

Maa Vindhyavasini University, Mirzapur, U.P.



National Education Policy-2020

Common Minimum Syllabus for all UP State Universities and Colleges

Syllabus for
UG (FYUG)-PG Course Program aligned with UGC Guidelines
(For Session 2026-27 onwards)

Including MINOR Papers

SUBJECT: ZOOLOGY

Dr. Laxmi Yadav
Professor & Head
Department of Zoology
K.P.M. Rajkiya Mahila Mahavidyalaya,
Auri, Bhadohi (U.P.)


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Dr. Prakash Chandra Gupta
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FYUG & PG Program Syllabus Developed by:

S.No.	Name	Designation	Department	College/University
1.	Dr. Laxmi Yadav	Professor & Head	Zoology	K.P.M. Rajkiya Mahila Mahavidyalaya, Auari, Bhadohi (U.P.)
2.	Dr. Prakash Chandra Gupta	Assistant Professor	Zoology	K.P.M. Rajkiya Mahila Mahavidyalaya, Auari, Bhadohi (U.P.)

Members of Board of Studies (Zoology)

S.No.	Name & Designation	Role	Department	College/University
1.	Dr. Laxmi Yadav Professor & Head	Convener	Zoology	K.P.M. Rajkiya Mahila Mahavidyalaya, Auari, Bhadohi (U.P.)
2.	Dr. Devendra Pandey Professor	Member	Chemistry	K.B.P.G. College, Mirzapur (U.P.)
3.	Dr. Prakash Chandra Gupta Assistant Professor	Member	Zoology	K.P.M. Rajkiya Mahila Mahavidyalaya, Auari, Bhadohi (U.P.)
4.	Dr. Ajay Kumar Assistant Professor	Member	Zoology	K.N. Govt. P. G. College, Gyanpur, Bhadohi (U.P.)
5.	Dr. Chandana Halder Professor	External Subject Expert	Zoology	Banaras Hindu University, Varanasi (U.P.)
6.	Dr. M. K. Thakur Professor	External Subject Expert	Zoology	Banaras Hindu University, Varanasi (U.P.)


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Members of the Board of Studies (BOS) in Zoology for Approval of FYUG Program

A meeting of BOS in Zoology was held on.....in Maa Vindhyavasini University, Mirjapur, for the implementation of syllabus for the 4 Year Undergraduate (FYUG) Program for students in Subject: Zoology.

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|----|---|----------------------------|-----------|---|
| 1. | Dr. Laxmi Yadav
Professor & Head
K.P.M. Rajkiya Mahila
Mahavidyalaya, Auari, Bhadohi (U.P.) | Convener | Zoology |  |
| 2. | Dr. Devendra Pandey
Professor
K.B.P.G. College, Mirjapur (U.P.) | Member | Chemistry |  |
| 3. | Dr. Prakash Chandra Gupta
Assistant Professor
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| 4. | Dr. Ajay Kumar
Assistant Professor
K.N. Govt. P. G. College, Gyanpur,
Bhadohi (U.P.) | Member | Zoology | |
| 5. | Dr. Chandana Halder
Professor
Banaras Hindu University, Varanasi (U.P.) | External (Subject Expert) | Zoology |  |
| 6. | Dr. M. K. Thakur
Professor
Banaras Hindu University, Varanasi (U.P.) | External (Subject Expert) | Zoology |  |

In the aforesaid meeting, consideration was given to approve the required modifications in the 3-YEAR UG syllabus (Zoology) to develop the syllabus for the 4-YEAR Undergraduate (FYUG) Program including 4 YEAR B.Sc. (HONOURS); 4 YEAR B.Sc. (HONOURS WITH RESEARCH) AND 4+1 YEAR (B.Sc. HONOURS/ B.Sc. HONOURS WITH RESEARCH + M.Sc.), for students in Subject: Zoology. The modifications introduced in the syllabus were in line with the guidelines of NEP 2020; a 4 YEAR Undergraduate (FYUG) Program for students in Zoology was unanimously approved by the committee members.

Semester-wise Titles/Papers in Four Year (FYUP) B.Sc./B.Sc. Honors/B.Sc. Honors with Research plus M.Sc. (Zoology)

B.Sc. (Zoology)

Year	Semester	Course Code	Paper Title	Theory/Practical	Credits	Marks Distribution
1	I	B050101T	Cytology, Genetics and Infectious Diseases	Theory	04	75+25
		B050102P	Cell Biology and Cytogenetics Lab	Practical	02	75+25
	II					
		B050201T	Biochemistry and Physiology	Theory	04	75+25
		B050202P/F	Physiological, Biochemical & Hematology Lab	Practical/Field work	02	75+25
2	III	B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	Theory	04	75+25
		B050302P	Bioinstrumentation & Molecular Biology Lab	Practical	02	75+25
	IV					
		B050401T	Gene Technology, Immunology and Computational Biology	Theory	04	75+25
		B050402P/F	Genetic Engineering and Counselling Lab	Practical/Field work	02	75+25
		B050403R	RESEARCH PROJECT	Field work	03	100
3	V	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	Theory	04	75+25
		B050502T	Diversity of Chordates and Comparative Anatomy	Theory	04	75+25
		B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	Practical	02	75+25
	VI					
		B050601T	Evolutionary and Developmental Biology	Theory	04	75+25
		B050602T	Ecology, Ethology, Environmental Science and Wildlife	Theory	04	75+25
		B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	Practical	02	75+25

