

SYLLABUS

ZOOLOGY

FOR

4 YEARS U.G (HONOURS) PROGRAMME

4 YEARS U.G (HONOURS WITH RESEARCH) PROGRAMME &

P.G. PROGRAMME

EFFECTIVE FROM SESSION 2026-27 ONWARDS



MAHARAJA SUHEL DEV UNIVERSITY

AZAMGARH (U. P.) -276128, INDIA

PREPARED BY

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AZMGARH, U.P.

CONVENOR OF ZOOLOGY

MSD STATE UNIVERSITY, AZMAGR H, U.P.

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M.SC. (ZOOLOGY)

4th YEAR UG (HONS.) / 4th YEAR UG (HONS. WITH RESEARCH) / M.Sc. (ZOOLOGY)

YEAR	SEM.	CATEGORY/TYPE OF THE COURSE	COURSE CODE	PAPER TITLE	THEORY / PRACTICAL	CREDITS
4 th YEAR UG (HONS.) / 4 th YEAR UG (HONS. WITH RESEARCH) / M.Sc. (I st YEAR) / P.G. DIPLOMA	VII Or Msc I sem	COMPULSORY	B050701T 1	CELL STRUCTURE AND FUNCTIONS 6	THEORY	4
			B050702T 2	GENETICS AND CYTOGENETICS 6	THEORY	4
			B050703T 3	MOLECULAR BIOLOGY AND GENETIC ENGINEERING 6	THEORY 75+25	4
		OPTIONAL	CHOOSE ANY ONE OF THE FOLLOWING			
			B050704A 4	EVOLUTION & SYSTEMATICS 6	THEORY	4
			B050704B	ANIMAL BEHAVIOUR 6	THEORY	4
			B050705P 5	PRACTICAL COMPULSORY 6	PRACTICAL 75/25	4
		RESEARCH (To be chosen only by students of 4-year UG Hons. with research instead of the above optional paper)	B050706R 6 X	RESEARCH Only by students of 4-year UG Hons. 4	RESEARCH WORK 100	4
	VIII Or Msc II sem	COMPULSORY	B050801T 1	DEVELOPMENTAL BIOLOGY AND IMMUNOLOGY 6	THEORY 75+25	4
			B050802T 2	BIOCHEMISTRY AND MAMMALIAN PHYSIOLOGY 6	THEORY	4
			B050803T 3	BIOTECHNIQUES AND BIostatISTICS 6	THEORY	4
		OPTIONAL	CHOOSE ANY ONE OF THE FOLLOWING			
			B050804A 4	MAMMALIAN ENDOCRINOLOGY 6	75+25	4
			B050804B	NEUROBIOLOGY	THEORY	
			B050805R 5	PRACTICAL COMPULSORY 6	75+25 PRACTICAL	4

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	RESEARCH (To be chosen only by students of 4-year UG Hons. with research instead of the above optional paper)	B050806R.	RESEARCH Only by students of 4-year UG Hons.	RESEARCH WORK	4
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YEAR	SEM.	CATEGORY/TYPE OF THE COURSE	COURSE CODE	PAPER TITLE	THEORY / PRACTICAL	CREDIT
M.Sc SECOND YEAR	IX Or III-sem	(COMPULSORY)	B050901T 1	ANIMAL DIVERSITY	THEORY 675+25	4
			B050902T 2	PARASITOLOGY AND BIOINFORMATICS	THEORY 6	4
		(OPTIONAL)	OPTIONAL	CHOOSE ANY ONE OF THE FOLLOWING		
			B050903A 3 B050903B	ENVIRONMENTAL BIOLOGY OR PRINCIPLES OF TOXICOLOGY	THEORY 6	4
		Practical	B050904P 4	PRACTICAL COMPULSORY	Practical 6	4
		RESEARCH PROJECT 0	B050905R 5	RESEARCH PROJECT FOR ALL STUDENTS 07	PROJECT/ Dissertation 100	4
	X Or IV-sem					
		OPTIONAL GROUPS	OPTIONAL PAPERS	CHOOSE ONE PAPER FROM EACH GROUP		
		GROUP - I	B0501001A 1	APPLIED ICHTHYOLOGY	THEORY 675+25	4
			B0501001B	CELLULAR ORGANIZATION & FUNDAMENTAL PROCESSES: CELL STRUCTURE	THEORY	4
			B0501001C	GENERAL AND CLINICAL ENDOCRINOLOGY	THEORY	4
		GROUP - II	B0501002A 2	FISH PHYSIOLOGY AND FISH PATHOLOGY	THEORY	4
			B0501002B	CELL ENERGETICS & IMMUNOLOGY	THEORY	4
			B0501002C	COMPARATIVE ENDOCRINOLOGY	THEORY	4
		GROUP - III	B0501003A 3	FISH TAXONOMY & SPECIALIZED ORGANS	THEORY	4

