.

Reference Books-

1. Environmental chemistry - Sodhi
2. Principals of Environmental chemistry - Manhan
3. Environmental hazards & human health R.B. Philip
4. Toxicology - principles & applications - Niesink & Jon devries
5. Principles of microbiology - Pelzar
6. Microbial bio technology - A.N. Glazer
7. Microbial ecology - R.M. Atlas

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M.Sc. 3rd Semester
Special Paper-I I – ZOY 911 (Environmental Biology-B)
Biodiversity and Energy Conservation

Unit- I: Biodiversity Conservation
Introduction to biodiversity concepts, significance and distribution, Levels of biological diversity, Threats to biodiversity, principles of biodiversity conservation in-situ and ex-situ conservation, acceleration of ecological succession, Mega biodiversity zones and Hot spots. Man and biosphere programme

Unit- II: Uses of biodiversity
Sources of food, medicines, raw material, aesthetic, cultural and ecosystem services, strategies for sustainable exploitation of biodiversity.

Unit- III: Energy Resources and Conservation
Renewable and non-renewable energy resources, sun as source of energy, solar radiation and its spectral characteristics, fossil fuels classification, composition.
Physiochemical characteristics and energy content of coal, petroleum and natural gas. Principle of generation and conservation of conventional and non-conventional energy.
Energy from biomass and biogas, energy conservation policies.

Unit- IV: Natural Resources and Movements
Land resources, Causes of deforestation; Impacts of mining and dam building on environment.
Water resources: Over exploitation of water resources; Floods, droughts, and international & interstate conflicts over water
Contemporary Indian issues related to mining, dams, forests, energy etc (e.g., National Solar Mission, Cauvery River water conflict, Sardar Sarovar dam, Chipko movement, Appiko movement, Tarun Bharat Sangh, Bishnois of Rajasthan, Narmada Bachao Andolan, etc) Environmental justice: National Green Tribunal and its importance.

Unit- V:Wetlands-
Concept, classification, importance, uses and threats to the wetlands, Productivity and development of Wetlands ,Important wetlands of India. Ramsar convention and National Wetland Policy.

References
1. Living in the environmental - T.J. Miller.
2. Natural resource conservation - Owen & Chiras.
3. Encyclopedia Energy - I & II.
4. Global Biodiversity - W.R. L.IUCN
5. Ecology of natural resource - Ramade
6. Ecology - P.D. Sharma
7. Keddy P.A (2000). Wetland Ecology: Principles and Conservation.
8. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science andConservation. S. Chand Publishing, New Delhi.

M.Sc. 3rd Semester
SPECIAL PAPER PRACTICAL – ZOY 916 (Environmental Biology)
Biodiversity, Ecological Studies and Toxicological Studies

- Monitoring Flora and fauna and other Environmental Components.

Collection of Zooplankton and Phytoplankton

- Analysis of soil micro flora by dilution plate method, study of rhizospheric and rhizoplane microbes
- Study of anatomical changes in plants to detect effect of pollution.
- Study of pond ecosystem
- Birds and Wildlife census.

- Biodiversity index
- Analysis of water : Dissolved Oxygen ,Biological Oxygen Demand, Chloride estimation. Dissolved Solids, Hardness of water ,Alkalinity, Acidity, Ph
- Testing of presence of bacteria : Gram + and Gram – Bacteria
- Toxicity analysis

Books/ Manuals Recommended:

- APHA, AWWA, WEF (1998). Standard Methods of water and waste water. APHA (20th Edition
- Booth C. (1971). Methods in microbiology Volume 4 Academic press
- Pelczar M.J, Chan E.C.S and Krieg N.R. (1993). Microbiology Tata Mecgrahill New Delhi

M.Sc. 3rd Semester
Special paper – I ZOY- 906 (Cell Biology – A)
Methods in cell and molecular biology

Unit – 1

- Microscopy : Light, Phase contrast and electron microscope.
- Basic principle and application micro-photometry.
- Tissue culture : Media, sterilization, monolayer and suspension culture, cell counting and infection.

Unit – 2

- Centrifugation : Principle and applications : Types of rotors, clinical, high speed and ultracentrifuges.
- Autoradiography: Principle, methods and applications.
- Radio immune assay.

Unit – 3

- Electrophoresis: Types, principles, methods and applications.
- Spectro photometry : Principles and applications.
- FT – IR (Fourier transform infrared) and NMR (Nuclear magnetic resonance) spectroscope.

Unit – 4

- Preparation of recombinant DNA (Gene cloning). Restriction enzymes and modifying enzymes.
- Preparation of genomic and c-DNA libraries. General idea of expression library : Screening of gene libraries.
- Methods in gene analysis : Hybridization technique (Southern, Northern, Western Blotting.
- PCR ,RAPD, RFLP, AFLP (Genetic analysis techniques) and its applications.

Unit – 5

- Methods of protein purification.
- DNA foot printing.
- Chromosome banding: Principle, methods and applications.
- RNA silencing.

Suggested Readings:

1. Karp: Cell and Molecular Biology: Wiley (2002).
2. Watson et al. Molecular Biology of the Gene. Pearson (2004).
3. Lewin. Genes VIII. Pearson (2004).
4. Primrose. Molecular Biotechnology. Panima (2001).
5. Clark & Switzer. Experimental Biochemistry. Freeman (2000).
6. L.Veera Kumari, Bio instrumentation MJP publishers

M.Sc.3rd Semester
Special Paper - II ZOY – 912 (Cell Biology - B)
Cell Structure and molecular organization

Unit – 1

- Chemical composition of cell membrane.
- Membrane protein : Spectrin, glycophorin and band 3.
- Structure and functions of lysosomes and peroxisomes.