B.Sc. Honors (Zoology)

4	VII	B050701T	Lower and Higher Non-Chordata	Theory	04	75+25
		B050702T	Biostatistics, Bioinformatics and Bioinstrumentation	Theory	04	75+25
		B050703T	Environmental Biology and Wildlife Conservation	Theory	04	75+25
		B050704T	Essential Biochemistry	Theory	04	75+25
		B050705P	Theory-based Practical I	Practical	04	75+25
	VIII					
		B050801T	Lower and Higher Chordata	Theory	04	75+25
		B050802T	Animal Physiology	Theory	04	75+25
		B050803T	Genetics and Molecular Biology	Theory	04	75+25
		B050804T	Endocrinology	Theory	04	75+25
		B050805P	Theory-based Practical II	Practical	04	75+25

OR

B.Sc. Honors with Research (Zoology)

(For students who has secured 75% marks or more in First Six Semester)

4	VII	B050701T	Lower and Higher Non-Chordata	Theory	04	75+25
		B050702T	Biostatistics, Bioinformatics and Bioinstrumentation	Theory	04	75+25

	B050703T	Environmental Biology and Wildlife Conservation	Theory	04	75+25
	B050704R	RESEARCH PROJECT	Field work	04	100
	B050705P	Theory-based Practical I	Practical	04	75+25
VIII	B050801T	Lower and Higher Chordata	Theory	04	75+25
	B050802T	Animal Physiology	Theory	04	75+25
	B050803T	Genetics and Molecular Biology	Theory	04	75+25
	B050804R	RESEARCH PROJECT	Field work	04	100
	B050806P	Theory-based Practical III	Practical	04	100

M.Sc. (Zoology)

5	IX	B050901T	Applied Zoology	Theory	04	75+25
		B050902T	Developmental Biology	Theory	04	75+25
		B050903T	Special [select any one]			
			B050903T/A-Fish Biology–Taxonomy and Morphology B050903T/B-Entomology– Morphology, Physiology, Development and Ecology B050903T/C-Cell Biology –Cytological Techniques	Theory	04	75+25
		B050904P	Theory-based Practical (General and Special)	Practical	04	75+25
		B050905RP	RESEARCH PROJECT	Field work	04	100
	X	B0501001T	Animal Behavior and Biosystematics	Theory	04	75+25
		B0501002T	Special [select any one]			
			B0501002T/A-Fish Biology-Applied Ichthyology and Development B0501002T/B-Entomology – Evolution and Taxonomy B0501002T/C-Cell Biology – Ultrastructure and Morphodynamics of Cell	Theory	04	75+25
		B0501003T	Special [select any one]			
			B0501003T/A-Fish Physiology and Ecology B0501003T/B-Entomology – Economic Entomology B0501003T/C-Cell Biology–Cell Regulation and Principles of Biotechnology	Theory	04	75+25
		B0501004P	Theory-based Practical (General and Special)	Practical	04	75+25
		B0501005RP	RESEARCH PROJECT	Field work	04	100

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Proposed Year-wise Structure of UG/PG Program in Zoology

Program/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/F	Genetic Engineering and Counselling Lab	02	60
		B050403R	RESEARCH PROJECT	03	45
3 Degree (General) 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
		B050701T	Lower and Higher Non-Chordata	04	60
		B050702T	Biostatistics, Bioinformatics and Bioinstrumentation	04	60

4 Degree (Honors) in Bachelor of Science	VII	B050703T	Environmental Biology and Wildlife Conservation	04	60
		B050704T	Essential Biochemistry	04	60
		B050705P	Theory-based Practical I	04	60
	VIII	B050801T	Lower and Higher Chordata	04	60
		B050802T	Animal Physiology	04	60
		B050803T	Genetics and Molecular biology	04	60
		B050804T	Endocrinology	04	60
		B050805P	Theory-based Practical II	04	60

4 Degree (Honors with Research) in Bachelor of Science	VII	B050701T	Lower and Higher Non-Chordata	04	60
		B050702T	Biostatistics, Bioinformatics and Bioinstrumentation	04	60
		B050703T	Environmental Biology and Wildlife Conservation	04	60
		B050704R	RESEARCH PROJECT	04	60
		B050705P	Theory-based Practical I	04	60
	VIII	B050801T	Lower and Higher Chordata	04	60
		B050802T	Animal Physiology	04	60
		B050803T	Genetics and Molecular Biology	04	60
		B050804R	RESEARCH PROJECT	04	60
		B050806P	Theory-based Practical III	04	60
5 Degree in Master of Science	IX	B050901T	Applied Zoology	04	60
		B050902T	Developmental Biology	04	60
		B050903T	B050903T/A-Fish Biology– Taxonomy and Morphology B050903T/B-Entomology– Morphology, Physiology, Development and Ecology B050903T/C-Cell Biology – Cytological Techniques	04	60
		B050904P	Theory-based Practical (General and Special)	04	60

		B050905RP	RESEARCH PROJECT	04	60
	X	B0501001T	Animal Behavior and Biosystematics	04	60
		B0501002T	B0501002T/A-Fish BiologyApplied Ichthyology and Development B0501002T/B-Entomology – Evolution and Taxonomy B0501002T/C-Cell Biology – Ultrastructure and Morphodynamics of Cell	04	60
		B0501003T	B0501003T/A-Fish Physiology and Ecology B0501003T/B-Entomology – Economic Entomology B0501003T/C-Cell Biology–Cell Regulation and Principles of Biotechnology	04	60
		B0501004P	Theory-based Practical (General and Special)	04	60
		B0501005RP	RESEARCH PROJECT	04	60

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Subject prerequisite

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

Program Objectives (POs)

1. The Program 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 behavioral 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 Program 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 Program 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.
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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 Program Specific Outcomes (PSOs)	
PSO1	☐ This Program 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.