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	B0501003B	CHROMOSOMES , PATTERNS OF INHERITANCE & EXTENSION OF MENDELISM	THEORY	4
	B0501003C	MOLECULAR ENDOCRINOLOGY AND MAMMALIAN REPRODUCTIVE SYSTEM	THEORY	4
PRACTICAL	⁴ B051004P	PRACTICAL COMPULSORY	PRACTICAL	4
RESEARCH PROJECT	⁵ B0501005R	RESEARCH PROJECT FOR ALL STUDENTS	PROJECT/ DISSERTATION ON 100	4

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Programme/Class: Bachelor's Degree (with Research)		Year: Four	Semester: Seventh
Subject: Zoology			
Course Code: -B050701T		Course Title: Paper1: Cell Structure and Function	
Course Outcomes: The student at the completion of the course will be able to: 1. Understand the structure and function of all the cell organelles. 2. Know about the chromatin structure and its location. 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. How one cell communicates with its neighboring cells?			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic		No. of Lectures
I	Prokaryotes: <i>Bacteriophage (Lambda phage, Phi x 174), Animal DNA virus (SV 40) Retroviruses (HIV), Bacteria: Plasmid and their functions</i>		12
II	Eukaryotes: <i>Active transport: Mechanism and related calculations Targetting and sorting of proteins Processing through endomembrane system, Targetting of cytosolic proteins</i>		12
III	Cytoskeleton: <i>Microfilaments: Structural organization, cell motility and cell shape Microtubule: Structural and functional organization, cilia, flagella, centriole Intermediate filaments</i>		12
IV	Cell Division, Cell cycle and its Regulation.		12
V	Cell signaling: <i>G protein coupled receptors: signaling via cAMP, IP3, Ca²⁺/calmodulin. Cell death pathways and their significance: Necrosis, Apoptosis</i>		12

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Recommended Books:

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. De Robertis: *Cell and Molecular Biology* (2017)

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

Programme/Class: Bachelor's Degree (with Research)	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: -B050702T	Course Title: Paper 2: Genetics &Cytogenetics	
Course Outcomes: 1. Understand the basic principles of genetics and how genes (earlier called factors) are inherited from one generation to another. 2. Understand the Mendel's laws and the deviations from conventional patterns of inheritance. 3. Comprehend how environment plays an important role by interacting with genetic factors. 4. How to detect chromosomal aberrations in humans and study the pattern of inheritance by pedigree analysis in families.		
Credits: 04	Paper: Core Compulsory	
Max. Marks: 25+75	Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.		

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Unit	Topic	No. of Lectures
I	<i>Fine structure of gene (rII locus)</i> <i>Regulation of gene activity in lac and trp operons of E. coli</i>	15
II	<i>Introduction to gene regulation in eukaryotes</i> <i>Organization of a typical eukaryotic gene</i> <i>Transcription factors, enhancers and silencers</i> <i>Transcriptional and post-transcriptional regulation.</i>	15
III	<i>Genome Organization: Nucleosomes and higher order structures, Structure of DNA, Histones and non-histone chromosomal proteins</i> <i>Chromatin modifications</i>	15
IV	<i>Morphological and functional elements of eukaryotic chromosome</i> <i>Coding and Non-coding DNA,</i> <i>Mobile DNA</i> <i>Mutation: Types and causes</i>	15
V	<i>Karyotyping: Preparation, banding technique (G- banding, R- banding, C- banding; Idiogram construction</i>	12
Recommended Books: 1. Lewin B. <i>Genes VIII</i> . Pearson (2004). 2. Watson et al. <i>Molecular Biology of the Gene</i> . Pearson (2004). 3. Klug et al. <i>Concepts of Genetics</i> (2018) 4. Brooker R.G. <i>Genetics Analysis and Principles</i> (1999) 5. Gardner et al. <i>Principles of Genetics</i> (2006)		
This course can be opted as an elective by the students of following subjects: Open to all		
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:		
Project/Assignment		10 Marks

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Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