Unit – 2

- Structure and chemical composition of mitochondria.
- Molecular organization of respiratory assemblies, ATP/ADP, translocase and Fo.F1 ATPase., ATP synthesis.
- Mitochondrial DNA : Structure expression and variability from genomic DNA.
- C-Value paradox, Cot value and its significance.

Unit – 3

- Structure and function of endoplasmic reticulum (ER).
- Structure, function and biogenesis of ribosomes.
- Cytochemistry of Golgi complex and its role in protein trafficking.

Unit – 4

- Cell nucleus: Nuclear envelop, nuclear pore complex and nucleolus.
- Nucleocytoplasmic transport : Import and export of protein and RNAs.
- Structure of chromosome, kinetochores and telomere.

Unit -5.

- General idea of oncogene and cancer : Transforming agent, proto-oncogenes and oncoproteins.
- Differences between normal cell and cancer cell : Biochemical, cytoskeletal cell surface changes, hormones in relation to cancer cells.
- Human cancer : Genetic basis and chromosomal abnormalities.
- Evolutionary origin of cancer

Book recommended:

- Cell and Mol. Biology – Gerald Karp.
- Genes VIII. B Lewin.
- Principle of Genetics – Snustad and Simmons.

M.Sc.3rd Semester
Special Paper Practical ZOY – 916(Cell Biology)

- Histochemical demonstration of lipids, proteins (including enzymes), carbohydrate and nucleic acids (DNA/RNA).
- Chromosome staining of grasshopper testis and polytene chromosomes from salivary glands of Drosophila.
- Gel electrophoresis of nucleic acid (DNA/RNA). Isolation and detection of DNA/RNA on agarose gel.
- Study of permanent slides of meiosis.

Marks Distribution : Duration: 6 hours

• Histology and Histochemistry	10
• Demonstration of Biomolecules / meiotic slides	10
• Chromosome staining of grasshopper testis /Polytene Chromosome	05
• Gel Electrophoresis of DNA	05
• Viva – Voce	05
• Record	05
Total	**40**

2-7-22

M.Sc. 3rd Semester

Special Paper-I – ZOY 907 (Applied zoology - A)
Aquaculture

Unit – 1

- Scope and significance of various streams of applied zoology
- Scope, importance and problems of aquaculture.
- Physiochemical properties of pond water
- Types and qualities of culturable fishes

Unit – 2

- Construction and lay out of different types of ponds
- Management of hatcheries, nurseries and rearing ponds.
- Pre and post management of stocking ponds.

Unit – 3

- Fresh water prawn culture
- Pearl culture
- Fin fish culture
- Integrated fish cum duck farming.
- Sewage fed fish culture.

Unit – 4

- Construction and maintenance of fish aquaria and important aquarium fishes.
- Cage culture.
- Brackish water fish culture.
- Biofloc fish farming.

Unit – 5

- Breeding habits of carps : Bandh breeding and induced breeding
- Fish byproducts and marketing .
- Fish preservation and transportation.

Suggested books

- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Hand book of Fisheries and aquaculture.2013 Indian Council of Agricultural Research ICAR New Delhi India
- Fish and fisheries of India :Jhingran,V.G. Hindustan publishing corporation New Delhi.
- Santhanam, R. Fisheries science Daya publishing house
- Lagler,K.Fet al.; Ichthyology, John Wiley

M.Sc. 3rd Semester

Special Paper-II – ZOY 913 (Applied zoology - B)

Human diseases , disorders and diagnostics

Unit – 1

- Types of parasites and hosts
- Brief introduction to pathogenic microbes: Viruses and bacteria.
- Host parasite relationship

Unit – 2

- Causes , types, symptoms, diagnosis and prevention of : Tuberculosis ,Hepatitis, Diabetes and Hypertension.
- Causes, types, symptoms, diagnosis and prevention of epidemic and pandemic diseases : Typhoid, cholera, small pox, plague and covid-19.

Unit – 3

- Types of tumors : Benign, malignant
- Tumor associated antigen
- Immuno diagnosis and immunotherapy in cancer

Unit – 4

- Methods used for analysis of : Blood and Urine
- Medical imaging : X-Ray, MRI and CT scan

Unit – 5

- Hybridoma technology
- Gene therapy
- Development of recombinant vaccine
- Production of recombinant protein : Insulin and growth hormone

Suggested books

- Introduction to parasitology: J.D Smith
- Parasitology – T.C.Cheng
- Biology of parasites – E.J.W.Soulsbey
- Medical parasitology-K.D.Chaterjee
- Noble and Noble , Parasitology, Lea and Febiger 1973

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M.Sc.3rd Semester
Special Paper Practical –ZOY-916 (Applied Zoology)

- Study of specimens of fresh water fishes and aquaculture animals.
- Study of specimens of helminths and arthropods.
- Study of slides of parasites of protozoan, helminths and arthropods.
- Counting of blood cells with haemocytometer.
- Identification of fish scales.
- Haematological experiments.

MARKS DISTRIBUTION

Duration: 6 hours

• Haematological experiments.	10
• Spotting	10
• Permanent slide preparation	10
• Record and collection	05
• Viva voce	05
TOTAL	40

2.7.22

M.Sc.3rd Semester
Special Paper-I – ZOY 908 (Entomology- A)
General Entomology & Insect Morphology

Unit – 1

- Insect diversity and their outline classification.
- Collection, preservation and culture of Insects.
- General organization of insect body: Head, thorax, abdomen and their appendages.

Unit – 2

- Mouthparts and relationship with feeding habits of insects.
- Wings: Origin, structure and venation.
- Structure of flight muscles and flight mechanisms in insects.

