Maa Pateswari University, Balrampur

B.Sc. Syllabus Structure CBCS (NEP)

Subject: Zoology

Maa Pateswari University, Balrampur

Syllabus Developed/Proposed by				
S.*No.*	**Name of Expert/BOS Member**	**Designation**	**Department**	**College/ University**
1.	Prof. Ashok Kumar	Convener	Department of Zoology	M.L.K PG College, Balrampur
2.	Dr. Sadguru Prakash	Member	Department of Zoology	M.L.K PG College, Balrampur
3.	Dr. Abhinav Singh	Member	Department of Zoology	AND Kisan P.G. College, Babhnan, Gonda
4.	Shri Shishir Tripathi	Member	Department of Zoology	L.B.S.PG College Gonda
5.	Prof. Vinay Kumar Singh	Member	Department of Zoology	D.D. U Gorakhpur University
6	Dr. Ashutosh Srivastava	Member	Department of Zoology	Siddharth University, Kapilvastu, Siddharth Nagar
7	Prof. Arvind Kumar Sharma	Member	Department of Zoology	K.S. Saket P.G. College, Ayodhya
	Invited Member			
1	Prof. Mukul Sinha	Retd. Professor and Expert	Department of Zoology	L.B.S.PG College Gonda

Maa Pateswari University, Balrampur

B.Sc. Syllabus Structure CBC

Subject: Zoology

Year	Course Code	Paper Title	Theory/Practical (Marks)	Credits
1.		**Semester-I**		
	B050101T	Cytology, Genetics and Immunology	100 (75 + 25)	4
	B050102P	Cell Biology and Cytogenetics Lab	100	2
		Semester-II		
	B050201T	Biochemistry and Physiology	100 (75 + 25)	4
	B050202P	Physiological, Biochemical & Haematology Lab	100	2
Exit 1: Certificate in Medical Diagnostics & Public Health				
2.		**Semester-III**		
	B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	100 (75 + 25)	4
	B050302P	Bioinstrumentation & Molecular Biology Lab	100	2
		Semester-IV		
	B050401T	Gene Technology and Human Welfare	100 (75 + 25)	4
	B050402P	Genetic Engineering Lab, Genetic Counselling & Telemedicine	100	2
Exit 2: Diploma in Molecular Diagnostics and Genetic Counselling				
3.		**Semester-V**		
	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	100 (75 + 25)	4
	B050502T	Diversity of Chordates and Comparative Anatomy	100 (75 + 25)	4
	B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	100	2
		Semester-VI		
	B050601T	Evolutionary and Developmental Biology	100 (75 + 25)	4
	B050602T	Ecology, Ethology, Environmental Science and Wildlife	100 (75 + 25)	4
	B050603P	Lab on Ecology, Environmental Science, Behavioural Ecology, & Wildlife	100	2
Exit 3: Degree in Bachelor of Science				
4.		**Semester-VII**		
	B050701T	Non-Chordata	100 (75 + 25)	4
	B050702T	Biostatistics And Computational Biology	100 (75 + 25)	4
	B050703T	Genetics and Cytogenetics	100 (75 + 25)	4
	B050704T	Biochemistry	100 (75 + 25)	4
	B050705P	Zoology Practical	100	4
		Semester-VIII		
	B050801T	Non-Chordata	100 (75 + 25)	4
	B050802T	Biostatistics And Computational Biology	100 (75 + 25)	4
	B050803T	Genetics and Cytogenetics	100 (75 + 25)	4
	B050804T	Ecological Principles	100 (75 + 25)	4
	B050805P	Zoology Practical	100	4
Exit 4: 4 Year B.Sc (Honours)				

Maa Pateswari University, Balrampur

Subject: Zoology

Subject prerequisite

To study Zoology as an 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 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 the 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 Year Programme Specific Outcomes (PSOs)

PSO1	This course introduces Systems Biology and various functional components of an organism. Emphasis will be on the physiological understanding of abnormalities and anomalies associated with white blood cells and red blood cells. The course emphasises cell identification, cell differentiation, and evaluation of cell morphology procedures. This will enhance haematology analytical skills, along with the skill of using various 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 techniques like microscopy, centrifugation and chromatography, and various biochemical techniques, which will help them in getting employment in pathology labs and contribute to the 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 year 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 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 analyse 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 to existing software effectively to extract information from large databases and to use this information in computer modelling.
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.**

B.Sc III year 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 wellbeing 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 Master's (2-year program) in Zoology and Allied subjects.**

Degree in Bachelor of Science (Apprenticeship/ internship embedded)	
B.Sc IV year Programme Specific Outcomes (PSOs)	
PSO1	The Degree courses will enable students to go for on-the-job training in the chosen area
PSO 2	This program will make the student industry-ready and earn while learn.
PSO 3	The degree course will enable students to learn new skill sets from the real world of academia, industry, administration, etc
PSO 4	**This program aims to equip students with soft skills as well as technical skills required in a real setup.**
PSO5	**The Degree courses will enable students to go for higher studies like Master's (1-year program) or Ph.D in Zoology and Allied subjects.**
4 Year B.Sc (Honours)	
B.Sc IV year Programme Specific Outcomes (PSOs)	
PSO1	After completing the program, students will be able to understand the origin, diversity and variations in various phyla of the animal kingdom
PSO 2	After completing the program, students will be able to analyse their biological data by choosing appropriate statistical and bioinformatic tools.
PSO 3	After completing the program, students will be able to understand and compare the physiology of organisms belonging to different phyla of the chordates
PSO 4	After completing the program, students will be able to explain the metabolism of various biomolecules/nutrients in the body

PSO 5	After completing the program, students will be able to understand the basic concepts in developmental biology, genetics, cytogenetics and animal taxonomy.
PSO 6	After completing the program, students will be able to understand environmental science, ecological concepts, the importance of wildlife and the economic aspects of animal rearing.
PSO 7	**The Degree courses will enable students to go for higher studies like Master's (1 years program) or Ph.D in Zoology and Allied subjects.**

Maa Pateswari University, Balrampur

Year: First	Semester: First	Credits: 4
Subject: ZOOLOGY		
Course Code: B050101T	**Course Title: Cytology, Genetics and Immunology**	
Course outcomes: • Understand the structure and function of cell organelles • Know the structure and location of chromatin • Comprehend cell division and its role in growth and reproduction • Learn how cells communicate with neighbouring cells • Grasp basic genetic principles and inheritance patterns • Understand laws of inheritance and their deviations • Analyse environmental interactions with genes • Detect chromosomal aberrations in humans • Study inheritance patterns through pedigree analysis • Gain in-depth knowledge of the immune system and its mechanisms		
Credits: 4	**Core: Compulsory** **Course Code : BZ050101T**	
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/Teaching Hours (60)
I	**Structure and Function of Cell Organelles I** • Plasma membrane: chemical structure—lipids and proteins, fraction freeze model plasma membrane • Cell-cell interaction: Cellular Junctions • Endomembrane system: endocytosis, exocytosis • Introduction to National Zoologists and their contribution to Life Sciences • Introduction to Sushruta, Charaka, Varahamihira, and Vaghata, as per the Indian Knowledge System.	6
II	**Structure and Function of Cell Organelles II** • Cytoskeleton: microtubules, microfilaments, intermediate filaments • Mitochondria: Structure and overview of ATP synthesis • Peroxisome and ribosome: structure and function	6
III	**Nucleus and Chromatin Structure** • Structure and function of the nucleus in eukaryotes • Types of DNA and RNA • Chromatin organisation and structure of the chromosome	8