Programme/Class: Bachelor's Degree (with Research)	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: -B050703T	Course Title: Paper 3: Molecular Biology and Genetic Engineering	
Course Outcomes: <i>The student at the completion of the course will be able to have:</i> 1. <i>A detailed and conceptual understanding of molecular processes viz. DNA to trait.</i> 2. <i>A clear understanding of the processes of central dogma viz. transcription, translation etc. Underlying survival and propagation of life at molecular level.</i> 3. <i>Understanding of how genes are ultimately expressed as proteins which are responsible for the structure and function of all organisms.</i> 4. <i>Learn how four sequences (3 letter codons) generate the transcripts of life and determine the phenotypes of organisms.</i> 5. <i>How genes are regulated differently at different time and place in prokaryotes and eukaryotes.</i> 6. <i>Understand the principles of genetic engineering, how genes can be cloned in bacteria and the various technologies involved in it.</i> 7. <i>Know the applications of biotechnology in various fields like agriculture, industry and human health.</i> 8. <i>Know the basics of industrial biotechnology.</i> 9. <i>Get introduced to DNA testing and utility of genetic engineering in forensic sciences.</i> 10. <i>Take up research in biological sciences.</i>		
Credits: 04	Paper: Core Compulsory	
Max. Marks: 25+75	Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.		

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Unit	Topic	No. of Lectures
I	<i>Mechanism of DNA replication in prokaryotes and eukaryotes, DNA polymerases, Origin of replication and formation of primosome, Replication fork and replisome, Termination of replication</i>	15
II	<i>Transcription and its regulation, RNA polymerases in prokaryotes and eukaryotes, Transcription factors: general and specific, Assembly of pre-initiation complex and initiation, Elongation and elongation factors and termination.</i> <i>Processing of hn-RNA, Capping, Poly(A) tailing, Splicing</i>	15
III	<i>Genetic code</i> <i>Mechanism of translation: Role of ribosomes and tRNAs, Formation of initiation complex, Elongation and termination.</i> <i>Recombinant proteins: expression and application</i>	15
IV	<i>Genetic engineering:</i> <i>Restriction enzymes and other enzymes for DNA manipulation</i> <i>Vector types: cloning and expression, Probes, cDNA and genomic libraries</i> <i>Screening of clones</i>	15
V	<i>Application: Transgenic organisms and genetically modified organisms (GMOs), Animal cloning, Ethical and social issues</i> <i>Vaccine production; Humulin production, Gene therapy, MABS</i>	15

Recommended Books:

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. Clark & Switzer. *Experimental Biochemistry*. Freeman (2000)
10. Primrose & Twyman. *Principles of Genome Analysis and Genomics*. Blackwell (2003).
11. Hartl & Jones. *Genetics: principles & Analysis of Genes & Genomes*. Jones & Bartlett (1998).

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12. Sambrook et al. *Molecular Cloning Vols I, II, III*. CSHL (2001).

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

OPTIONAL

Programme/Class: Bachelor's Degree (with Research)	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: -B050704A	Course Title: Paper 4: Evolution & systematics	
Course Outcomes: <i>The student at the completion of the course will be able to:</i> <i>1. 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.</i> <i>2. Understand that natural selection is one of several processes that can bring about evolution; although it can also promote stability rather than change.</i> <i>3. To understand and identify behaviours in a variety of taxa.</i> <i>4. The proximate and ultimate causes of various behaviours.</i> <i>5. About the molecules, cells, and systems of biological timing systems.</i> <i>6. Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.</i> <i>7. To interpret the cause and effect of lifestyle disorders contributing to public</i>		

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understanding of biological timing.

Credits: **04**

Paper: **Core Compulsory**

Max. Marks: **25+75**

Min. Pass Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0.**

Unit	Topic	No. of Lectures
I	An overview of evolutionary thoughts, development and the concept of synthetic theory. Population genetics: Gene frequencies in Mendelian population, Hardy-Weinberg equilibrium, Conditions for the maintenance of genetic equilibrium,	12
II	Elemental forces of evolution: Mutation, Selection (types of selection, selection coefficient, selection in natural populations), Random genetic drift, Migration Isolating mechanisms Molecular phylogenies	12
III	Types of fossils, Incompleteness of fossil record, Dating of fossils, Evolution of Human	12
IV	Concept of biosystematics & Taxonomy, New trends of taxonomy. Procedure in taxonomy: classification hierarchy of categories taxonomic and nontaxonomic character. different species concepts, subspecies and infraspecific categories	12
V	Concepts of species and models of speciation: allopatric, sympatric and stasipatric International code of zoological nomenclature (ICZN)	12

Recommended Books:

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. Alcocks J (2009) *Animal Behaviour*
7. Aubrey M (2012) *An Introduction to Animal Behaviour*
8. Ernst M (1969) *Principals of Systematic Zoology*

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

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Open to all	
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:	
Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

Programme/Class: Bachelor's Degree (with Research)	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: -B050704B	Course Title: Paper 5: Animal Behavior	
Course Outcomes: <i>The student at the completion of the course will be able to:</i> <i>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.</i> <i>Understand that natural selection is one of several processes that can bring about evolution; although it can also promote stability rather than change.</i> <i>To understand and identify behaviours in a variety of taxa.</i> <i>The proximate and ultimate causes of various behaviours.</i> <i>About the molecules, cells, and systems of biological timing systems.</i> <i>Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.</i> <i>To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing.</i>		
Credits: 04	Paper: Core Compulsory	
Max. Marks: 25+75	Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.		