Unit – 3

- Coloration and mimicry in insects.
- Light producing organ and its mechanism.
- Sound producing organ and its mechanism.

Unit – 4

- Phase theory of locusts.
- Polymorphism in insects.
- Methods of insect communication.

Unit – 5

- Insect and Abiotic environment.
- Insect and biotic environment.
- Insects and humans.

Suggested books

- O.W.Richards and R.G.Davies, Imms textbook of Entomology. Methuen and Co. London.
- R.E.Snodgreass, Principles of insect morphology. Tata MacGraw.Hill, Bombay.
- R.M.Fox and J.W.Fox, Introduction to comparative entomology. Reinhold Publ.Corp, New York.
- R.F.Chapman. The insects structure and function(ELBS,London)
- K.K.Nayar, T.N. Ananthakrishnan and B.V.David, General and Applied Entomology. Tata MacGrow Hill, New Delhi.
- K.G.V. Smith, Insects and other arthropods of medical importance.
- H.H.Ross. A Textbook of Entomology, John Wiley and sons, New York.

M.Sc.3rd Semester
Special Paper – II ZOY- 914 (Entomology – B)
Insect Anatomy & Physiology

Unit – 1

- Structure and function of insect integument.
- Head and its Appendages.
- The digestive system.

Unit – 2

- Respiratory system.
- Circulatory system.
- Excretory system.

Unit – 3

- Nervous system.
- Endocrine system.
- Reproductive system.

Unit – 4

- The Development.
- Sense organs.
- Visual organs.

Unit – 5

- Insect Parasitism.
- Dispersal and migration in insects.
- Behaviour : Orientation, innate and parental.\

Suggested books

- Chapmn : the insects: structure and function 4th edition.
- Pedigo : entomology and pest management , prentice hall , New delhi 1989.
- Gullan & Cranston:the insects : an outline of entomology 2nd edition Blackwell science 2000.
- Dhaliwal and Arora : principles of insect pest management,national agriculture technology information centre Ludhiana.
- Atwaal : agriculture pest of India and south east asia , kalyaani publication New Delhi.
- Klowden : physiological systems in insects, academic press 2002.

M.Sc.3rd Semester
Special Paper Practical ZOY - 916

General Entomology

- Dissection of various organ systems (nervous, digestive, reproductive, neuroendocrine etc.) in available insects like grasshopper, cricket, cockroach, beetle, bug, wasp, honey bee, butterfly, moth, dragonfly etc.
- Preparation of permanent stained mounts of insects, their body parts and dissected organs.
- Study of permanent slides of insects, their body parts, organs and histological preparations.
- Study of insect specimens showing colouration, mimicry, light production, polymorphism, sound production and reception and other morphological modification.
- Physiological / Biochemical experiments in insects like extirpation and implantation of endocrine organs, parabiosis, ligation of dipteran/ lepidopteran larvae, preparation of isolated abdomen demonstration of digestive enzymes, excretory products, Chitin and cuticular lipids etc.
- Microtomy of insect material.

MARKS DISTRIBUTION **Duration: 6 hrs.**

• Dissection with display and diagram..	10
• Mounting with identification, diagram and comments.	05
• Spotting	10
• Physiological/Biochemical Experiments	05
• Viva – Voce	05
• Practical record	05
Total	**40**

27/7/22

M.Sc. 4th Semester
General Paper-I- ZOY 1001
Infection Biology and Immunology

Unit-I

- Introduction to parasitology, types of host and parasites.
- Parasitic adaptation in helminth parasites, parasitoids.
- Application of molecular biology in parasitic diseases.
- Biochemical and molecular mechanism of drug resistance in parasites.

Unit-II

- Innate & Acquired immunity
- Cells & organs of immune system
- Antigen & immunogenicity
- Anti body structure, function and diversity.
- Clonal selection theory.

Unit-III

- Humoral & cell mediated immune response.
- Maturation, Activation of lymphocytes (T & B cells), cytotoxic T-cells, NK cells, T-helper cells
- Major Histocompatibility Complex, antigen processing and presentation.
- Complete system
- Mammalian tole like receptors.

Unit-IV

- Monoclonal antibodies
- Antigen, antibody reaction (Precipitation and agglutination)
- Immunological technique (ELISA-Radio immunoassay,Immunohistochemistry ,Immunoelectrophoresis)

Unit-V

- Tumor immunology and Immunity to cancer.
- Transplant immunology and immunological tolerance
- Congenital & acquired immunodeficiencies.

Suggested Readings:

1. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).
2. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).
3. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)
4. Januway et.al. ,immunobiology- the immune system in health and diseases, Garland publishing U.S.A.
5. D.M.Weir and John Stewart: Immunology.
6.Kuby Immunology 8Ed. Macmillan publication.

M.Sc. 4th Semester
General Paper-II – ZOY 1002
Developmental Biology

Unit-I - Historical perspective and basic concepts

- Historical review and theories of embryology
- Cell division and cell differentiation
- Developmental biology and human welfare
- Sex determination in birds and mammals

Unit-II - Early embryonic development in mammals

- Male gonads and spermatogenesis
- Female gonads and oogenesis
- Semination, Ovulation and transport of gametes
- Reproduction cycle ; estrous and menstrual cycle
- Fertilization and cleavage
- Blastulation and Gastrulation

Unit-III - Late Embryonic Development

- Morphogenesis; formation of neural tube, cell migration
- Fat map of germinal layers, extra embryonic membranes.
- Implantation in mammals
- Placentation in mammals
- Axis and pattering in Drosophila

Unit-IV - Post embryonic Development

- Metamorphosis in amphibian
- Regeneration epimorphic regeneration in reptile
- Ageing ; concept & theories
- Stem cells