Program/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
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IV	Cell cycle, Cell Division and Cell Signaling • 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
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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 <i>Drosophila</i>, Sex Determination in Humans□ □ • Sex-linked characteristics and Dosage compensation□	8
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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
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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
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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: <i>Trypanosoma</i>, <i>Giardia</i> and <i>Wuchereria</i>	8
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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



Program/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 types such as buccal 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 <i>Drosophila</i>. 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/12 th 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.



Program/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	
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. Zubayet *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 Elli 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



Program/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's haemoglobinometer 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. Hecourt 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.



Program/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, aminoacyl tRNA synthetase • Initiation, elongation and termination of translation in prokaryotes and eukaryotes	7



III	Regulation of Gene Expression I - Regulation of gene expression in prokaryotes: <i>lac</i> and <i>trp</i> operons in <i>E. coli</i> - Regulation of gene expression in eukaryotes: Role of chromatin in gene expression - Regulation at transcriptional level, Post-transcriptional	8
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	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 sequencing DNA 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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Program/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 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 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@premiereducationaltechnologies.com https://li.wsu.edu	
Suggested Readings: 1. Sambrook <i>et al</i> .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.





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Faculty of Science And Technology
Maa Vinaykavasi University, Mirzapur

Program/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 & 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).
7. Wilson. Clinical Genetics-A Short Course, Wiley (2000).
8. Pasternak. An Introduction to Molecular Human Genetics. Fitzgerald (2000).
9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.
10. Statistical Methods (Eighth Edition) by G. W. Snedecor 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:

Program/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 Program PHYLIP. 5. To learn how to perform Primer designing for PCR using available softwares etc.	15
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/CpGX1UFSI4A 4. PCR Part 2- https://youtu.be/6IcHAYPTAEw 5. DNA isolation Part 1- https://youtu.be/QE7UI0JnY9A 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 & 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). 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.

Program/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 – <i>Paramecium</i> (Morphology and Reproduction)□ • Porifera – <i>Sycon</i>(Canal System)□ • Coelenterata – <i>Obelia</i> (Morphology and Reproduction)□	7
II	Ctenophora to Nematelminthes • Ctenophora - Salient features□ • Platyhelminthes - <i>Taenia</i> (Tape worm) (Morphology and Reproduction)□ • Nematelminthes –<i>Ascaris lumbricoides</i> (Morphology and Reproduction)□	7
III	Annelida □ Annelida –<i>Hirudinaria</i> (Leech) (Morphology and Reproduction)	8
IV	Arthropoda □ Arthropoda – <i>Palaemon</i> (Prawn) (Morphology, Appendages, Nervous System and Reproduction)	8

V	Mollusca to Hemichordata • Mollusca – <i>Pila</i> (Morphology, Shell, Respiration, Nervous System and Reproduction) □ • Echinodermata – <i>Pentaceros</i> (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. Thomas 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. Sericulture 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:

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Program/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 <i>Balanoglossus</i>(Habit and Habitat, Morphology, Anatomy, Physiology and Development).	6
II	Cephalochordata and Urochordata • Cephalochordata : General characteristics, classification and detailed study of <i>Branchiostoma (Amphioxus)</i> (Habit and Habitat, Morphology, Anatomy, Physiology). • (ii)Urochordata : General characteristics, classification and detailed study of <i>Herdmania</i>(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:

Program/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 <i>Palaemon</i> .	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: <i>Euglena</i>, <i>Paramecium</i> 2. Study of prepared slides/specimens of <i>Entamoeba</i>, <i>Giardia</i>, <i>Leishmania</i>, <i>Trypanosoma</i>, <i>Plasmodium</i>, <i>Fasciola</i>, <i>Cotugnia</i>, <i>Taenia</i>, <i>Rallietina</i>, <i>Polystoma</i>, <i>Schistosoma</i>, <i>Echinococcus</i>, <i>Enterobius</i>, <i>Ascaris</i> and <i>Ancylostoma</i> 3. Permanent Preparation of <i>Cimex</i> (bed bug)/ <i>Pediculus</i> (Louse), <i>Haematopinus</i> (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.