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Unit	Topic	No. of Lectures
I	Introduction to behaviour, Patterns of behaviour Biological rhythms & Biological clocks: Circadian, circannual rhythm and tidal rhythms. Orientation and navigation Migration of fishes, and birds	12
II	Communication in Animals Auditory, Chemical, Tactile, visual, and acoustic communication	12
III	Role of Hormones and Pheromones in control of behavior Animal signals and communication, Evolution of animal signals Sexual conflict: Parental care, Sexual selection	12
IV	Social organization in Termites and Apes; Theories of social behaviour, Altruism in eusocial animals	12
V	Mimicry and Colouration: Types of Mimicry: protective and aggressive Types of colouration: protective aggressive and warning	12

Recommended Books:

9. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
10. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
11. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
12. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
13. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
14. Alcock J (2009) *Animal Behaviour*
15. Aubrey M (2012) *An Introduction to Animal Behaviour*
16. Ernst M (1969) *Principals of Systematic Zoology*

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

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Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	<i>To study this course, a student must have passed/opted Zoology in B.Sc. IV</i>

Programme/Class: Bachelor's Degree (with Research)	Year: Four	Semester: Seventh
Subject: ZOOLOGY		
Course Code: - B050705P	Course Title: Practical: Zoology Practical	

Course Outcomes:

After 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.
7. Learn about some of the commonly used advance DNA testing methods.
8. Understand the principles of genetic engineering with hands-on experiments in mutation detection, testing of infectious diseases like Covid 19.
9. Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
10. Get employment in Hospitals/Diagnostic and forensic labs/Counsel families with genetic disorders.
11. Enable students to take up research in biological sciences.

Credits: 04		Paper: Core Compulsory
Max. Marks: 25+75		Min. Pass Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.		
Unit	Topic	No. of Lectures
I	1. To study the different types of cell such as buccal epithelial cells, nerve cells, striated muscle cell using Methylene blue.	20

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	- To study the mitochondria using Janus Green B. - To study the different stages of mitosis in onion root tip - To study the different stages of meiosis in testis of grasshopper - Enumeration of red blood cells and white blood cells using haemocytometer - Preparation of molecular models of amino acids, dipeptides, nucleotides etc.	
II	- Study of sex chromatin (Barr body) in human female from buccal epithelial and hair bud cells using Methylene blue - Preparation of polytene chromosome from salivary gland cell of <i>Drosophila</i> and <i>Chironomus</i> - Examination of wild type (males and females) and mutants of <i>Drosophila</i> - Handling of <i>Drosophila</i> and study of its life cycle - Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. - To prepare family pedigree against rare disease - Survey of human genetic disease - Study of colchicinated metaphase chromosomes in bone marrow of rodent by air dry method - Sex linked inheritance in <i>Drosophila melanogaster</i> - Linkage and crossing over in <i>Drosophila melanogaster</i> - Genetics exercise (data to be provided) - Study of permanent slides for the following - Dicentric bridge in the anaphase I chromosomes of grasshopper - Inversion in polytene chromosomes - Autoradiography detection of transcription in polytene chromosomes - Lampbrush chromosomes of <i>Triturus</i> oocyte - G-banded and C-banded metaphase chromosomes - Chromatid exchanges and chromosomal anomalies - Sister chromatid exchanges - Replicon organization by DNA-fibre autoradiography - Premature chromosome condensation	20
III	- Study of circadian functions in humans (daily eating, sleep and temperature patterns). - Phototaxis behavior in house fly - Study of courtship behavior in <i>Drosophila</i> - Schooling behavior in fishes - Chemotaxis behavior in earthworm	20

Recommended Books:

- 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).

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5. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby Kuby Immunology. W HFreeman (2007).
6. Lewin. Genes VIII. Pearson (2004).
7. Pierce B. Genetics. Freeman (2004).
8. Sambrook et al .Molecular Cloning Vols I, II, III. CSHL (2001).

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

1. A complete record of practical exercises in Zoology lab done during the session must be produced by the candidates in three separate record books at the time of practical examination.
2. Total duration of practical examination will be 6 hours spread over one day.