IV	**Cell Cycle and Cell Division** • Cell division: mitosis and meiosis • Cell cycle and its regulation • GPCR and Role of Second Messenger (cAMP)	8
V	**Mendelism and Sex Determination** • Basic principles of heredity: Mendel's, monohybrid and dihybrid crosses, Test cross, Back cross • Complete and Incomplete Dominance • Sex-Determination • Sex-linked inheritance	8
VI	**Extensions of Mendelism, Genes and Environment** • Extensions of Mendelism: Multiple Alleles • Cytoplasmic Inheritance, Genetic Maternal Effects • Interaction Between Genes and Environment: Environmental Effects on Gene Expression, Inheritance of Continuous Characteristics	8
VII	**Human Chromosomes and Patterns of Inheritance** • Basics of human karyotype • Chromosomal numerical aberrations with examples • Pedigree analysis • Patterns of inheritance: autosomal dominant, autosomal recessive, X-linked recessive, X-linked dominant	8
VIII	**Immune System and Its Components** • Structure and functions of different classes of immunoglobulins • Hypersensitivity • Immune system: innate and adaptive immunity, clonal selection • Humoral immunity and cell-mediated immunity • Vaccine: Types of vaccine	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 Kuby Immunology. W H Freeman (2007).		
Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/Research Orientation / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		

Maa Pateswari University, Balrampur

Year: First	Semester: First	Credits: 2
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 principles of life, how a cell divides, leading to the growth of an organism and also reproduces to form new organisms. 4. The chromosomal aberrations are identified 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/Teaching Hours(60)
1	1. To study buccal epithelial cells using Methylene blue. 2. To study the different stages of mitosis in the root tip of the onion. 3. To study the different stages of meiosis 4. To prepare molecular models of nucleotides, amino acids, and dipeptides using the bead and stick method. 5. To check the permeability of cells using a salt solution of different concentrations.	6
II	1. To study different mammalian blood cell types using the Leishman stain. 2. Determination of ABO Blood Group 3. Enumeration of red blood cells and white blood cells using a haemocytometer	6
III	1. Preparation of polytene chromosomes. 2. Study of sex chromatin (Barr bodies) in buccal smear and hair bud cells (Human). 3. Study the chromosomal aberrations with respect to number, translocation, deletion, etc., from the pictures provided. 4. To prepare family pedigrees.	8
IV	• Virtual Labs • https://www.vlab.co.in • https://zoologysan.blogspot.co • m www.vlab.iitb.ac.in/vlab • www.onlinelabs.in	8

	• www.powershow.com • https://vlab.amrita.edu • https://sites.dartmouth.edu	

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 Kuby Immunology. W H Freeman (2007).

Suggested Continuous Evaluation Methods:
Total Marks: 25
House Examination/Test: 10 Marks
Written Assignment/Presentation / Term Papers/Seminar: 10 Marks
Class performance/Participation: 5 Marks

Maa Pateswari University, Balrampur

Year: First	Semester: Second	Credits: 4
Subject: ZOOLOGY		
Course Code: B050201T	**Course Title: Biochemistry and Physiology**	
Course outcomes: • The student, upon completion of the course, will learn: • To develop a deep understanding of the structure of biomolecules like proteins, lipids and carbohydrates • How simple molecules together form complex macromolecules. • To understand the thermodynamics of enzyme-catalysed reactions. • Mechanisms of energy production at the 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 the 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/Teaching Hours (60)**
1	**Structure and Function of Biomolecules** • Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, and Polysaccharides • Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids) • Proteins: Structure and classification of α-amino acids; Levels of organisation in proteins	8
II	**Enzyme Action and Regulation** • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action • Isozymes and Allosteric Enzymes • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition	8
III	**Metabolism of Carbohydrates and Lipids** • Metabolism of Carbohydrates: glycolysis, Pyruvate carboxylation, Citric acid cycle • Lipid metabolism: β-oxidation of fatty acid	8
IV	**Metabolism of Proteins and Nucleotides** • Catabolism of amino acids: Transamination, Deamination, Urea cycle • Nucleotide metabolism	6
V	**Digestion and Respiration** • Structural organisation and functions of the	7

	gastrointestinal tract and associated glands • Mechanical and chemical digestion of food; Absorption of carbohydrates, lipids, proteins; Structure of trachea and lung • Mechanism of respiration, Pulmonary ventilation; Transport of oxygen and carbon dioxide through haemoglobin and plasma	
VI	**Circulation and Excretion** • Components of blood and their functions • Haemostasis: Blood clotting system, Blood groups: Rh factor, ABO and MN • Structure of the mammalian heart • Cardiac cycle; Electrocardiogram, Blood pressure and its regulation, Frank-Starling Law of the heart, • Structure of the kidney and its functional unit; Urine formation, ornithine cycle	8
VII	**Nervous System and Endocrinology** • Structure of the neuron and nerve conduction • Synaptic transmission • Location of Endocrine glands and their hormones • Classification of hormones and their action	8
VIII	**Muscular System** • Types of muscle; Ultrastructure of skeletal muscle • Molecular and chemical basis of muscle contraction	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. 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).		
Total Marks: 25 House Examination/Test: 10 Marks Written Assignment/Presentation/ Research Orientation/ Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		

Maa Pateswari University, Balrampur

Year: First	Semester: Second	Credits: 2
Subject: ZOOLOGY		
Course Code: B050202P	**Course Title: Physiological, Biochemical & Haematology Lab**	
Course outcomes: • The student, upon completion of the course, will be able to: • Understand the structure of biomolecules like proteins, lipids and carbohydrates • Perform basic haematological laboratory testing, • Distinguish normal and abnormal haematological laboratory findings to predict the diagnosis of haematological 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: 4-0-0		

Unit	Topics	Total No. of Lectures/Teaching Hours (60)
1	• Estimation of haemoglobin using Sahli's haemoglobinometer • Preparation of haemin and haemochromogen crystals • Recording of blood pressure using a sphygmomanometer • Recording of blood glucose level by using a glucometer • Preparation of molecular models of amino acids, dipeptides, etc.	8
II	• Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid • Recording of simple muscle twitch with electrical stimulation (or Virtual) • Demonstration of the unconditioned reflex action (Deep tendon reflex, such as the knee jerk reflex)	8
III	• Ninhydrin test for α-amino acids. • Benedict's test for reducing sugar and iodine test for starch. • Test for sugar and acetone in urine. • Qualitative tests of functional groups in carbohydrates, proteins and lipids. • Paper chromatography of amino acids. • Action of salivary amylase under optimum conditions.	8
IV	**Virtual Labs** • https://www.vlab.co.in • https://zoologysan.blogspot.com • www.vlab.iitb.ac.in/vlab	6

	• www.onlinelabs.in • https://sites.dartmouth.edu	

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

Maa Pateswari University, Balrampur

Year: Second	**Semester: Third**	**Credits: 4**
Subject: ZOOLOGY		
Course Code: B050301T	**Course Title:** Molecular Biology, Bioinstrumentation & Biotechniques	

Course outcomes:

- The student, after 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 the central dogma, namely transcription and translation, is essential for the survival and propagation of life at the 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 times and places 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	**Topics**	**Total No. of Lectures/Teaching Hours (60)**
1	**Process of Transcription** • Fine structure of a gene • RNA polymerases • Transcription factors and machinery • Formation of the initiation complex • Initiation, elongation and termination of transcription in prokaryotes and eukaryotes	8
II	**Process of Translation** • The Genetic code • Ribosome • Factors involved in translation • Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase • Initiation, elongation and termination of translation in prokaryotes and eukaryotes	8
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 the transcriptional level, Post-transcriptional modifications: Capping, Splicing, Polyadenylation • RNA editing.	8

IV	**Regulation of Gene Expression II** • Regulation of gene expression in eukaryotes: • Regulation at the translational level, Post-translational modifications: protein folding, etc. • Intracellular protein degradation • Gene silencing, RNA interference (RNAi)	6
V	**Principles 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	7
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, thin layer, column---ion-exchange, gel filtration, HPLC, affinity	8
VII	**Spectrophotometry and Biochemical Techniques** • Colorimetry and spectrophotometry: Beer-Lambert law. absorption spectrum • Biochemical techniques: Measurement of pH. Preparation of buffers and solution • Measurement, applications and safety measures of radio-tracer techniques	8
VIII	**Molecular Techniques** • Nucleic acid fractionation, detection by electrophoresis, DNA sequencing, Polymerase Chain Reaction (PCR), primer designing, DNA fingerprinting, site-directed mutagenesis, RFLP • Molecular cloning, genomic libraries, Gene transfer techniques: electroporation, microinjection • Detection of proteins, PAGE, ELISA, Western blotting, Hybridoma technology	7

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. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & Sons (2006).

Suggested Continuous Evaluation Methods:

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

Maa Pateswari University, Balrampur

Year: Second	**Semester: Third**	**Credits: 2**
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, the 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 advanced DNA testing methods.		
Credits: 2	**Core: Compulsory**	
Max. Marks: 100	**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/Teaching Hours (60)**
1	1. To study the working principle of Simple, Compound and Binocular Microscopes 2. To study the working principle of various lab equipment, such as pH Meter, Electronic balance, vortex mixer, use of glass, and micropipettes, Laminar flow, Incubator shaker, Waterbath, Centrifuge, Chromatography apparatus, etc.	15
II	1 To prepare solutions and buffers. 2. To learn the working of Colorimeter and Spectrophotometer. 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 spectrophotometer.	15
IV	**Virtual Labs** **www.labinapp.com** **www.uwlax.edu** **www.labster.com** **www.onlinelabs.in** **www.powershow.in**	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).
5. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & Sons(2006).
6. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
7. Chatterjee C C Human Physiology Volume 1 & 2. 11th edition. CBS Publishers (2016).

Year: Second	Semester: Fourth	Credits: 4
Subject: ZOOLOGY		
Course Code: B050401T	**Course Title:** Gene Technology and Human Welfare	

Course outcomes:

The student, after 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.

Know the basics of industrial biotechnology.

Get introduced to DNA testing and the utility of genetic engineering in forensic sciences.

Get introduced to computers and the 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	Topics	Total No. of Lectures/Teaching Hours (60)
1	**Principles of Gene Manipulation** • Recombinant DNA Technology • Restriction Enzymes, DNA-modifying enzymes, Cloning, Vectors, Ligation • Gene transfer techniques, Gene therapy • Selection and identification of recombinant cells	10
II	**Applications of Genetic Engineering** • Single-cell proteins • Biosensors, Biochips • Crop and livestock improvement, • Development of a transgene • Development of DNA drugs and vaccines	8
III	**Enzyme Technology** • Microbial culture • Methods of enzyme production • Immobilization of enzymes • Applications, antibiotics	6
IV	**DNA Diagnostics** • Genetic analysis of human diseases, detection of known • and unknown mutations • DNA fingerprinting • Concept of pharmacogenomics and pharmacogenetics	6

	• Personalized medicine-optimizing drug therapy	
V	**Biostatistics I** • Calculations of mean, median, mode, varíance, standard deviation • Concepts of coefficient of variation, Skewness, Kurtosis, • Elementary idea of probability and application	8
VI	**Biostatistics II** • Data summarizing: frequency distribution, graphical presentation-bar, pie diagram, histogram • Tests of significance: one and two-sample tests, t-test and the 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	7
VIII	**Bioinformatics 8** • 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 & Analysis of Genes & Genomes. Jones & Bartlett (1998). 3. Sambrook 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).

Suggested Continuous Evaluation Methods:

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

Year: Second	Semester: Fourth	Credits: 2
Subject: ZOOLOGY		
Course Code: B050402P	**Course Title:** Genetic Engineering Lab, Genetic Counselling & Telemedicine	
Course outcomes: Upon completing the course, students will understand genetic engineering principles through hands-on mutation detection and infectious disease testing. They will gain knowledge of DNA testing and forensic applications. Students will apply biology, computer science, and math concepts using software for data analysis and modeling. They will use bioinformatics tools to explore evolutionary relationships and will be prepared for employment in diagnostics, forensics, counseling, or pursue research in biological sciences.		
Credits: 2	**Core: Compulsory**	
Max. Marks: 100	**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/Teaching Hours (60)
1	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. To perform bacterial culture and calculate the generation time of bacteria. 2. To study Restriction enzyme digestion using teaching kits. 3. To study Polymerase Chain Reaction (PCR) using teaching kits. 4. Demonstration of agarose gel electrophoresis for the detection of DNA. 5. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for the detection of proteins. 6. To calculate the 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
IV	**Virtual Labs** https://www.ncbi.nlm.nih.gov/tools/primer-blast/	15

	http://bioinfo.ut.ee/primer3/ **http://evolution.genetics.washington.edu/phylip.html** **https://www.ebi.ac.uk/Tools/msa/clustalo/** **https://www.ncbi.nlm.nih.gov/BLAST/tutorial/**	
	Suggested Readings: 1. Primrose & Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003). 2. Hartl & Jones. Genetics: Principles & Analysis of Genes & Genomes. Jones & Bartlett (1998). 3. Sambrook et al.Molecular Cloning Vols I, II, III. CSHL (2001). **4.** Primrose. Molecular Biotechnology. Panima (2001).	

Year: Third	**Semester: Fifth**	**Credits: 4**
Subject: ZOOLOGY		
Course Code: B050501T	**Course Title:** Diversity of Non-Chordates, Parasitology and Economic Zoology	
Course outcomes: The student, after the course, will be able to: The student, after the course, will be able to: demonstrate comprehensive identification abilities of non-chordate diversity, explain the structural and functional diversity of non-chordate explain the evolutionary relationship amongst non-chordate groups Get employment in different applied sectors Students can start their own business, i.e. self self-employment. 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	**Topics**	**Total No. of Lectures/Teaching Hours (60)**
1	**Protozoa to Coelenterata** • Protozoa - Euglena, Monocystis and Paramecium. • Porifera - Sycon Coelenterata - Obelia and Aurelia	7
II	**Ctenophora to Nemathelminthes** • Ctenophora - Salient features Platyhelminthes - Fasciola (Liver fluke) and Taenia (Tape worm) • Nemathelminthes - Ancylostoma (Hookworm)	7
III	**Annelida to Arthropoda** • Annelida - Nereis and Hirudinaria (Leech) • Arthropoda - Palaemon (Prawn) & Schistocerca(Locust)	8
IV	**Mollusca to Hemichordata** • Mollusca - Lamellidens (Fresh water mussel) and Pila • Echinodermata -Pentaceros (excluding development)	8
V	**Parasitology** Structure, life cycle, pathogenicity, including diseases, causes, Symptoms and control of the following parasites of domestic animals and humans: I. Trypanosoma, II. Giardia and III. Wuchereria	8
VI	**Vectors and pests** • Life cycle and their control of the following pests:	8