Unit-V - Implication of developmental Biology

- Tretogenesis- teratological agents and their effect on embryonic development
- Amniocentesis
- Assisted reproductive techniques IVF, ICSE, GIFT etc

Suggested Books

- Gilbert, S.F. (2010) Developmental Biology, Sinauer Publisher
- Balinsky, B.I. and Fabian B.C. (1981) Introduction of Embryology
- Carlson, R.F. Patter's Foundation of Embryology
- Kalthoff. (2008) Analysis of Biologycal Development, Hill Publishers
- Lewis Wolpert (2002) Principales of Development Oxford University Press.
- Chordate embryology Verma and Agarwal. S.Chand Publication Recent edition

M.Sc. 4th Semester
Special Paper-I – ZOY 1003 (Fish- A)
Pisciculture

Unit – 1

- Construction and layout of different types of ponds.
- Physiochemical properties of pond water and soil.
- Pre and post management of stocking ponds.
- Management of hatcheries, nurseries and rearing ponds.
- Management of fish germ plasm.

Unit – 2

- Dams and their impact on riverine fisheries.
- Culturable fish species of inland water .
- Planktons and their importance in fish culture.
- Construction and maintenance of fish aquaria and important aquarium fishes.

Unit – 3

- Fishing crafts and gears.
- Remote sensing technique used in fish culture.
- Fishways and screens.
- Fish feed: Natural, artificial and commercial .

Unit – 4

- Brakish water fish culture.
- Sewage fed fish culture.
- Biofloc fish farming .
- Recirculating aquaculture system.

Unit – 5

- Methods of fish preservation.
- Problem associated with fish preservation.
- Fish spoilage, rigor mortis, rancidity and enzyme spoilage.
- Transportation and marketing of fish.

Suggested books

- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Hand book of Fisheries and aquaculture.2013 Indian Council of Agricultural Research ICAR New Delhi India
- Fish and fisheries of India : Jhingran,V.G. Hindustan publishing corporation New Delhi.
- Santhanam, R. Fisheries science Daya publishing house
- Lagler,K.Fet al.; Ichthyology, John Wiley
- C.I.F.R.I; Prawn Fisheries Bulletin no 10 1977.
- Huet M.;Text book of fish culture, breeding and cultivation of fish ,fishing news(books) LTD
- Ribelin, W .E.& Migeki, G.: the pathology of fishes,the university of Wisconsin press , 1975.

M.Sc. 4th Semester
Special Paper-I I – ZOY 1009 (Fish- B)
Aquaculture and economic importance of fishes

Unit – 1

- Cage or pen culture.
- Prawn and shrimp culture.
- Pearl culture.
- Fish culture in swamps and marshes.

Unit – 2

- Integrated and composite fish culture.
- Rice field aquaculture .
- Induced breeding and bandh breeding

Unit – 3

- Fish as a model organism.
- Genetically modified fishes and their importance.
- Chromosome manipulation (Gynogenesis, androgenesis and polyploidy).
- DNA polymorphism in fishes.

Unit – 4

- Biosensors used in aquaculture.
- Fishes as biofactories.
- Extension services : Basic principles and immerging issues of extension.
- Role of information and communication technology(ICT) in fisheries extension.

Unit – 5

- Fish by products : Fish skin, scales, fish manure, fish isinglass, fish flour, fish sausage and fish silage.
- Economic importance of fish liver oil, fish body oil.
- Chemical composition of fish liver oil.
- Shark liver oil industry in India

Suggested books

- An introduction to fishes : S.S.Khanna ,Central book depot publication.
- Hand book of Fisheries and aquaculture.2013 Indian Council of Agricultural Research ICAR New Delhi India
- Fish and fisheries of India :Jhingran,V.G. Hindustan publishing corporation New Delhi.
- Santhanam, R. Fisheries science Daya publishing house
- Lagler,K.Fet al.; Ichthyology, John Wiley
- Srivastava , C.B.L: a Textbook of fishery science and Indian fisheries, Kitaab Mahal 1985.

M.Sc. 4th Semester
Special paper practical – ZOY1015
(Fish and fisheries)

- Pituitary gland collection from fishes
- Study of different types of nets and gears.
- Fish skeletal preparation.
- Identification of fish parasites , their fixation and permanent slide preparation .
- Microtomy of fish organs (Block making , section cutting and slide preparation).
- Testing of Physiochemical parameters of water.
- Identification of fishes through keys.
- Identification of different weeds.
- Representation of catchment of fishes through histogram and pie diagram.
- Study of museum specimens and histological slides.

Marks distribution : **Duration:- 6 hours**

• Dissection of pituitary gland	10
• Study of nets / gear	10
• Microtomy	15
• Water testing	05
• Spotting	10
• Submission of skeleton of fish already prepared	10
• Slide preparation	05
• Identification of fish	05
• Viva and record	05
Total Marks	**75**

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M.Sc. 4th Semester
Special Paper 1st –ZOY 1004 (ENDO-A)
Male Reproductive Endocrinology

Unit-I

1. Differentiation of the testes and male genital ducts.
2. Histology and ultra structure of testis.
3. Spermatogenic function of the testis.
4. Endocrine regulation of Spermatogenesis
5. Testosterone its structure & functions

Unit-II

1. Structure and functional significance of Sertoli cells.
2. Endocrine and paracrine function of Sertoli cells.
3. Structure and functional role of Leyding cells.
4. Metabolism of testicular androgens

Unit-III

1. Biochemistry of semen and analysis of semen.
2. Structure and physiology of male reproductive tract.
3. Metabolism of testicular androgen.
4. Inhibin and activin

Unit-IV

1. Structure and ultrastructure of mammalian sperm
2. Metabolic changes in spermatozoa during maturation
3. Capiciation of Spermatozoa
4. Testicular disorders and their remedies.