Programme/Class: Bachelor's Degree (with Research)		Year: Four	Semester: Seventh
Subject: ZOOLOGY			
Course Code: -B050706R		Course Title: Paper 6: Research Project / Dissertation	
Credits: 04		Paper: Core Compulsory	
Max. Marks: 100		Min. Pass Marks:	
This course can be opted as an elective by the students of following subjects: Open to all			
Course prerequisites:		To study this course, a student must have passed/opted Zoology in B.Sc. IV	

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Programme/Class: Bachelor's Degree (with Research)		Year: Four	Semester: Eighth
Subject: ZOOLOGY			
Course Code: -B050801T		Course Title: Paper 7: Developmental biology and Immunology	
Course Outcomes:			
After completing this course, the students will be able to:			
1. Understand how the single cell formed at fertilisation forms an embryo and then a full adult organism. 2. Integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development. 3. Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features. 4. 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: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic		No. of Lectures
I	Gametogenesis: Spermatogenesis - formation of spermatids and spermiogenesis; Oogenesis- oocyte growth, maturation and vitellogenesis, Types of eggs. Fertilization: Molecular events during pre- and post-fertilization, Prevention of polyspermy and egg activation, IVF		15
II	Cleavage- patterns and mechanisms; Reorganization of embryonic cells-gastrulation and fate of germinal layers. Regeneration, Senescence, Stem cells and their applications.		15
III	Extra-embryonic membranes; Placenta: Structure function and types; Dynamics of organ development		
IV	Concept of Immunity. Immune cells: Activation and differentiation of B and T cells. Innate Immunity and Humoral immunity, Antigen and haptens.		15

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	Antibody: types, structure, Generation of antibody diversity and functions. Cell mediated immunity, T cell receptors, MHC	
V	Proteins in immune system: Monoclonal antibodies Interferons Inflammation, hypersensitivity and autoimmunity Vaccination Basic concept of cancer.	15

Recommended Books:

1. *Developmental Biology*: T. Subramaniam, (Reprint), Narosa Publishing House Pvt. Ltd., New Delhi(2013).
2. *Essential Developmental Biology*: Jonathan M. W. Slack, (3rd ed.), Wiley-Blackwell. (2012).
3. *Developmental Biology: From a Cell to an Organism (Genetics & Evolution)* eBook: Russ Hodge, Infobase Publishing. (2009).
4. *Current Topics in Developmental Biology*: Roger A. Pedersen, Gerald P. Schatten, Elsevier. (1998).
5. *Developmental biology*: Werner A. Müller, Springer Science & Business Media. (2012).
6. *Human Embryology and Developmental Biology E-Book*: Bruce M. Carlson, Elsevier Health Sciences. (2018).
7. (2018).
8. *Developmental Biology*: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).
9. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby Kuby Immunology. W H Freeman (2007).
10. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).
11. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)
- 12.

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

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Programme/Class: Bachelor's Degree (with Research)		Year: Four	Semester: Eighth
Subject: ZOOLOGY			
Course Code: -B050802T		Course Title: Paper 8: Biochemistry and Mammalian Physiology	
Course Outcomes: After completing this course, the students will be able to know: 1. To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates 2. How simple molecules together form complex macromolecules. 3. To understand the thermodynamics of enzyme catalyzed reactions. 4. Mechanisms of energy production at cellular and molecular levels. 5. To understand systems biology and various functional components of an organism. 6. To explore the complex network of these functional components. 7. To comprehend the regulatory mechanisms for maintenance of function in the body.			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	<i>Carbohydrates: Structure and classification.</i> <i>Lipids: Structure and classification, Cholesterol synthesis and transport, Eicosanoids.</i> <i>Protein structure: primary structure, Forces and interactions involved in structural organization of fibrous and globular proteins</i>	12	
II	<i>Enzymes: classification, Enzyme kinetics, Michaelis-Menten equation,</i> <i>Mechanism of action: Active site, substrate binding, transition state analogues and abzyme, Acid-base and covalent catalysis (chymotrypsin, carboxypeptidase)</i> <i>Concepts of regulation of enzyme activity</i>	12	
III	<i>Digestion and absorption of carbohydrates, lipids and proteins</i> <i>Hormonal and neural regulation of gastrointestinal function</i>	12	

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	<i>Muscle: Muscle proteins, Mechanism of contraction and energetics.</i>	
IV	<i>Blood and circulation:</i> <i>Blood corpuscles, Haemopoiesis, blood groups, haemoglobin and haemostasis</i> <i>Lymph: composition and dynamics.</i> <i>Origin and conduction of cardiac impulse, ECG</i> <i>Respiration:</i> 2.1. Exchange and transport of gases 2.2. Neural and chemical regulation of respiration 2.3. Respiratory adaptation to low oxygen tension	12
V	<i>Excretion: Urine formation, Regulation of water balance, Electrolyte balance and Acid-base balance.</i> <i>Nervous system: Membrane potential and action potential, Transmission of nerve impulse, Types of synapses and synaptic transmission.</i>	12