Program/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 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 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
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	□ 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



Program/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

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

Program/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

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

Program/Class: Degree (Honors) in Bachelor of Science	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: B050701T	Course Title: Lower and Higher Non-Chordata	
Course outcomes: The student at the completion of the course, will learn; - To enable the students to develop an appreciation for the biodiversity of invertebrate species with impart knowledge about co-existence of different forms of living organisms ranging from unicellular to multicellular animals - Morphological and Anatomical Knowledge: Students will understand the structural complexity, functional anatomy, and adaptive features of various non-chordate groups. - Practical Skills: Through lab sessions and museum specimens, students will develop skills to identify, classify, and dissect representative non-chordate organisms.		
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, Porifera, Cnidaria and Ctenophora - General characteristics and Classification up to classes - Protozoa-Locomotion- locomotory organelles and methods of locomotion, Nutrition- Holozoic, Holophytic, Saprophytic and Myxotrophic nutrition, Reproduction- Asexual and sexual, Protozoa and Diseases - Porifera-Canal system and spicules in sponges - Coelenterata-Origin of Metazoa, Polymorphism- Basic forms and patterns, Importance of polymorphism, Corals-coral polyp, coral skeleton, types of corals. - General organization and affinities of Ctenophora	15
II	Platyhelminthes and Nematelminthes - General characteristics and Classification up to classes. - Parasitism in Platyhelminthes and Aschehelminthes, - Parasitic adaptations in Trematodes and Cestodes-Morphological and physiological adaptations, - Larval stages/ of Trematoda and Cestoda	15

III	Annelida and Arthropoda • General characteristics and Classification up to classes. • Annelida-Segmental organs, Filter feeding, Coelom and Metamerism • Trochophore larva- Structure, affinities and evolutionary significance. • Arthropoda-Larval forms of crustacean, Parasitism in crustacean, Respiration in Arthropods. • Onychophora-General characteristics and Evolutionary significance of Onychophora	15
IV	Mollusca and Echinodermata • General characteristics and Classification up to classes. • Respiration in Mollusca, Torsion and detorsion in Gastropoda, • Structure and affinities of Neopilina. • Water-vascular system in Asteroidea, • Larval forms in Echinodermata, Affinities with Chordates. • Introduction to Minor phyla, Distinguishing characters and examples of Rotifera, Acanthocephala and Sipunculida	15

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.
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					




Program/Class: Degree (Honors) in Bachelor of Science	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: B050702T	Course Title: Biostatistics, Bioinformatics and Bioinstrumentation	
Course outcomes: The student at the completion of the course, will learn: • After successfully completing this course, the students will be able to know the theory behind fundamental bioinformatics analysis methods. • Know basic statistical methods and probability distributions relevant for molecular biology data. • Know the applications and limitations of different bioinformatics and statistical methods. • Acquire knowledge of various databases of proteins, nucleic acids. Primary, secondary and composite databases.		
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	Biostatistics • Collection and classification of data. Graphical representation of data: Pie chart, Bar diagram, Histogram, Frequency polygon. • Probability theory: Binomial distribution, Poisson distributions. • Measures of central tendency: Arithmetic Mean, Median, Mode; Measures of dispersion: Variance, Standard deviation and Standard error, Concept of Coefficient of variation. • Correlation: Types of correlation, Calculation of correlation in continuous data and ordinal data. • Regression: Linear regression, regression coefficient. • Analysis of variance (ANOVA); Hypothesis testing: Parametric tests (Paired and unpaired t-test, z-test, F-test) & Non Parametric tests (Chi-square test)	15

II	Bioinformatics • Introduction and scope of bioinformatics: concept of digital laboratory. Basics of information technology, computer, operating systems, network. Concept of internet protocol (TCP/IP), hypertext, home-page, webpage and uniform resource locators (URL). Introduction to data archiving systems (FASTA format, Accession, and GI-Number). • Introduction to Genomics and Proteomics • Biological database: Nucleic acid sequences databases, Genome databases, Protein	15
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	sequence, structures and interacting proteins databases, Literature databases, Introduction to data retrieval systems, Search engines, Entrez, sequence retrieval system (SRS) and protein identification resource (PIR). □ Introduction to molecular sequence analysis software packages and tools, Prediction of motifs, folds and domains, Sequence alignments (BLAST and Clustal W) and phylogenetic trees (PHYLIP).	
III	Bioinstrumentation I • Microscopy: Introduction to Microscopy. Definitions-Resolving Power, Limit of Resolution and Magnification, Numerical Aperture. Types of microscopes, bright field, dark-field, phase contrast. Basic principles of Light, Electron, Fluorescence and Confocal Microscopy. • Microtomy: Tissue preparation, fixation, block preparation, sectioning, staining, dehydration and mounting. • Basic Principle and Application of Centrifugation, Colorimetry and Spectrophotometry, BeerLambert's Law.	15
IV	Bioinstrumentation II • Principle and applications of Electrophoresis: Separation of Biomolecules by Native PAGE, 2D PAGE. Agarose gel electrophoresis. • Antigen-Antibody Interactions-Immunodiffusion, • Western Blotting, ELISA, RIA. Principle & Working of ELISA, Hormone assay methods. Application of Immunological techniques in disease diagnosis • Principle and Applications of Paper chromatography, Thin layer chromatography, Gel-filtration chromatography	15

Suggested Readings:

1. Daniel, W.W. (2012) Biostatistics: A Foundation for Analysis in Health Sciences (10th edition) John Wiley.
2. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition) McGraw Hill.
3. Zar, J.H. (2013) Biostatistical Analysis (5th edition) Pearson.
4. Barnes, M.R. and Gray, I.C. (2003) Bioinformatics for geneticists, Wiley.
5. Mount, D.W. (2006) Bioinformatics (2nd edition) CBS.
6. Primrose & Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
7. Hartl & Jones. Genetics: principles & Analysis of Genes & Genomes. Jones & Bartlett (1998).
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)
11. Sudbery. Human Molecular Genetics. Prentice-Hall (2002).
12. Wilson. Clinical Genetics-A Short Course, Wiley (2000).
13. Pasternak. An Introduction to Molecular Human Genetics. Fitzgerald (2000).
14. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zar, Pearson Education Inc., Delhi.
15. Statistical Methods (Eighth Edition) by G. W. Snedecor and W. G. Cochran, Wiley Blackwell
16. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
17. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners
18. 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