Unit-V

1. Regulation of fertility in male through ART
2. Contraception through male.
3. Hormone & sexual Behaviour
4. Effect of Environmental factors in reproduction

Suggested Reading Books

1. Gayatri Praksah, Reproductive Biology,Narosa Publication
2. Yen et al Reproductive Endocrinology, W.B. Saunder,s Publication.
3. A.V. Nalbandov, Reproductive Physiology of Mammals, W.H.Freeman & Co.
4. Mac. E.Hadley, Endocrionology Printice Hall.
5. Gayton and Hall Medical Physiology Elsevier Publication.

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M.Sc. 4th Semester
Special Paper 2nd –ZOY 1010 (ENDO –B)
Female Reproductive Endocrinology

Unit-I

1. Differentiation of the ovary and female genital duct.
2. Histology of ovary and ultrastructure of ovum.
3. Estrous cycle in mammals.
4. Menstrual cycle in primates.
5. Menopause

Unit-II

1. Puberty and its hormonal control and disorders
2. Implantation and its hormonal regulation and types
3. Pregnancy and hormonal regulation of pregnancy.
4. Parturation & its hormonal regulation
5. Lactation and its regulation

Unit-III

1. Fine structure and types of placenta and their significance.
2. Placental hormones and proteins secretions and significance.
3. Corpus leuteum and its functional significance
4. Neuroendocrine control of ovarian functions.

Unit-IV

1. Prostaglandins and their role in reproduction.
2. Endocrine control of ovulation and lutenization.
3. Endocrine control structure and function of mammalian oviduct.
4. Bioregulators, Acetylcholine, GABA, Interleukin, Gaseous bioregulator.

Unit-V

1. Impotency sterility ART in human
2. Invitro fertilization, ZIFT, GIFT, ICSI
3. Control of Fertility in females.

Suggested Reading Books

1. Gayatri Praksah, Reproductive Biology,Narosa Publication
2. Yen et al Reproductive Endocrinology, W.B. Saunder,s Publication.
3. A.V. Nalbandov, Reproductive Physiology of Mammals, W.H.Freeman & Co.
4. Mac. E.Hadley, Endocrionology Printice Hall.
5. Gayton and Hall Medical Physiology Elsevier Publication.

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M.sc 4th Semester
Special Paper Practical-ZOY1015 (Endocrinology)

Reproductive Endocrinology

1. Dissection of various reproductive glands in vertebrates.
2. Operation in male rat: castration, vasectomy
3. Operation in female rats; Overictomy, Hysterectomy, adrenalectomy, thyroidcctomy, laparotomy.
4. Preparation of vaginal smear, identification and staining with papeniculaou stain.
5. Preparation of sperm smear and classification of types of sperms with abnormities.
6. Confirmation of pregnancy in urine using antibody method.
7. Separation of steroidal hormones; using thin layer chromatography.
8. Identification of permanent slides of reproductive organs.
9. Identification of chemical structures of steroidal hormones.
10. Study of human embryos at different stages of development.

Scheme of Examination

Duration: 6.00 Hrs

1.	Dissection of reproductive gland	20
2.	Experiments in living rats (Two) Operation in male and female	10
3.	Vaginal smear and sperm studies/Embryo study	10
4.	Spotting	15
5.	Practical Record	10
6.	Viva-voce	10
	Total	**75**

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M.Sc. 4th Semester
Special Paper-I – ZOY 1005 (Envi. Biol. - A)
Environmental Management

Unit- I: Environmental Management

Introduction and scope of environmental management, basic concepts of sustainable development, Role of natural products, Environmental Impact Assessment (EIA),environmental management plan (EMP), international organization for standardization (ISO), environmental safety, Remote sensing, GIS technology and its uses, environmental monitoring.

Unit- II: Water Pollution Management

Water quality standard, physico-chemical and biological properties of sewage, effects of water pollutants on phytoplankton productivity, bio-indicators of water pollution., Biological treatment of waste waters, chemical and other methods for disinfection. , Water management strategies, rain water harvesting, recharging of ground water, Treatment of Industrial effluents.

Unit- III: Air Pollution Management

National air monitoring programme, effects of air pollution on human health, Vehicular pollution monitoring, Air pollution control equipments, control of sulphur dioxide and control of NO2. Hazardous air pollutants and their management, scope of green belt development

Unit- IV: Waste and Disaster Management

Solid waste management methods - Sanitary land filling, Recycling, Vermi composting, energy recovery from organic waste, Hospital Waste Management, Control measures for various types of urban, industrial lwaste, Hazardous waste, E-waste, etc; Waste segregation and disposal, Disaster Management.

Unit- V:Environmental Health Management

Effects of mercury, lead, chromium, cadmium, arsenic and nitrate on human health, Prevention and protection of community health from water borne diseases, Prevention of Air borne disease, Effects of weather and climate on diseases

References :

1. Solid Waste Management CPCB. New Delhi.
2. Ecotechnology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr.
3. Basic Environmental Technology - J.A. Nathanson

M.Sc. 4th Semester
Special Paper-II – ZOY 1011 (Envi. Biol. - B)
Environmental issues and legislation

Unit- I: Climate Change
Global warming, Greenhouse effect, Acid rain, Ozone Depletion, El-Nino effect, Impact of Climate change, Carbon sink, Carbon credit, Soil erosion, Deforestation, National action plan on Climate change, Green Economy
Development without destruction: Eco-transport, Eco farming, green belts

Unit- II: Wild Life Conservation
Endemic and endangered species of India, major causes of extinctions of wild life, threats to wildlife, IUCN threat categories, Red data book, Birds and wildlife census, Wild life conservation, National parks and sanctuaries, Biosphere reserves, Contemporary Indian wildlife and biodiversity issues, movements, and projects (e.g., Project Tiger, Project Elephant, Vulture breeding program, Project Great Indian Bustard, Crocodile conservation project, Silent Valley movement, Save Western Ghats movement, etc)

Unit- III: Global conventions and Protocols
Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity(CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc

Unit- IV: Environmental legislation
Wildlife Protection Act 1972, The Water (Prevention and Control of Pollution) Act 1974. Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981, Environment (protection) Act 1986, Biological Diversity Act, 2002, Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 and new legislations related to environment.