1. Recommended Books:

- Nelson & Cox: *Lehninger's Principles of Biochemistry*: McMillan (2000)
- Zubay et al: *Principles of Biochemistry*: WCB (1995)
- Voet & Voet: *Biochemistry Vols 1 & 2*: Wiley (2004)
- Murray et al: *Harper's Illustrated Biochemistry*: McGraw Hill (2003) Elliott and Elliott;
- Biochemistry and Molecular Biology*: Oxford University Press 14
- Guyton, A.C. & Hall, J.E. *Textbook of Medical Physiology*. XI Edition. Hercourt Asia PTE Ltd. /W.B.Saunders Company. (2006).
- Tortora, G.J. & Grabowski, S. *Principles of Anatomy & Physiology*. XI Edition John Wiley & sons (2006).
- Christopher D. Moyes, Patricia M. Schulte. *Principles of Animal Physiology*. 3rd Edition, Pearson Education (2016).
- Hill, Richard W., et al. *Animal physiology*. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
- 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:

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

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Programme/Class: Bachelor's Degree (with Research)		Year: Four	Semester: Eighth
Subject: ZOOLOGY			
Course Code: -B050803T		Course Title: Paper 9: BIOTECHNIQUES AND BIOSTATISTICS	
Course Outcomes: After completing this course, the students will be able to learn: 1. Understand the basic principles of microscopy, working of different types of microscopes 2. Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules. 3. Understand the principle of measuring the concentrations of macromolecules in solutions by colorimeter and spectrophotometer and use them in Biochemistry. 4. To learn about the use of biostatistics in research and data analysis purpose. 5. To learn the separation of different type of DNA and RNA			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Theory (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	Types of microscopes and their biological applications: Phase contrast microscope, Fluorescence microscope, Transmission and scanning electron microscope.	15	
II	Centrifugation: Principle, High speed and ultracentrifuge Spectrophotometry: Types of spectrophotometers, Beer-Lambert's law, Applications	15	
III	Electrophoresis: Principle, Agarose and polyacrylamide gel Detection of proteins: Western blotting, Recombinant DNA techniques: Southern and Northern hybridizations. Polymerase chain reaction: principle and applications	15	
IV	Measures of central tendency: Arithmetic Mean, Median, Mode Measures of dispersion: Variance, Standard deviation and Standard error;	15	

S2AC

	Correlation: Calculation of correlation in continuous data and ordinal data	
V	Regression: Linear regression, Regression coefficient Analysis of variance (ANOVA): One way Hypothesis testing: t-test, Chi-square test, Z-test	15

Recommended Books:

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. Sambrook et al. Molecular Cloning Vols I, II, III. CSHL (2001).
7. Primrose. Molecular Biotechnology. Panima (2001).
8. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
9. Pagano et al. (2022) Principles of biostatistics

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

Note: Select any one of the elective course code B050804T and B050805T.

Programme/Class: Bachelor's Degree (with Research)	Year: Four	Semester: Eighth
Subject: ZOOLOGY		
Course Code: -B050804A	Course Title: Paper 6: Mammalian Endocrinology	
Course Outcomes: After completing this course, the students will be able to: 1. Learn the roles of the endocrine system in maintaining homeostasis, integrating growth and		

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development, responding to environmental insults and promoting successful reproduction.

2. Understand the definition of a hormone in terms of its general properties.
3. Gain knowledge about among endocrine, paracrine and autocrine systems.
4. Learn the different classes and chemical structures of hormones.
5. Identify the glands, organs, tissues and cells that synthesize and secrete hormones, hormone precursors and associated compounds.
6. Learn the synthesis and modes of secretion of hormones.
7. Understand how the secretion of hormones is regulated, including the principles of negative and positive feedback mechanisms.

Credits: **04**

Paper: **Core Compulsory**

Max. Marks: **25+75**

Min. Pass Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): **6-0-0**.