Program/Class: Degree (Honors) in Bachelor of Science	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: B050703T	Course Title: Environmental Biology and Wildlife Conservation	
Course outcomes: The student at the completion of the course, will learn: • After successfully completing this course, the students will be able to know the fundamentals of Ecology. • To know the types of ecosystem, food chain and food web. • To know about current environmental challenges and their impact on human health. • To know about biodiversity, its significance and methods 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	Population Ecology • Characteristics of Population, Population size and exponential growth , • Population dynamics, Competition ,Intra-specific and Inter-specific competition , • Mutualism and Commensalism	15
II	Ecosystem • Nature and types of Ecosystem, • Food chain: Detritus and grazing food chains • Food webs and Energy flow through ecosystems • Biogeochemical cycles, Biomes	15
III	Environment issues □ Climate change, Greenhouse gases, Global warming, Acid Rain, Environmental contaminants- their uptake and bioaccumulation and biotransformation, Bio-indicators and Biomarkers	15

IV	Biodiversity and Wildlife Conservation - Biodiversity definition, Biodiversity Types: (a) Species, Ecosystem level, Genetic Level: (b) Alpha, Beta, Gamma level; Indian Biodiversity & Its Distribution; Importance/Significance; Biodiversity Hotspots/Parks; Keystone species, Indicator Species - Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.	15
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	☐ National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve	
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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
10. Biodiversity and Ecosystem functioning. edited by Michel Loreau, Shahid Naureen and Pablo Inchausti (Oxford University Press.)
11. Biodiversity and Conservation in Forests By Diana. F. Tomback. Publication MDPI Multidisciplinary Digital Publishing Institute.
12. Fundamentals of Ecology. E.P. Odum & Gray. W. Barrett, 1971, Saunders. Handbook of Population 2005, Dudley L. Poston, Michael Micklin, Springer

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

Program/Class: Degree (Honors) in Bachelor of Science		Year: Four	Semester: Seventh
Subject: ZOOLOGY			
Course Code: B050704T		Course Title: Essential Biochemistry	
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 and how simple molecules together form complex macromolecules. - To understand the thermodynamics of enzyme catalyzed reactions. - Mechanisms of energy production at cellular and molecular levels.			
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	Bioenergetics □ Elementary thermodynamics- First law and second law of thermodynamics, Cell as an open thermodynamic system, Calculation of free energy change during biological oxidationreduction reactions	15	
II	Enzymes - 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, isoenzymes, Ribozymes, Abzymes.	15	
III	Biomolecules I - Carbohydrates- Classification, structure, general properties, and biological significance, - Lipids- Classification, structure, general properties and biological significance, - Metabolic pathways- Glycogenesis and Glycogenolysis, HMP shunt, Oxidative phosphorylation, Beta oxidation of fatty acids	15	
IV	Biomolecules II - Amino Acids: Structure, Classification and General properties of α-amino acids; Essential and nonessential α-amino acids, - Levels of organization in proteins; Simple and conjugate proteins., Ramachandran plot, protein isolation, solubilities and protein targeting - Classification and significance of Vitamins	15	

Suggested Readings:

1. Nelson & Cox Lehninger's Principles of Biochemistry McMillan 2000 Zubay et al Principles of Biochemistry WCB 1995
2. Voet & Voet Biochemistry Vols 1 & 2 Wiley 2004
3. Murray et al Harper's Illustrated Biochemistry McGraw Hill 2003
Wilson and Walker Practical Biochemistry—Principles and Techniques Cambridge University Press

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



Program/Class: Degree (Honors) in Bachelor of Science	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: B050705P	Course Title: Theory-based Practical I	
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: 0-0-4		
Unit	Topic	Total No. of Lectures (60)
I	Major Dissections Labeling: Labeling of dissected circulatory system and reproductive system of earthworm, Reproductive and Nervous system of Unio, Pila, Prawn, Sepia and other available non- chordates. Preparations: Slide preparation of Euglena and Paramecium, sponge gemmules, Obelia colony, Nereis parapodia, Hastate palate of Prawn, salivary glands of Cockroach, mouth parts of other insects. Museum specimen: General survey and classification of lower non-chordates: Protozoa- Prepared slides of Paramecium (conjugation and binary fission), Euglena, Vorticella, Ceratium, Noctiluca; Porifera-Museums of Euplectella, Spongilla, Euspongia Prepared slides of T.S. Sycon, L.S. Sycon, Spicules of sponges; Coelenterata Museums of Physalia Corralium, Madrepora, Fungia, Pennatula, Metridium, Vellela, Porpita, Tubipora, Gorgonia, Prepared slides of Hydra, Obelia; Helminths- Museums of Taenia solium, Cysticercus larva of Taenia solium, Schistosoma, Ascaris male, Ascaris female, Ancylostoma; Annelida-Nereies,Heteroneries, Aphrodite, Chaetopterus, Arenicola, Terebella, Pheretima,Eutyphoeus, Dero, Branchellion, Bonellia, Sipunculus and other available museums; Arthropoda- Museums and slides of major representatives of different classes of phylum Arthropoda; Mollusca-Museums and slides of major representatives of Mollusca; Echinodermata-Museum and slides of major representatives of Echinodermata. Prepared slides: Miracidium larva, Redia larva, Cercaria larva, Scolex of Taenia solium, Mature proglottid and gravid proglottid of T. solium, T.S of Mature proglottid and gravid proglottid of T.solium, T.S. through body of male Ascaris, T.S. through body of female Ascaris, T.S. Nereies through body segments, Parapodium of Nereies, etc.	15