	Gundhi bug, Sugarcane leafhopper, Rodents. Termites and Mosquitoes, and their control	
VII	**Economic Zoology-1** • Animal breeding and culture: Aquaculture, Pisciculture, Poultry	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)
3. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press) 5. Brusca and Brusca (2016). Invertebrates. Sinauer
4. Nielsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford 8. Parasitology- Chatterjee
5. Jhingran. V.G. Fish and fisheries in India.,
6. Khanna. S.S., An introduction to fishes
7. Boyd. C.E. & Tucker, C.S., Pond aquaculture water quality management,

Suggested Continuous Evaluation Methods:

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

Maa Pateswari University, Balrampur

Year: Third	Semester: Fifth	Credits: 4
Subject: ZOOLOGY		
Course Code: B050502T	**Course Title:** Diversity of Chordates and Comparative Anatomy	
Course outcomes: After completing the course, the student will be able to: • Accurately recognize and classify the wide range of chordate species. • Describe the various structural features and functional adaptations found in chordates. • Illustrate the evolutionary connections and lineage among different chordate groups. • Pursue further studies or research in the field of 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	Topics	Total No. of Lectures/Teaching Hours (60)
1	• **Origin of Chordates & Hemichordata** Origin of Chordates. Classification of Phylum Chordata up to the Order. • **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). • 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 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 the kidney, Evolution of urinogenital ducts, Types of mammalian uteri	8
VIII	**Nervous System** • Comparative account of the 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. McFarland et al: Vertebrate Life(1979, Macmillan Publishing)
5. Parker and Haswell: Textbook of Zoology, Vol. II (1978, ELBS)
6. Romer and Parsons: The Vertebrate Body (6th ed, 1986, CBS Publishing Japan)
7. Young: The Life of vertebrates (3rd ed, 2006, ELBS/Oxford)
8. Weichert C.K, and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw-Hill

Suggested Continuous Evaluation Methods:

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

Maa Pateswari University, Balrampur

Year: Third	Semester: Fifth	Credits: 2
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-chordate diversity
- Explain the structural and functional diversity of chordates and non-chordates
- Explain the evolutionary relationship among chordates and non-chordates
- Generate self-employment
- Enable students to take up research in biological sciences.

Credits: 2	**Core: Compulsory**
Max. Marks: 100	**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/Teaching Hours (60)
1	Study of animal specimens of various animal phyla. 1. To prepare a permanent stained slide of the septal nephridia of the earthworm. 2. To take out the nerve ring of the earthworm. 3. To take out the hastate plate from Palaemon.	15
II	1. Study of animal specimens of various animal phyla 2. Study on the use and ethical handling of model organisms (Mice, rats, rabbits and pigs). 3. To prepare a stained/unstained slide of placoid scales. 4. Comparative study of bones of different vertebrates. 5. 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), freshwater 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 aquatid insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of the antenna of the housefly.	15

	6. Identification of pests. 7. Life history of silkworm, honeybee and lac insect. 8. Different types of important edible fish of India. 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; study of ommatidium of cockroach eye 14. Wallago: Afferent and efferent branchial vessels, Cranial nerves, Weberian ossicles.	
IV	**Virtual Labs** Virtual Labs 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	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. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS) 6. Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)	

Year: Third	Semester: Sixth	Credits: 4
Subject: ZOOLOGY		
Course Code: B050601T	**Course Title:** Evolutionary and Developmental Biology	

Course outcomes:

The student, after the course, will be able to:

- Understand that biological evolution refers to the process by which organisms today differ from those in the past.
- Recognise natural selection as one of the evolutionary processes, though it can also promote stability.
- Grasp how a fertilised single cell develops into an embryo and eventually a full adult organism.
- Integrate knowledge from genetics, molecular biology, biochemistry, cell biology, anatomy, and physiology in embryonic development.
- Understand the various processes that contribute to an organism's diverse shapes, sizes, and structural features.
- Comprehend how a cell responds to internal or external signals, and the scientific methods used in experimental life 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	Topics	Total No. of Lectures/Teaching Hours (60)
1	**Theories of Evolution** • Origin of Life • Historical review of the evolutionary concept: Lamarckism, Darwinism (Natural, Sexual, and Artificial 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 Evidence of Evolution** • Types of fossils, Incompleteness of fossil record, • Dating of fossils, Phylogeny of the horse	7
IV	**Species Concept and Extinction**	7

	• Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric) • Mass extinction (Causes, Names of five major extinctions	
V	**Gamete Fertilisation and Early Development** • Gametogenesis, Fertilisation • 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 the eye, kidney, and limb • Metamorphosis: the hormonal reactivation of • development in amphibians, insects • Regeneration: salamander limbs, mammalian liver, • Hydras • Ageing: the biology of senescence	8

Suggested Readings:

- Ridley, M. (2004). Evolution. Ill Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution.
- Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). Evalution. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings.
- Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.), Wiley-Blackwell. (2012).
- Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).

Suggested Continuous Evaluation Methods:

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

Year: Third	Semester: Sixth	**Credits: 4**
Subject: ZOOLOGY		
Course Code: B050602T	**Course Title:** Ecology, Ethology, Environmental Science and Wildlife	
Course outcomes: After completing the course, the student will be able to: • Understand environmental systems, global ecological issues, and their solutions. • Analyse animal behaviour, including its immediate and evolutionary causes. • Explore biological timing systems at molecular, cellular, and systemic levels. • Interpret how species adapt their activities across time and seasons. • Recognise the impact of biological rhythms on lifestyle disorders and the need for 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	**Topics**	**Total No. of Lectures/Teaching Hours (60)**
1	**Introduction to Ecology** • History of ecology, Autecology and synecology, • Levels of organisation, 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 the 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	7

	• Acid rain, Ozone layer destruction	
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 the 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 Wildlife** Values of wildlife - 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 the Tiger reserve	8

Suggested Readings:

1. Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall.
2. Ecological Modelling. 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. Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.
5. Fundamental Processes in Ecology: An Earth System Approach. 2007. Wilkinson, D.M., Oxford University Press, UK.

Suggested Continuous Evaluation Methods:

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

Maa Pateswari University, Balrampur

Year: Third	**Semester: Sixth** **Credits: 2**	
Subject: ZOOLOGY		
Course Code: B050603P	**Course Title:** Lab on Ecology, Environmental Science, Behavioural Ecology, & Wildlife	
Course outcomes: The student, after the course, will be able to: • The student, after the course, will be able to: • To understand the basic concepts, importance, status and interaction between organisms and the environment. • Get employment in forest services, sanctuaries, conservatories, etc. • Enable students to take up research in wildlife.		
Credits: 2	**Core: Compulsory**	
Max. Marks: 100	**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/Teaching Hours (60)**
1	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/Wildlife sanctuary	4
III	1. Demonstration of basic equipment needed in wildlife studies, use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses) 2. Familiarisation and study of animal evidence in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nests, antlers, etc. 3. Demonstration of different field techniques for flora and fauna: fauna, Haematopinus (cattle louse), freshwater 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 aquatid insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of the antenna of the housefly. 6. Identification of pests. 7. Life history of silkworm, honeybee and lac insect.	15