Unit	Topic	No. of Lectures
I	Hypothalamo-hypophysial System: General organization, Neurohypophysial and Adenohypophysial hormones: chemistry and physiological roles of oxytocin and vasopressin, Somatotropin and prolactin, FSH, LH and TSH, ACTH, MSH.	15
II	Mechanism of hormone action: Protein hormones and Steroid hormones (genomic and nongenomic pathways)	15
III	Thyroid hormones: biosynthesis, control of secretion and physiological roles. Steroid hormones: biosynthetic pathways, physiological roles of androgens, estrogen, progesterone, relaxin and inhibin.	15
IV	Adrenal cortex: Organization, Physiological role of glucocorticoids and mineralocorticoids. Adrenal medulla: catecholamine biosynthesis, release and physiological role. Role of parathormone, calcitonin and vitamin D in calcium homeostasis.	15
V	Endocrine pancreas: biosynthesis and physiological actions of insulin and glucagon. Gastrointestinal hormones: secretin, gastrin and cholecystokinin. Pineal organ: structure and function.	15

Recommended Books:

1. Norris and Carr (2020) Vertebrate Endocrinology
2. Hadley, M.C.: Endocrinology, Prentice Hall, International Edition, 2000
3. Wilson and Foster, Williams Text Book of Endocrinology 10th edition, W.B. Saunders

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Company Philadelphia, 2005

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

Programme/Class:	Year:	Semester:
Bachelor's Degree (with Research)	Four	Eighth
Subject: ZOOLOGY		
Course Code: -B050804B	Course Title: Paper 9: Neurobiology	
Course Outcomes: After completing this course, the students will be able to learn:		
1. Understand the structure and function of neurons, nerves, and nervous tissue along with their working mechanisms behavior. 2. Learn about neuron, nerves, glial cells, neurotransmitters, acetylcholine, dopamine, serotonin, central nervous system, neural networks, peripheral nervous system, Automatic nervous system, endocrine system, Hormones, etc. 3. Understand the different neuronal degenerative diseases (Alzheimer disease, Huntington disease, Parkinson disease). 4. Learn integrated approach towards neuroscience and builds a student's expertise via experimental skill training as well as theoretical learning. It gives a clear outline of how neuroscience evolved and the future that it holds for the upcoming generations.		
Credits: 04	Paper: Core Compulsory	
Max. Marks: 25+75	Min. Pass Marks:	

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Total No. of Lectures-Tutorials-Theory (in hours per week): 6-0-0.

Unit	Topic	No. of Lectures
I	Plasticity of brain and neurogenesis Organization of nervous system Brain structure Neurons and glia Cerebrospinal fluid Neural network Blood brain barrier Autonomic nervous system	15
II	Axonal and synaptic transmission Types of neurons Resting Potential & Action potential, Propagation of Nerve Impulses. Types of synapses Excitatory and inhibitory post-synaptic potential Chemical transmission, neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides	15
III	Neuropathology Strokes; Epilepsy; Alzheimer disease; Huntington disease; Parkinson disease	15
IV	Neurophysiology: Neurons and glial cells, Degeneration & regeneration /repair of nerve fibers, Nerve growth factors. Synaptic & neuro-muscular transmission, Muscle tone, posture, Equilibrium & their regulation.	15
V	Pain production, pathways and analgesics, head ach & referred pain. Vestibular apparatus & motion sickness. Integrative functions of thalamus, cerebellum, basal ganglia & Cerebral cortex. Electroencephalogram (EEG)	15

Recommended Books:

1. Ganong: Review of Medical Physiology (22nd ed 2005, Lang Medical Publications)
2. Guyton and Hall: Text Book of Medical Physiology (11th ed 2006, W.B. Saunders)
3. Keel et al: Samson Wright's Applied Physiology (13th ed 1989, Oxford Press)
4. Murray et al: Harper's Illustrated Biochemistry (27th ed 1989, Appleton & Lange)
5. West: Best and Taylor's Physiological Basis of Medical Practice (11th ed 1981, Williams and Wilkins)
6. Longstaff: Neuroscience (2002, Viva Books)
7. Shepherd: Neurobiology (1994, Oxford Univ Press)
8. Squire et al: Fundamental Neuroscience (2003, Academic Press)

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9. *Eric Kandel: Principles of Neural Science (2000, Mc Graw Hill)*

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

Open to all

Suggested Continuous Evaluation Methods:

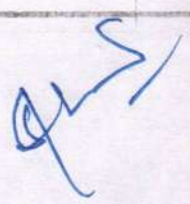
Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. IV

Programme/Class: Bachelor's Degree (with Research)	Year: Four	Semester: Eighth
Subject: ZOOLOGY		
Course Code: - B050805P	Course Title: Zoology Practical	
Course Outcomes: After completing this course, the students will be able to: 1. Learn the different classes and chemical structures of hormones. 2. Identify the glands, organs, tissues and cells that synthesize and secrete hormones, hormone precursors and associated compounds. 3. Understand the structure of biomolecules like proteins, lipids and carbohydrates 4. Perform basic hematological laboratory testing, 5. Distinguish normal and abnormal hematological laboratory findings to predict the diagnosis of hematological disorders and diseases. 6. Understand the basic principles of microscopy, working of different types of microscopes. 7. Understand the basic techniques of centrifugation and chromatography for studying cells and separation of biomolecules. 8. Understand the principle of measuring the concentrations of macromolecules in solutions by colorimeter and spectrophotometer and use them in Biochemistry. 9. Understand how the single cell formed at fertilisation forms an embryo and then a full adult organism in <i>Drosophila melanogaster</i>. 10. Understand the developmental stages in the chick embryo.		