II	Biostatistics, Bioinformatics and Bioinstrumentation exercise- Experiments on probability, sampling of data for frequency diagram and calculation of mean, median and mode and standard deviation.	15
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III	Environmental Biology exercise- Study of different structural adaptations to ecological conditions Study of micro and macro fauna of soil by froth-floatation method; Comparative study of physic-chemical ecofactors in different localities-temperature, pH Estimation of CO ₂ , O ₂ , carbonate in freshwater; Study of plankton in a water body; Study of biological effects of certain pollutants	15
IV	Biochemistry experiments: determination of glycogen in animal tissues. Kinetic assay of salivary amylase and study of the effects of time and temperature on urease activity	15

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

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

Class performance/Participation: 5 Marks

Program/Class: Degree (Honors) in Bachelor of Science		Year: Four	Semester: Eight
Subject: ZOOLOGY			
Course Code: B050801T		Course Title: Lower and Higher Chordata	
Course outcomes: The student at the completion of the course, will learn: • Demonstrate comprehensive identification abilities of chordate diversity • Explain the structural and functional diversity of chordates • Explain the evolutionary relationship amongst chordates			
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	Origin of Chordates • General characteristics and outline classification of chordate • Dipleurula concept and the Echinoderm theory of origin of chordates, Advanced features of vertebrates over Protochordata • Origin of Gnathosomes • Pisces: Ostracoderms and Devonian fishes,	15	
II	Pisces and Amphibians • Lung fishes and their peculiar features' □ Migration and Osmoregulation in fishes. • Amphibia: Origin of Tetrapoda • Parental care in Amphibians	15	
III	Reptilians and Aves • Origin and Evolution of Reptiles, Mesozoic reptiles, Extinct reptiles, • Affinities of Sphenodon • Origin of birds , Flightless birds • Flight adaptations in birds	15	
IV	Mammals • Origin and evolution of Mammals, • Characteristic features and affinities of Monotremes, Marsupials and Placental mammals • Aquatic mammals	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. 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

Program/Class: Degree (Honors) in Bachelor of Science		Year: Four	Semester: Eight
Subject: ZOOLOGY			
Course Code: B050802T		Course Title: Animal Physiology	
Course outcomes: The student at the completion of the course, will learn: - To understand systems biology and various functional components of an organism. - To enable the students, know about all the physiological processes controlling the human body □ 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	Topic	Total No. of Lectures (60)	
I	Digestion and Respiration System - Physiology of Digestion- Digestion and Absorption of Proteins, Carbohydrates and lipids - Physiology of Respiration- Gaseous exchange in terrestrial and aquatic animals, Respiratory pigments	15	
II	Circulation System - Physiology of Circulation, Patterns of Circulation among different animals, Physiological categories of Heart, - Haemodynamics	15	
III	Excretion and Muscular System - Physiology of Excretion- Excretory products, Biosynthesis of Urea, Structure and functional mechanism of the nephron - Physiology of Muscle Contraction- Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction	15	
IV	Immune System - Physiology of Defense Mechanism: Immunity, Types of Immune response, Immune cells, - Cell mediated Immunity and Humoral Immunity, Antibody diversity, Antigen and antibody reaction	15	

Suggested Readings:

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

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

Program/Class: Degree (Honors) in Bachelor of Science	Year: Four	Semester: Eight
Subject: ZOOLOGY		
Course Code: B050803T	Course Title: Genetics and Molecular biology	
Course outcomes: The student at the completion of the course, will learn: • 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	Genetics I • Basic concept of mendelian inheritance, gene interaction, epistasis, complementation test, • Sex linked inheritance, sex limited and sex influenced trait, cytoplasmic inheritance, • Genomic imprinting, environment and heredity, pleiotropy, • Genetic disease testing and gene therapy	15
II	Genetics II • Linkage, crossing over and recombination, recombination frequency, gene mapping, • Gene mutation, chromosomal mutation and their significance	15
III	Molecular Biology I • Bacterial genome, transformation, transduction, conjugation, bacteriophage, • Chromosomal organization of DNA in eukaryotes, • Transposable elements in prokaryotes and eukaryotes, role of transposable elements in genetic regulation	15

IV	Molecular Biology II - Chromosome and gene, DNA replication in prokaryote and eukaryotes, - Gene expression: transcription in prokaryotes and eukaryotes, - Translation in prokaryotes and eukaryotes,	15
	- uptake in endoplasmic reticulum, - Trafficking mechanism of protein, - Regulation of gene expression in prokaryotes: lac and Trp operons in E. coli - Regulation of gene expression in eukaryotes: transcriptional and post-transcriptional levels, translational and post-translational levels	
Suggested Readings: - Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004). - Alberts et al: Molecular Biology of the Cell: Garland (2002). - Cooper: Cell: A Molecular Approach: ASM Press (2000). - Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004). - Lewin B. Genes VIII. Pearson (2004). - Watson et al. Molecular Biology of the Gene. Pearson (2004).		
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		