	8. Different types of important edible fish of India. 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** Virtual Labs 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 Hawksworth, Springer publication.	15
	Suggested Continuous Evaluation Methods: House Examination/Test: 10 Marks Written Assignment/Presentation/Project/ Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks	

Maa Pateswari University, Balrampur

BSc IVth Year: VIIth & VIIIth Semester Syllabus Structure CBCS (NEP)
Subject: Zoology

4th Year		**Semester-VII**		
	B050701T	Non-Chordata	100 (75 + 25)	4
	B050702T	Biostatistics And Computational Biology	100 (75 + 25)	4
	B050703T	Comparative Animal Physiology	100 (75 + 25)	4
	B050704T	Biochemistry	100 (75 + 25)	4
	B050705P	Zoology Practical	100	4
		Semester-VIII		
	B050801T	Chordata	100 (75 + 25)	4
	B050802T	Developmental Biology	100 (75 + 25)	4
	B050803T	Genetics and Cytogenetics	100 (75 + 25)	4
	B050804T	Ecological Principles	100 (75 + 25)	4
	B050805P	Zoology Practical	100	4

Maa Pateswari University, Balrampur

BSc IVth Year: VIIth Semester Paper I NON-CHORDATA

Course Code: B050701T	**Marks: 25+75 Credits: 4**	**Core Paper**
Total no. of Lectures (in hours per week) - 4	**Course Title: Non-Chordata**	

Course objectives

- To create in the student an appreciation of non-chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student an understanding of the evolutionary relationship amongst non-chordate groups

Unit	Topics	No. of Lectures
I	Protozoa - Organization, osmoregulation, locomotion, nutrition and reproduction Porifera - Organisation and affinities Cnidaria - Origin of metazoa, polymorphism, coral reefs	15
II	Helminthes - General organisation and larval forms of trematodes and cestodes, parasitic adaptation Annelida -Adaptive radiation in polychaeta, segmental organs	15
III	Arthropoda -Larval forms in Crustacea, respiratory organs in Arthropods, mouthparts and modes of feeding in insects, economic importance of arthropods	15
IV	Mollusca-Modifications in the foot, nervous system and torsion in gastropods Echinodermata -Water vascular system, larval forms and their affinities Minor Phyla - Organisation and affinities of Rotifera, Ctenophora and Sipunculoidea	15

Student learning outcomes

The student, upon completion of the course, will be able to:

• Structural and functional diversity of non-chordate.
• Explain evolutionary relationship and larval forms amongst non-chordate groups.

Suggested Literature:

1. A life of invertebrates by W.D. Russel-Hunter, MacMillan Publishing Co., inc., New York.
2. Advances in invertebrates' reproduction by K.G. Adiyodi and R.G. Adiyodi, Peralam Kenoth Kerivellur, Kerala.
3. Biology of the invertebrates by Jan Pechenik, William C. Brown Publishers, Dubuque, Iowa.
4. Invertebrate Zoology by A. Kaestner, Interscience Publishers.
5. Invertebrates zoology by Alfred Kaestner, H.W.Levi & L.R. Levi, John Wiley & Sons Inc.
6. Invertebrates (Protozoa to Echinodermata) by Ashok Verma, Narosa Publishing House, New Delhi.
7. Invertebrates Learning by W.C. Corning and J.A.Dayal.

Maa Pateswari University, Balrampur

BSc IVth Year: VIIth Semester

Paper II BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

Course Code: B050702T	**Marks: 25+75** **Credits: 4**	**Core Paper**
Total no. of Lectures (in hours per week) - 4	**Course Title:** Biostatıstics and Computational Biology	

Course objectives

The course is designed so that students will learn:

- Representation of data in the form of a Table and a Graph
- Statistical Analysis
- Basics of Computers and Bioinformatics

Unit	**Topics**	**No. of Lectures**
I	Tabulation and graphical representation of the data: frequency distribution, tabulation, bar diagram, histogram, pie diagram and their significance, measure of central tendencies and variation in data, principle of probability, Probit log analysis	15
II	Test of Significance: t-test, analysis of variance, f-test, null hypothesis and chi-square test; distribution. normal, binomial and Poisson, correlation and regression ,	15
III	Basic components of computer hardware (CPU, input, output, storage device) and software (operating system); MS Excel: use of worksheet to enter, edit, copy, move data, Use of input statistical function for computation of mean, S.D., Correlation, Regression coefficient and graphical presentation	15
IV	Introduction to bioinformatics: Database: Nucleotide sequence database (Gene Bank, UCSC, EMBL, DDBJ) and protein sequence database (Swiss Prot, PDB, Blast, Ps1-Blast), FASTA, sequence alignment: pairwise and multiple sequence alignment	15

Student learning outcomes

Introduction to basic components of computers, Software (operating systems) and application software used in biological and statistical studies.

An overview of databank search, data mining, data management and interpretation.

An introduction and learning of Probit Log Analysis for the interpretation of toxicity data.

Books recommended :

1. P N Arora and P.K Malhan. Biostatics, Himalaya publishing house
2. Pagano M. Gauvreau, K (2000). Principles of Biostatistics, Duxbury press, USA
3. I A Khan and A Khanam, Fundamental of Biostatics, Ukaaz publıcation, Hyderabad
4. Batschelet, E., Introduction to mathematics for life scientists. Springer-Verlag, Berling.
5. Jorgensen, S.E., Fundamentals of ecological modeling, Elsevier, New York.

6. Swartzman, G.L., and S.P.O. Kaluzny, Ecological simulation primer, Mac mıllan, New York.

Maa Pateswari University, Balrampur

BSc IVth Year: VIIth Semester Paper III Comparative Animal Physiology

Course Code: B050703T	**Marks: 25+75** **Credits: 4**	**Core Paper**
Total no. of Lectures (in hours per week) - 4	**Course Title:** Comparative Animal Physiology	

Course objectives

To develop in the student an understanding of:

- Functioning of the organism's body
- The various homeostatic systems of the body
- Regulation of function in the body

Unit	**Topics**	**No. of Lectures**
I	• Digestion - Digestion and absorption of carbohydrates, proteins, lipids and nucleic acids • Excretion - Structure of the nephron, urine formation and its regulation • Acid-base balance and homeostasis • Thermoregulatory mechanism	15
II	• Respiration - Gaseous exchange through the respiratory membrane, respiratory pigments, respiratory adaptation to low oxygen tension, the mechanism and regulation of respiration • Circulation - Blood, lymph - composition. regulation of circulation: cardiac cycle	15
III	• Muscular System - Types and ultrastructure of muscle fibres, mechanism of muscular contraction, muscle twitch, summation, tetanus and fatigue	15
IV	• Nervous System - Structure and Functions of neurons, mechanism of conduction and transmission of nerve impulses, mechanism of synaptic transmission • Major endocrine glands, their secretion and functions (pituitary, thyroid, parathyroid, adrenal)	15

Student learning outcomes

The student, upon completion of the course, will be able to

- Understand various functional components of an organism's body
- Analyse the complexities and interconnectedness of these functional components
- Identify the mechanism underlying the maintenance of homeostasis of the body.
- Understand the regulatory mechanisms for maintenance of function in the body

Books recommended :

- Chatterjee C.C. (2016) Human Physiology Volume 1 & 2. 11th edition. CBS Publishers
- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company
- Tortora, G.J. & Grabowskı, S. (2006). Principles of Anatomy & Physiology. XI Edition John