Unit- V: Environmental Policies and Rules
National Forest policy, Hazardous waste (Management and Handling) Rules, 1989, Bio-Medical Waste (Management and Handling) Rules, 1998, E- Waste Management Rules, 2016, Plastic Waste Management Rules, 2016, National Wetland Policy

References-

1.Divan, S. and Rosencranz, A. (2002). *Environmental Law and Policy in India: Cases, Material & Statutes*, 2nd Edition. Oxford University Press, India.
2. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y. and Berg, L.R. (2015). *Environment*, 9th Edition. Wiley Publishing, USA.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. (2017). *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi
4. Primack, R.B. (2014). *Essentials of Conservation Biology*, Oxford University Press, USA

M.Sc. 4th Semester

SPECIAL PAPER PRACTICAL 2– ZOY 1015 (Environmental Biology)

Pollution Monitoring, Analysis and Waste Management

Air pollution indices. Air Pollutant analysis, Auto – exhaust monitoring. High Volume Sampler and Stack Gas analysis kit, Estimation of the amount of oxides of Sulphur, oxides of Nitrogen in the ambient air, Estimation of the amount of in the ambient air, Air Pollution Tolerance Index ,Indicator plants for Air pollution

Noise Pollution Monitoring studies

Quantitative analysis - Gas chromatographic techniques, Titrimetric methods , Colorimetric methods, AA Spectro photometric analysis , HPLC techniques , Ion exchange chromatography, Electrophoresis methods, PCR technique

Environmental monitoring using remote sensing - Remote Sensing – Raster Analysis, Remote Sensing – Vector Analysis, GIS Analysis, GPS in Remote Sensing Analysis, Modelling

Sampling methods of soil and solid waste - Analysis of Moisture content, Organic Matter, Organic Carbon, Analysis of Sodium and Potassium, Nitrogen content, Potassium, Phosphorus, Preparation of Compost

Chemical toxicity tests in wastewater (Industrial), Heavy metal analysis, Predicting techniques (impact prediction).

Biological analysis of Municipal Solid waste, Waste water treatment methods

Books Recommended:

- Stern A. C.,(1977), Air Pollution, Academic Press, New York
- Park- Air Pollution- Analysis.
- Aery. N.C (2002), Manual of Environmental Analysis, Ane Books Pvt. Ltd.

M.Sc.4th Semester
Special Paper - I ZOY- 1006 (Cell Biology – A)
Chromosomes, genes and genetic engineering

Unit – 1

- Molecular organization of eukaryotic chromatin, nucleosome and higher order compaction of mitotic chromosomes.
- Genes, gene mutations and molecular mechanism of occurrence of mutations.
- Organization and significance of hetero-chromatin.

Unit – 2

- Organization of eukaryotic transcriptional machinery, promoter obstructers, enhancers, transcription factors and polymerases.
- DNA binding domains of transcription apparatus, zinc finger, steroid receptors homeo domains, Halix-loop-Helix and Leucine Zipper.
- Structural organization of eukaryotic genes : Interrupted genes and overlapping genes and their evolution.
- DNA methylation and DNAs sensitivity in relation to gene activity and chromatin organization.

Unit – 3

- Gene families : Organization, evolution and significance.
- Environmental modulation of gene activity (stress responses) : Stress genes and stress proteins.
- Molecular basis of Thalassemia, Muscular dystrophy and Cystic fibrosis.

Unit – 4

- DNA rearrangement and amplification during development with special reference to ciliates, chorion gene and ssRNA genes.
- General plan of embryonic development of Drosophila embryo, transdetermination.
- Basic idea of organization and evolutionary significance of homeoboxes.
- Basic idea of homeotic genes and homeotic mutation.

Unit – 5

- Genetic and cytological mapping of chromosome.
- Transposable elements : Charateristics and types.
- Single nucleotide polymorphisms and its significance.

Suggested reading Material :

- DeRobertis, Alberts et al.: Cell and molecular biology.
- J.D. Watson, Molecular biology of the gene.
- Gerald Karp, Cell biology.
- Lewin, Genes Vol. VIII.

M.Sc.4th Semester
Special Paper - II - ZOY – 1012 (Cell Biology – B)
Neurobiology, Ageing and immunology

Unit – 1

- Neuron, General organization and function of nerve fibers.
- Chemical synaptic transmission, Neurotransmitters and role of synaptic vesicles in nerve transmission.
- Voltage gated channels in electrically excitable membrane.
- C- AMP and calcium as second messenger and their role in cellular regulatory mechanism.

Unit – 2

- Chromatophores : Types, structure, composition and functional significance.
- Autonomic neural regulation of melanophores and colour change.
- Ageing : Theories of ageing and the current concept.
- Free radicals and age pigments (Lipofuschin and ceroids) and their significance in cellular sequence.

Unit – 3

- Apoptosis and cell death, the current concept and sequence in cellular sequence and ageing .
- Age associated neurodegenerative diseases, Alzheimer's and Parkinson's disease.
- Change of chromatin organization and enzyme activities during ageing.