Program/Class: Degree (Honors) in Bachelor of Science		Year: Four	Semester: Eight
Subject: ZOOLOGY			
Course Code: B050804T		Course Title: Endocrinology	
Course outcomes: The student at the completion of the course, will learn: - To enable students to learn endocrinology with special emphasis on the human endocrine system covering the anatomy, physiology and biochemistry of the system, biological phenomena at cellular level - To provide detailed information on the release, effect and functioning of hormones. - To acquire knowledge about the role of hormones as therapeutic agents.			
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	Pituitary, Pancreas, Adrenal Glands - Hormones as messengers and their types, - Structure and functions of Pituitary, Pancreas, Adrenal Glands	15	
II	Thyroid, Parathyroid, and Gonads - Phylogeny of Thyroid gland, - Structure and functions of Thyroid, Parathyroid, and Gonads.	15	
III	Hormone action - Nature of action of peptide and steroid hormones, - Biosynthesis and secretion of Hormones, Feedback mechanisms in signaling pathways	15	
IV	Neurosecretion - Neuro endocrine system and neuro secretion, Hypothalamo-hypophyseal interactions with the gonads, adrenal and other endocrine gland - Hormones and Behaviour	15	
Suggested Readings: - Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press. - Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company. - Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd. - Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.			

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

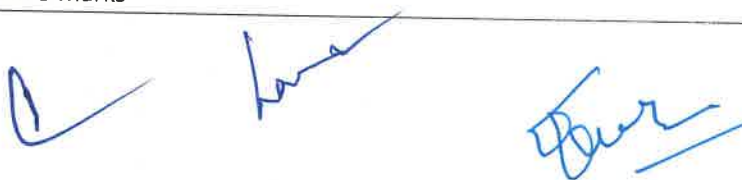
Further Suggestions: None

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Program/Class: Degree (Honors) in Bachelor of Science		Year: Four	Semester: Eight
Subject: ZOOLOGY			
Course Code: B050805P		Course Title: Theory-based Practical II	
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: 0-0-4			
Unit	Topic	Total No. of Lectures (60)	
I	• Major Dissection Labeling: labeling of cranial nerves of major representative types of fish and amphibian. Afferent and efferent branchial arteries of Scoliodon, urinogenital system of Scoliodon. • Comparative Osteology: Study of bones of different chordate class with focus on evolutionary significance • Preparation- Placoid scale of Scoliodon, Ampulla of Lorenzini; T.S. through liver, intestine, skin etc of frog. • Museum study- Study of museums and slides of representative types of Protochordates, Cyclostomata, fishes and amphibian, Reptilia, Aves and Mammalia	15	
II	• Physiology exercise- Total counts of erythrocytes, total leucocyte counts and differential leucocyte counts of fish, frog, bird and rat • Estimation of hemoglobin content in fish, frog, bird and rat • Rate of Oxygen consumption of aquatic animals and effects of different stresses upon it • Determination of respiratory quotient of an air breathing animal • Study of functional properties of the cardiac muscles of frog using acetylcholine and adrenalin	15	

III	• Molecular Biology exercise- Isolation and colorimetric determination of protein from fat bodies of cockroach and liver; Isolation and colorimetric determination of DNA from fat bodies of cockroach and liver • Cytology and Genetics exercise- Demonstration of mitochondria in human buccal epithelium by supra vital staining; Study of mitosis in onion root tip and meiosis in testis of grasshopper with acetocarmine squash method; Study of salivary gland chromosomes of Drosophila and Chironomus; Study of the pattern of different hereditary traits in human beings	15
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IV	• Endocrinology: Simulation of dissection and virtual display of endocrine glands in rat model • Study of permanent slides of Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid	15
Suggested Continuous Evaluation Methods: House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		



Program/Class: Degree (Honors with Research) in Bachelor of Science		Year: Four	Semester: Eight
Subject: ZOOLOGY			
Course Code: B050806P		Course Title: Theory-based Practical III	
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: 0-0-4			
Unit	Topic	Total No. of Lectures (60)	
I	• Major Dissection Labeling: labeling of cranial nerves of major representative types of fish and amphibian. Afferent and efferent branchial arteries of Scoliodon, urinogenital system of Scoliodon. • Comparative Osteology: Study of bones of different chordate class with focus on evolutionary significance • Preparation- Placoid scale of Scoliodon, Ampulla of Lorenzini; T.S. through liver, intestine, skin etc of frog. • Museum study- Study of museums and slides of representative types of Protochordates, Cyclostomata, fishes and amphibian, Reptilia, Aves and Mammalia	15	
II	• Physiology exercise- Total counts of erythrocytes, total leucocyte counts and differential leucocyte counts of fish, frog, bird and rat • Estimation of hemoglobin content in fish, frog, bird and rat • Rate of Oxygen consumption of aquatic animals and effects of different stresses upon it • Determination of respiratory quotient of an air breathing animal • Study of functional properties of the cardiac muscles of frog using acetylcholine and adrenalin	15	

III	• Molecular Biology exercise- Isolation and colorimetric determination of protein from fat bodies of cockroach and liver; Isolation and colorimetric determination of DNA from fat bodies of cockroach and liver • Cytology and Genetics exercise- Demonstration of mitochondria in human buccal epithelium by supra vital staining; Study of mitosis in onion root tip and meiosis in testis of grasshopper with acetocarmine squash method; Study of salivary gland chromosomes of <i>Drosophila</i> and <i>Chironomus</i>; Study of the pattern of different hereditary traits in human beings	15
IV	□ Research methodology: Sketching a research proposal; Presentation of report in class seminar on related topic through power-point presentation; Analysis of references and citation for at least 10 documents (books, journals, reports, thesis etc.)	15
Suggested Continuous Evaluation Methods: House Examination/Test: 10 Marks Written Assignment/Presentation/Project / Term Papers/Seminar: 10 Marks Class performance/Participation: 5 Marks		

B.Sc.