Maa Pateswari University, Balrampur

BSc IVth Year: VIIth Semester Paper IV BIOCHEMISTRY

Course Code: B050704T	**Marks: 25+75** **Credits: 4**	**Core Paper**
Total no. of Lectures (in hours per week) - 4	**Course Title:** Biochemistry	

Course objectives

To develop in the student an understanding of:

- an understanding of the biochemical basis of life
- role of stabilizıng interaction and biomolecular complexity
- biochemical processes as the foundation of all physiologıcal events occurring in anımals

Unit	**Topics**	**No. of Lectures**
I	• Thermodynamics -- Elementary thermodynamic system, second law and its applications, concept and calculation of free energy change during biologıcal redox reactions. Electrolytes - Concepts of Buffers, Henderson-Hasselbach Equation	15
II	• Carbohydrates- Glycolysis, Krebs' cycle, oxidative phosphorylation, gluconeogenesis, glycogenesis, glycogenolysis, hexose monophosphate pathway	15
III	• Amino Acids -Biosynthesis of amino acids (Phenylalanine, tryptophan and aspartate, and proline) • Proteins -Organisation and structure of proteins (a-helix, ß-sheet, motifs, folds, domains), Ramachandran plot	15
IV	• Lipid - Structure, classification and beta oxidation • Nucleic Acids - Structure, types and biosynthesis of nucleotides • Enzymes - Kinetics; inhibition; mechanism of action; Michaelis and Menton Equation; Isozyme: allosteric enzymes, ribozymes • Vitamins and coenzymes - Structure and functions	15

Student learning outcomes

The student, upon completion of the course, will be able to

- Understand various functional components of an organism's body
- Analyse the complexities and interconnectedness of these functional components
- Identify the mechanism underlying the maintenance of homeostasis of the body.
- Understand the regulatory mechanisms for the maintenance of function in the body
- In addition, the application of Biochemistry in understanding disease and medicine will be apprised

Books recommended :

- Berg et al. Biochemistry (5th Ed.), Freeman, 2001
- Davıd L. Nelson and Michael M. Cox. Lehninger Principles of Biochemistry (8rd Ed.), W.H. Freeman & Co Ltd; 2021
- Mathews et al.: Biochemistry (3rd Ed.), Benjamin/Cummings Publishing, 1990
- Watson et al: Molecular Biology of the Gene (2nd Ed.), Benjamin/Cummings, 1976
- Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995 7. Rawn: Biochemistry, Neil Patterson, 1989
- Primrose et al: Principles of gene manipulation (6th Ed.), Blackwell Scientific, 2001
- 11. Harpur's Illustrated Biochemistry McGraw-Hill (Ed 2018)

BSc IVth Year: VIIth Semester : ZOOLOGY Practical Syllabus CREDIT: 4	
B050705P	
Distribution of Marks:	**Time: 6 hours**
Exercise	**Marks**
Physiology Exercise	20
Biochemistry Exercise	20
Biostatistics and Computer Exercise	10
Slide preparation	06
Spotting (12 spots)	24
Viva voce	10
Class record	10
Total Marks	**100**

Non-Chordata

General characters and classification of the non-chordate phyla (Protozoa to Echinodermata) with the help of museum specimens and slides.

1. **Protozoa**: Vital staining and staining preparation of Paramecium; Study of cyclosis and trichocysts in Paramecium; Permanent preparation of Ceratium, Noctiluca, Paramecium, Vorticella.
   Study of prepared slides: Balantidıum, Nyctotherus, Opalına, Paramecium - conjugation/bınary fission. Entamoeba histolytica, Entamoeba coli, Entamoeba gingivalis, Monocystis, Giardia, Trypanosoma, Leishmania, Trichomonas, Trichonympha, Plasmodium.
2. **Porifera:** Permanent preparation of gemmules and different kinds of spicules
   Study of museum specimens/models; Lecuosolania, Sycon, Grantia, Euplectella, Hyalonema, Oscarella, Chondrilla, Chliona, Chalina, Spongilla, Spongia, Hippospongia.
3. **Cnidaria and Ctenophora:** Study of nematocysts of Hydra, Permanent preparation of Hydra; Obelia and other hydrozoan colonies and Obelia Medusa
   Study of museum specimens/ models: Tubularia, Bougainvillia, Pennaria, Hydractınia, Sertularia, Campanularia, Millepora, Stylaster, Physalia, Porpita, Valella, Aurelia, Rhizostoma. Tubipora, Alcyonium, Gorgonia, Corallium, Pennatula, Zoanthus, Metridium, Adamsıa, Cerianthus, Fungia, Madrepora, Cestum.
4. **Helminths.** Permanent preparation of selected soil and plant nematodes, cestode and trematode parasites of cattle and poultry and different larval stages of liver fluke,
   Study of museum specimens/ whole mounts: Dugesia, Polystoma, Bipalium, Fasciola, Paramphistomum, Schistosoma, Taenia solium, Moniezia, Echinococcus, Trichurıs, Trichinella, Heterodera, Enterobius, Ascaris, Ancylostoma, Dracunculus, Wuchereria
   Study of prepared slides: Scolex of tapeworm, mature and gravid proglottid of tapeworm; Study of cysticercus larva, larval stage of Fasciola

5. **Annelida**: Study of museum specimens/models: Aphrodite, Tomopteris, Glycera, Chaetopterus, Arenicola, Sabella, Amphitrite, Serpula, Tubifex, Branchiobdella, Eisenia, Metaphire, Placobdella, Pontobdella, Branchellion, Polygordius,
   Study of prepared slides: T.S. of the body of a leech passing through various places.
6. **Arthropoda**. Study of museum specimens: Limulus, Palamnaeus, Lycosa, Apus, Argulus, Balanus, Sacculina. Mysıs, Gmmarus, Squilla, Prawn, Lobster, true crab, hermit crab, Julus, Scolopendra. Scutigerella, Lepısma, Mantis, stick insect, grass hopper, termites, Forficula, Pediculus, Ranatra, Dysdercus, Musca, Ladybird beetle, butterfly, wasp, Xenopsylla, life history of honey bee, lac insect and silk moth, spider
   Study of prepared slides: Mouth parts of male and female Anopheles and Culex, house fly, honey bee, butterfly, Cimex, Daphnia, Cypris, Cyclops, Pediculus,
7. **Mollusca:**study of museum specimens/models: Chiton, Dentalium, Pila, Aplysia, Dorıs, Lymnaea, Mytilus, Patella, Pecten, Limax, pearl oyster, Teredo, Nautilus, Loligo, Sepia, Octopus.
   Study of prepared slide: Radula, T.S of shell of Unio, T.S of gill lamina of Unio, T.S of body of Unio passing through middle region; Larvae of molluscs.
8. **Echinodermata:** Study of museum specimens/ models: Astropecten, Asterias, Ophiothrix, Opiura, Echinus, Clypeaster, Echınocardıum, Thyone, Holothuria, Antedon
   Study of prepared slides. Larvae of echinoderms: Aristotle's lantern
9. **Minor phyla** Representative specımens of Sipunculida (Sıpunculus)

Biostatistics and Computational Biology.

Numerical Based on: Matrices. Mean, median and mode. Mean deviation, variance, standard deviation and standard error. Representation of data: Bar diagrams, n-diagrams, Histograms, Frequency polygons, t-test, F-test, Chi-square test, ANOVA. Demonstration of PubMed in searching scientific literature using authors' names, fields, limits, etc. Demonstration of BLAST in comparing Protein Sequences. Use of Sigma Stat/Prism Software for Statistical analysis. Use of Search engines and online resources.