Unit – 4

- Introductory ideas of innate and adaptive immunity.
- Cells and Tissues of immune system: General organization and functions.
- General structure of immunoglobulin (antibody) molecule.
- Antibody diversity (rearrangement, recombination in immunoglobulin genes).

Unit - 5

- Major histocompatibility (MHC) complex.
- Concept of humoral and cell mediated immune responses.
- Allergy, autoimmunity, Immune response genes and AIDS.
- Auto immune diseases.

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. D.M.Weir and John Stiwart: Immunology.
6. Kuby Immunology 8Ed. Macmillan publication.

M.Sc.4th Semester
Special Paper Practical ZOY – 1015(Cell Biology)

- Preparation of mitotic chromosomes from rat bone marrow.
- Study of inversion/ inversion frequency from polytene chromosome of Drosophila larvae.
- Study on antigen antibody reactions : Blood group and Rh factor.
- Study of Monohybrid and Dihybrid crosses / sex linkage in Drosophila.
- Study of development (homeotic) and other phenotypic mutants of Drosophila.
- Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
- Demonstration of DNA extraction from blood or tissue samples.
- To estimate amount of DNA using spectrophotometer.
- To calculate molecular weight of unknown DNA and protein fragments from gel pictures.

Marks Distribution: Duration : 6 hours

• Preparation mitotic chromosome from rat bone marrow	10
• Preparation of polytene chromosomes to study inversions	10
• Analysis of Mono / Dihybrid / sex linkage crosses in Drosophila	10
• Experimental in immunology	10
• Calculation molecular weight of DNA from gel picture/ extraction of DNA	20
• Permanent slides preparations	05
• Viva-voce	05
• Record	05
Total	**75**

2.7.22

M.Sc. 4th Semester
Special Paper-I – ZOY 1007 (Applied zoology - A)
Applied Entomology

Unit - 1

- Apiculture
- Sericulture
- Lac culture

Unit – 2

- Characteristic features, biology, nature of damage and management measures of :
  - Insect pests of sugar cane : Scirpophaga, Chilotraea, Pyrilla, Aleurolobus.
  - Insect pests of cotton : Sylepta, Erias, Pectinophora, Dysdercus.
  - Insect pests of oil seeds : Mustard aphid, Sawfly, Castor Semi-looper

Unit – 3

- Characteristic features, nature of damage and management measures of:
  - Important insect pests of cereals and pulses
  - Important insect pests of stored grains
  - Polyphagus insects
  - Important general pests : Grasshoppers, locusts, termite, aphids

Unit – 4

- Characteristic features, nature of damage and control measures of :
  - house hold pests : Cockroaches, crickets, ants, wasps, silverfish, cloth and carpet beetle, furniture beetle
  - Role of insects as vectors of human diseases.
  - Pest management including mechanical, physical, cultural ,chemical , legal biological and recent trends of management

Unit – 5

- Mode of action of pesticides : Organophosphorous, organochlorine, carbamate, pyrethroids and neem products.
- Forest entomology : Its pests and control
- Forensic entomology and its importance
- Veterinary insects and their control

Suggested books

- O.W.Richards and R.G .Davies, Imms textbook of Entomology. Methuen and Co. London.
- R.E .Snodgreass, Principles of insect morphology. Tata MacGraw Hill, Bombay.
- R.M.Fox and J.W.Fox, Introduction to comparative entomology. Reinhold Publ.Corp, New York.
- R.F.Chapman. The insects structure and function(ELBS,London)
- K.K.Nayar, T.N. Ananthakrishnan and B.V.David, General and Applied Entomology, Tata MacGrow Hill, New Delhi.
- K.G.V. Smith, Insects and other arthropods of medical importance.
- H.H.Ross. A Textbook of Entomology, John Wiley and sons, New York.

M.Sc. 4th Semester

Special Paper-I – ZOY 1013 (Applied zoology - B)

Parasitology and immunology

Unit – 1

- Morphology, life cycle, physiology ,pathogenicity , epidemiology and treatment of :
  1- Sarcodina: Entamoeba spp.,Naegleria sp
  2- Sporozoa : Toxoplasma spp., Eimeria spp.,plasmodium spp.
  3- Ciliata : Balantidium spp., Nyctotherus spp.,

Unit – 2

- Morphology, life cycle, physiology pathogenicity , epidemiology and treatment of :
  1- Homoflagellate : Trypanosoma spp.and leishmania spp.
  2- Intestinal flagellate : Giardia and trichomonas spp.
  - Opalinids : Opalina spp.

Unit – 3

- Protozoan diseases of fish : Costiasis, White spot diseases, Pimple disease
- Helminth diseases of fish : Yellow grab, white grab, blood flukes, tape worms, gyrodactylus.
- Bacterial diseases of fish : Cotton wool disease, tail and fin rot, dropsy, furunculosis.
- Viral diseases : Lymphocystis, pox disease

Unit – 4

- Application of molecular biology in parasitic diseases
- Biochemical and molecular mechanism of drug resistance in protozoan parasites
- Drug target identifications in protozoan parasites

Unit -5

- Components of immune system
- Innate and adaptive immunity to infection
- Structure and function of antigen and antibody
- Complement system

Suggested books

- Introduction to parasitology: J.D Smith
- Parasitology – T.C.Cheng
- Biology of parasites – E.J.W.Soulsbey
- Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)
- Januway et.al. ,Immunobiology- the immune system in health and diseases, Garland publishing U.S.A.