Semester: II Zoology (NEP 2020)

Course type: Minor

Course Title- Animal Diversity & Basic Biology

Total Credit 6

Teaching Hours: 60

Format: 4units x 1.5 credits

Unit I- Fundamentals of Biology & Cell Biology (1.5 Credits, 15 Hours)

Topics:

- Scope and branches of biology, levels of biological organization.
- Cell as a structural and functional unit
- Prokaryotic vs. eukaryotic cells
- Cell organelles and their functions
- Cell cycle, mitosis

Course Outcome:

Understand the basic principles of biology and cell structure.

Unit II–Non-Chordate Diversity (1.5 Credits, 15Hours)

Topics:

- Distinction between chordates and non-chordates
- Locomotion in Protozoa, Canal system in Porifera, Polymorphism in Cnideria
- Platyhelminthes & Nematohel minthes: parasitic adaptation, Annelida: segmentation and excretion.
- Arthropoda: Economic importance & Mollusca: Respiration, economic importance, shell types
- Echinodermata: General character with few examples.



Course Outcome:

Classify major non-chordate phyla and explain their adaptations and economic.

Unit III -Chordate Diversity (1.5 Credits, 15Hours)**Topics:**

- General classification of chordates
- Ecological adaptations in Reptiles and Birds.
- Mammalia: dentition.

Course Outcome:

Identify chordate classes and relate their morphological and physiological adaptations to their environment.

Unit IV –Integrated Functional Biology (1.5 Credits, 15 Hours)**Topics:**

- Overview of fundamental physiological concepts.
- Immune system: innate and adaptive immunity, vaccination
- Vitamins

Course Outcome:

Apply knowledge of animal structure and function to basic physiology and adaptation concepts.



Assessment Pattern

Component

Marks Weightage

Internal Assessment (Assignments/Quiz/Seminar)

25 (40%)

End Semester Examination (Theory)

75 (60%)

Suggested References

1. Jordan & Verma -Chordate Zoology
2. Kotpal -Invertebrate Zoology
3. E.L. Jordan –Vertebrate Zoology
4. P.S. Verma & V.K. Agarwal -Cell Biology
5. C.C. Chatterjee & R. K. Basu -Human Physiology



B.Sc.

Zoology Semester: IV (NEP-2020)

Course Title: Applied Zoology & Functional Biology

Course Type: Minor Total Credit- 6

Teaching Hours: 90

Unit Credits: 4 Units x 1.5 Credits

Unit I - Human Physiology

Credits: 1.5 | Hours: 20

Topics:

- Digestive system: structure & functions.
- Respiratory system: mechanism of breathing, gas exchange
- Circulatory system: blood composition, types of circulation.
- Excretory system: kidney structure and function.

Course Outcomes:

Explain structural organization and functions of major organ systems. Relate physiological mechanisms to survival and adaptation.

Unit II - Nervous, Endocrine & Reproductive Systems

Credits: 1.5 | Hours: 25

Topics:

- Nervous system fundamentals: neuron, nerve impulse, CNS and PNS overview
- Endocrine system: Thyroid & Pancreatic hormones
- Gametogenesis: Spermatogenesis, Oogenesis

Course Outcomes:

Understand neural integration and hormonal control mechanisms. Describe human reproductive biology basics.



Unit III - Applied Zoology -Economic Importance

Credits: 1.5 |Hours: 20

Topics:

- Apiculture: bee biology, hive management, honey and product
- Sericulture: silkworm life cycle, types of silk, silk industry basics
- Vermiculture: earthworm species, vermin-compost production and uses

Course Outcomes:

Recognize the economic applications of animals in agriculture and industry. Explain how biological processes are used for sustainable production.

Unit IV –Animal Husbandry, Fisheries & Conservation Biology

Credits: 1.5 |Hours: 25

Topics:

- Livestock management: artificial breeding and their improvement
- Fisheries science: freshwater fish culture and their economic importance
- Conservation biology: Parks and Sanctuaries.

Course Outcomes:

Apply zoological knowledge to livestock and fish production systems. Understand principles of biodiversity conservation and sustainable resource use.

Assessment Pattern

Component	Marks Weightage	
Internal Assessment (Assignments/ Quiz, Seminars/CA)	25	40%
End Semester Examination (Theory)	75	60%

Suggested Textbooks & References



1. Textbook of Zoology -Parker & Haswell
2. Chordate Zoology -Jordan & Verma
3. Applied Zoology -Shukla & Upadhyay
4. Animal Physiology -Stewart & Farrell
5. Human Physiology -C.C. Chatterjee & R.K. Basu



(Dr. P.C. Gupta)



(Prof. Laxmi Yadav)



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