Physiology

1. Determination of the rate of Oxygen consumption of Albino rats/Fish
2. Study of the total count of erythrocytes and leukocytes of rats /Fish
3. Study of different leukocyte counts of rats/Fish
4. Determination of the Rh factor in human blood
5. Colourimetric estimation of haemoglobin content of the blood, colour index and mean corpuscular in rat/Fish.
6. Determination of respiratory rate of rat in relation to size and sex; Respiration rate in fish at different temperatures.

Biochemistry

1. Isolation and colorimetric determination of glycogen content of rat liver
2. Demonstration of the effect of epinephrine on the glycogen yield from the liver
3. Estimation of protein content liver of fish and rats

4. Quantitative estimation of total free amino chromatographic separation of these amino acids at acid in tissues of the cockroach and paper chromatographic separation of these amino acids.
5. Kinetic essay of salivary amylase and study of effects of time, temperature and pH. Estimation of total lipid in the fat body of the cockroach and the liver of fish and rat.

Maa Pateswari University, Balrampur

BSc IVth Year: VIIIth Semester Paper I CHORDATA		
Course Code: B050801T	**Marks: 25+75** **Credits: 4**	**Core Paper**
Total no. of Lectures (in hours per week) - 4	**Course Title:** CHORDATA	

Course objectives

To develop in the student an understanding of:

- an appreciation of chordate diversity
- an understanding of structural and functional diversity
- the understanding of the evolutionary relationship amongst chordates

Unit	Topics	No. of Lectures
I	• Origin of chordates: Pisces - ostracoderm, placoderms and Devonian fishes: general organization and affinities of holocephali, crossopterygii and dipnoi	15
II	• Origin of tetrapoda: general organisation of anura, peculiarities of urodela and apoda, neoteny in amphibia	15
III	• Origin and evolution of Reptilia: General organisation of Chelonia, Rhynchocephalia, Squamata and Crocodilia	15
IV	• Origin and Evolution of Birds: Aerodynamics in Birds: Flight Adaptations Origin and Evolution of Mammals: Characteristic Features of Monotremes, 15 Marsupials and Placentals	15

Student learning outcomes

The student upon completion of the course, will be able to.
Demonstrate comprehensive identification abilities of chordate diversity
Explain the structural and functional diversity of chordates
Explaın the evolutionary relationship amongst chordates

Books recommended :

Boolootian, R. A. and Stiles, K. A., College Zoology, 10th edition, Macmillan Publishing Co., Inc., New York, 1981.
Colbert, E H., Morales, M. and Minkoff, E. C. Colbert's Evolution of the Vertebrates. A history of the backboned animals through time, 5th edition, John Wiley & Liss, Inc., New York, 2002
Farner, D. S. and King, J. R., Avian Biology (in several volumes), Academic Press, New York, 1971.
Jordan, E. L. and Verma, P. S., Chordate Zoology. S. Chand & Company Ltd, 1998.
Kenneth V Kardong (2015). Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
Kotpal, R. L. The Birds, 4th edition, Rastogı Publications, Shivaji Road, Meerut, 1999
Marshall, A. J., Biology and Comparative Physiology of Birds, Volume I & II, 1960.

McFarland, W. N., Pough, F. H., Cade, T. J. and Heiser, J. B., Vertebrate Life, Macmillan Publishing Co., Inc., New York, 1979.
Parker, T. S. and Haswell, W. A., Textbook of Zoology, Vol. II, ELBS, 1978.
Young, J. Z. The life of vertebrates, 3rd edition, ELBS with Oxford University Press, 1981

Maa Pateswari University, Balrampur

BSc IVth Year: VIIIth Semester Paper II DEVELOPMENTAL BIOLOGY		
Course Code: B050802T	**Marks: 25+75** **Credits: 4**	**Core Paper**
Total no. of Lectures (in hours per week) - 4	**Course Title:** DEVELOPMENTAL BIOLOGY	

Course objectives

- The objective of this course is to provide insight into:
- How the single cell formed at fertilisation forms an embryo and then a fully formed adult organism.
- Integration of genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development, and
- The treatment of birth defects and infertility in humans.

Unit	Topics	No. of Lectures
I	Cellular differentiation, signalling, Potency, Induction, Competence, morphogenetic gradient, cell fate and cell lineages, Stem cells,	15
II	Structure and recognition of gametes, Sperm capacitation and acrosomal reaction, Fertilisation, Prevention of polyspermy, egg activation, Nature of Egg, Cleavage Pattern, Blastula formation, Gastrulation, Formation and fate of the germinal layers, Causes of fetal deformities	15
III	Organogenesis of vertebrate eye and heart, Evolution of viviparity in mammals, Cellular and Biochemical events in Amphibian and Insect metamorphosis.	15
IV	Determination of polarity and symmetry, Induction and Organiser concept, Regeneration of salamander limbs, morphallactic regeneration in Hydra, Transgenic animals, Ageing and cellular death	15

Student learning outcomes

The student, after the course, will be able to understand:

A variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features,

How a cell behaves in response to an autonomous determinant or an external sıgnal, and

The scientific reasoning is exhibited in experimental life science.

Books recommended :

Gilbert Developmental Biology. Sinauers, 2003.
Kalthoff: Analysis of biological development. McGraw-Hill, 1996.
Wolpert: Principles of development. Oxford, 2002. Young, J. Z. The life of vertebrates, 3rd edition, ELBS with Oxford University Press, 1981
Roger A. Pedersen, Gerald P. Schatten. Current Topics in Developmental Biology: 1998 Elsevier.
Michael J. F. Barresi, Scott F. Gilbert. Developmental Biology. 2019, Oxford University Press T. Subramaniam. Developmental Biology. (Reprint) 2013, Narosa Publishing House Pvt. Ltd., New Delhi
Werner A Müller. Developmental biology: 2012, Springer Science & Business Media. 9. Jonathan M. Balansky. An introduction to embryology by, CBS college publishing

BSc IVth Year: VIIIth Semester Paper III Genetics and Cytogenetics		
Course Code: B050803T	**Marks: 25+75** **Credits: 4**	**Core Paper**
Total no. of Lectures (in hours per week) - 4	**Course Title: Genetics and Cytogenetics**	

Course objectives

- To study the structure of genes and learn how the information contained within them gets transferred from one generation to another.
- Human genetics will impart knowledge about the human chromosome constitution that would help in applying basic principles of chromosome behaviour to the disease context.
- To create awareness of genetic diseases.

Unit	Topics	No. of Lectures
I	Mendelian Principles of Inheritance, Current status of Mendelism, Concept of gene, allele, multiple alleles, Pseudoalleles	15
II	Cytoplasmic Inheritance, Environment and heredity, lethal genes, chromosomal mapping, Extension of Mendelian principles-codominance, incomplete dominance, gene interactions, pleiotropy, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage	15
III	Euchromatin and heterochromatin, chromosomal aberration, DNA Replication, transposable elements in prokaryotes and eukaryotes	15
IV	Bacterial transformation, transduction, conjugation, mapping of genes interrupted, elements of eugenics, imprinting of genes, gene therapy	15

Student learning outcomes

The students will get the idea about Mendelism, cytoplasmic inheritance, aberration, and gene therapy

The students will have awareness about genetic diseases, their types and causes.

The principles of inheritance, linkage and crossing over, which lead to variations, will be made clear as well as the application thereof in gene mapping.