M.Sc.4TH Semester
Special Paper Practical ZOY – 1015(Applied Zoology)

- Insect collection and preservation for systematic studies.
- Identification of insects.
- Field studies of insects to understand their habit, habitat environment impact.
- Beneficial and harmful activities etc.
- Study of beneficial insects, benefits derived from them and useful products.
- Study of destructive insects, damage caused by them and damaged products.
- Study of insecticidal formulatives and insect control appliances.
- Simple experiments on insect control like C-50/LD-50, knock down and recovery.
- Effect, repellency / antifeedance tests, percentage damage tests for leaf eating.
- Study of ABO blood group.
- Study of prepared slides of protozoa , helminthes and arthropoda

MARKS DISTRIBUTION — Duration: 6 hours

• Identification of insects (5) upto orders	10
• Identification of insects (2) upto families	10
• Blood group testing	10
• Spotting	20
• Experiment on insect control	10
• Preparation of slide of parasite	05
• Record	05
• Viva voce	05
TOTAL	**75**

M.Sc.4th Semester
Special Paper - I - ZOY – 1008 (Entomology – A)
Insect Taxonomy, Ecology and Development

Unit – 1

- Classification of Apterygota with distinctive feature, economic importance and example of various orders and their sub divisions.
- Classification of Pterygota up to orders with distinguishing characters and examples.
- Classification of Exopterygota up to orders with distinguishing characters and examples.
- Classification of Endopterygota up to orders with distinguishing characters and examples.

Unit – 2

- Classification of the Dictyoptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Orthoptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Hemiptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Isoptera up to families with distinguishing characters, economic importance and examples.

Unit – 3

- Classification of the Lepidoptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Diptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Hymenoptera up to families with distinguishing characters, economic importance and examples.
- Classification of the Coleoptera up to families with distinguishing characters, economic importance and examples.

Unit – 4

- Social organization in insects (honey bees, termite, Ant etc.)
- Influence of climatic factors on insect populations.
- Adaptation of insects to their surroundings (aquatic, terrestrial and parasitic)
- Insects – host plant relationship.

Unit – 5

- Biotechnological methods for the control of pest and diseases.
- Insects as human food.
- Types of insect larvae, pupae and metamorphosis.
- Insect diapauses.

Suggested study material:

- O.W.Richards and R.G.Davies. Imms textbook of Entomology. Methuen and Co. London.
- H.H.Ross. A Textbook of Entomology, John Wiley and sons, New York.
- M.S.Mani. General Entomology.

M.Sc.4th Semester
Special Paper -II - ZOY – 1014(Entomology – B)
Applied Entomology

Unit – 1

- Structure life history, significance nature of damage and control methods of following pests of sugarcane :
  - Scirpophaga (b) Chilotracea (c) Pyrilla (d) Aleurolobus.
- Structure life history, significance nature of damage and control methods of following cotton pests :
  - Sylepta (b) Erias (c) Pectinophora (d) Dysdercus.
- Structure life history, significance nature of damage and control measures of following oil seed pests :
  - Mustard aphid (b) saw fly (c) Castor semilooper (d) linseed gall midge.
- Structure life history, significance nature of damage and control measures of following stored grain pests :
  - Sitophilus (b) Trogoderma (c) Rhizopertha (d) Tribolium (e) Bruchus (f) Sitotroga (g)Ephestia.
- Significance, life history and control measures of following general pests.
  - Grasshoppers (b) Locusts (c) Termites (d) Aphids (e) Hairy caterpillars.

Unit – 2

- Household pests (Cockroaches, Crickets, Ants, Wasps, Silverfish, Cloth with carpet beetle, furniture beetle, book lice, cigarette beetles and their control.
- Role of insect as vectors of human diseases.
- Mosquitoes as pests of public health importance and their control.
- Housefly : A human health hazard and its control.
- Live-stocks pests and their control.

Unit – 3

- Beneficial activities of insects.
- Apiculture
- Lac Culture
- Sericulture
- Types and significance of entomophagous Insects.

Unit-4

- Detailed information and classification of insecticide and their mode of action.
- Merits and demerits of chemical insecticides and development of resistance against them.
- Biological pest control.
- Different measures of insect pest control and integrated pest management.

Unit – 5

- Forest entomology and its pests and control measures.
- Forensic entomology and its importance.
- Veterinary insects and its control.
- Medical entomology.

Suggested study material:

1.O.W.Richards and R.G.Davies, Imms textbook of Entomology. Methuen and Co. London.
2.R.E.Snodgreass, Principles of insect morphology. Tata MacGraw.Hill, Bombay3.R.M.Fox and J.W.Fox, Introduction to comparative entomology. Reinhold Publ.Corp, New York.

- K.G.V. Smith, Insects and other arthropods of medical importance.
- H.H.Ross. A Textbook of Entomology, John Wiley and sons, New York.
- M.S.Mani. General Entomology.

M.Sc.4th Semester

Special Paper practical- ZOY-1015 (Entomology)

- Insect Collection and preservation for systematic studies.
- Identification of different insect up to orders.
- Identification of insect up to families of economically important orders as studied in theory course.
- Identification of insect up to species: Mosquitoes, honeybees and stored grain beetles..
- Field studies of insects to understand their habit, habitat environmental impact, beneficial and harmful activities etc.
- Study of beneficial insects, benefits derived from them and useful products.
- Study of destructive insects, damage caused by them and damaged products.
- Study of insecticidal formulatives and insect control appliances.
- Simple experiments on insect control like LC-50, knock down and recovery effect, repellency / antifeedance tests, percentage damage tests for leaf eating insects, and stored grain pests.

Scheme of Examination — Duration : 6 Hours

• Identification of insects (10) upto orders	10
• Identification of insects (5) upto families	10
• Identification of insects of special upto species	10
• Spotting related to applied entomology	10
• Experiment on insect control	10
• Viva-voce	05
• Record/collection	05
• Seminar / Excursion/Field Trip	15
Total	**75**