Books recommended:

1. Brooker: Genetics: Analysis and Principles (Addison-Wesley, 1999)
2. Gardner et al: Principles of Genetics (John Wiley, 1991)
3. Snustad & Simmons: Principles of Genetics (John Wiley, 2003).
4. Alberts et al: Essential Cell Biology (Garland, 1998)
5. Alberts et al: Molecular Biology of the Cell (Garland, 2002)
6. De Robertis & De Robertis. Cell and Molecular Biology (Lee & Febiger, 1987)
7. Karp. Cell and Molecular Biology (John Wiley & Sons, 2002)
8. Lewın, Genes VIII (Wiley, 2004)
9. Lodish et al: Molecular Cell Biology (Freeman, 2000) 8. Pollard & Earnshaw: Cell Biology (Saunders, 2002)

BSc IVth Year: VIIIth Semester Paper IV ECOLOGICAL PRINCIPLES

Course Code: B050804T	**Marks: 25+75** **Credits: 4**	**Core Paper**
Total no. of Lectures (in hours per week) - 4	**Course Title: ECOLOGICAL PRINCIPLES**	

Course objectives

To develop in the student an understanding of:

- To develop in the student an understanding of Ecosystem structure and function, Ecologıcal development, Ecosystem modelling

Unit	**Topics**	**No. of Lectures**
I	• Concept of habitat and niche, ecosystem - structure and functions, concept of limiting factors, Liebig's law of the minimum; Shelford law of tolerance; energy flow, first and second law of thermodynamics, biogeochemical cycles (carbon, nitrogen and phosphorus)	15
II	• Characteristics of population, population growth curve, life history strategies (r and k selection), nature of community, community structure, edges and ecotones; ecological indicator	15
III	• Ecological pyramids, ecological succession-types, mechanism; species interaction; tritrophic interaction, concept of homeostasis and feedback	15
IV	• Ecosystem modelling, acclimation and acclimatization; different types of ecosystem -terrestrial and aquatic; conservation of natural resources; wetlands	15

Student learning outcomes

- The students will get the idea about
- Ecological relationships between organisms and their environment.
- Explained and identified the role of the organism in energy transfers.
- Described the habitat ecology and resource ecology.

Books recommended :

- Clifford B. Knight. Basic concepts of Ecology, The Macmıllan Company, New York
- E.P. Odum. Fundamentals of Ecology, Oxford and IBN Publishing Co., New Delhi
- Grant, W.E. and Swannack. T.M Ecological Modelling. (2008), Blackwell.
- Benton and Werner. Field Biology and Ecology, McGraw-Hill Book Company
- Wilkinson, D.M. Fundamental processes in Ecology: An Earth system Approach, (2007). Oxford University PRESS, UK,
- Fahey, T.J. and Knapp, A.K. Principles and standards for Measuring Primary Production, (2007), Oxford University Press, UK.

B050805P	ZOOLOGY PRACTICAL
BSc IVth Year: VIIIth Semester Credits: 4	
Distribution of marks:	**Time: 6 hours**
Exercise	**Marks**
Cytogenetics exercise	**10**
Ecology exercise	**15**
Embryology exercise	**15**
Preparation	**10**
Spotting (10 spots)	**25**
Viva-voce	**15**
Class Record	**10**
Total Marks	**100**

Chordata

1. **Urochordata:** Study of museum specimens/ whole-mount Oikopleura, Herdmania, Ascidia, Pyrosoma, Doliolum, Salpa
2. **Cephalochordate:** Study of museum specimen: Branchiostoma**.**
3. **Cyclostomata: Study of museum specimens /models:** Petromyzon, Myxine; Ammocoete larva.
4. **Pisces:**

a) Natural history of cartilaginous fishes (class Chondrichthyes): Scoliodon, Sphyrna (hammer headed shark), Torpedo (electric rays), Pristis, Rhinobatus, Raja (skate), Trygon (sting rays),

Chimaera

b) Natural hıstory of bony fishes (class Osteichthyes)

Polypterus, Acipenser, Polydon, Amia, Lepidosteus, Salmo, Hilsa, Notopterus, Labeo, Catla,

Cyprinus, Cırrhina, Heteropneustes, Clarias, Wallago, Mystus, Anguilla, Exocoteus.

Hippocampus, Channa, Amphipinus, Anabas, Synaptura, Echeneis, Syngnathus, Pleuronectes,

Lophius, Tetraodon, Diodon, Ostracion

c) Lung Fishes: Protopterus, Lepıdosiren, Neoceratodus

d) Study of the disarticulated bone of a carp.

5. **Amphibia: Study of museum specimens/models**: Ichthyophis, Uraeotyphlus, Cryptobranchus,

Ambystoma, Axolotl larva, Salamandra, Amphiuma, Triturus, Proteus, Necturus, Siren, Alytes,

Bufo, Hyla, Rhacophorus,

a) Study of the disarticulated bone of a frog

6. **Reptilia: Study of museum specimens/models:** Testudo, Chelone, Kachuga, Sphenodon,

Hemidactylus, Phrynosoma, Calotes, Draco, Iguanas, Chamaeleon, Heloderma, Varanus, Ophisaurus, Typhlops. Python, Ptyas, Natrix, Eryx, Hydrophis. Crotalus. Bungarus, Naja, Russell's Viper, Pit Viper, Crocodylus, Alligator, Gavialis.

a) **Study of the disarticulated bones of Varanus**

7. Aves: Study of museum specimens/models:

Archaeopteryx, Phoenicopterus (Flamingo). Pavo (Peacock), Columba (Pigeon), Eudynamys (Koel), Psittacula (Parrot), Bubo (Owl), Dendrocopus (Woodpecker), Passer domesticus (House sparrow), Corvus (Crow)

a) Study of disarticulated bones of fowl

8. Mammals. Study of museum specimens/models: Ornithorhynchus, Tachyglossus, Erinaceus.Talpa, Sorex, Macropus, Pteropus, (Bat), Loris, Funambulus, Rattus, Oryctologus, Hystrix,

a) Study of disarticulated bones of the rabbit

9. Developmental Biology

a) Experiments on artificial ovulation and insemination in the study of the life history stages of the frog
b) Study of hormonal control of amphibian metamorphosis
c) Incubation and mounting of chick embryos;
d) Study of prepared slides of the embryology of frog, chick and mammals and mammalian
e) placentation
f) Microtomy of embryonic stages of the chick embryo
g) Application of window techniques for in situ study of chick embryo with special reference to
h) morphogenetic movement
i) Determination of the effect of temperature on the embryonic development of the chick;
j) Study of the development of selective organs through preserved specimens and prepared slides:
k) Experiment on regeneration in earthworms; regeneration of lizards.

10. Genetics and Cytogenetics

a) Study of mitosis in the onion root tip
b) Meiosis in the testis of the grasshopper with the acetocarmine squash method
c) Study of the salivary gland chromosomes of Drosophila and Chironomus.

11. Ecological Principles

a) Study of different structural adaptations of animals to ecological conditions
b) Study of micro and macro fauna of soil by the froth flotation method
c) Comparative estimation of physicochemical eco factor of/ in different localities; Temperature,
d) pH, Carbonate, sulphate, nitrate, and turbidity, in a freshwater sample; the moisture content of the soil sample
e) Study of seasonal variation in plankton population, demonstration of parallax vision and height
f) perception
g) Analysis of plant community, biodiversity, and biomass
h) Study of seasonal plankton population, both qualitative and quantitative