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Credits: 04		Paper: Core Compulsory
Max. Marks: 25+75		Min. Pass Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.		
Unit	Topic	No. of Lectures
I	1. Handling and maintenance of rat in laboratory 2. Demonstrate the endocrine glands and reproductive organs in mammals 3. Surgical ablations of testis, ovary, adrenal and thyroid in mammals 4. Study of oestrous cycle of rat by vaginal smear preparation 5. Study of the following using permanent slides 5.1 Endocrine glands and reproductive organs (testis and ovary) of mammals 5.2 Thyroid of mammals 5.3 Adrenal homologues (interrenal and chromaffin tissues) in mammals 5.4 Cell types of pituitary gland in mammals 5.5 Hypothalamo-neurohypophyseal system of a mammal in in situ preparation 6. Demonstration of ELISA-based hormone assay 7. Endocrine glands of rat (Location through models, Charts) 8. Endocrine disorders (Photographs) 9. Principles of fixation and staining of nervous tissue; Methods of tissue processing for microtomy, cryotomy and vibratome 10. Golgi and other impregnation methods in brain tissues. 11. Immunocytochemistry: Principles and application 12. Isolation of neurons and glia by differential centrifugation 13. Perfusion techniques 14. Fluorescence microscopy and immunofluorescence methods	20
II	1. To study different mammalian blood cell types using Leishman stain. 2. Determination of ABO Blood group 3. Estimation of haemoglobin using Sahli's haemoglobinometer 4. Preparation of haemin and haemochromogen crystals 5. Recording of blood pressure using a sphygmomanometer 6. Recording of blood glucose level by using glucometer 7. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid gland. 8. Recording of simple muscle twitch with electrical stimulation (or Virtual) 9. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex) 10. Ninhydrin test for α-amino acids. 11. Benedict's test for reducing sugar and iodine test for starch.	20

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	12. Test for sugar, protein and ketone bodies in urine. 13. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 14. Paper chromatography of amino acids. 15. To prepare solutions and buffers. 16. Action of salivary amylase under optimum conditions. 17. Determination of Haemoglobin (gm %) in human blood; also calculation of colour index and the mean corpuscular haemoglobin concentration 18. Estimation of total leucocyte number per cubic mm of frog and human blood 19. Differential count of leucocytes in the human blood 20. Estimation of total erythrocyte count per cubic mm of blood 21. Cell permeability of RBC of human blood in saline solution of different concentrations	
III	1. Study of eggs from collected / preserved material 2. Study of development of frog, chick, and Drosophila 3. Study of chick embryos from 16-18 hrs, 24-28 hrs 33-36 hrs, 42-72 hrs of development (Whole mount models, charts) 4. Study of development of chick by window method 5. Study of primary and secondary lymphoid organs through microphotograph or models or chart. 6. Immunoprecipitation dry lab exercise. 7. Performance of ELISA test [Dry lab exercise in case lab facility is not available]. 8. Immunohistochemistry [Dry lab exercise in case lab facility is not available]. 9. Western blotting [Dry lab exercise in case lab facility is not available]. 10. Comments including principle, functioning and utility of some common instruments like Microscopes, Microtome, Colorimeter, Spectrophotometer, Centrifuge, Electrophoresis 11. Calculation of mean, median, mode, standard deviation, standard error from the data provided 12. Virtual Labs 1. Gel Documentation System-https://youtu.be/WPpt3-FanNE 2. Colorimeter- https://youtu.be/v4aK6G0bGuU 3. PCR Part 1- https://youtu.be/CpGX1UFS14A 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	20

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8. Spectrophotometer-<https://youtu.be/ubL8QxTeuG4>

9. Agarose Part 1- <https://youtu.be/7gyHPFww--g>

10. Agarose part 2- https://youtu.be/j_bOZCHNsSg

Recommended Books:

1. Norris and Car (2020) *Vertebrate Endocrinology*
2. Hadley, M.C.: *Endocrinology*, Prentice Hall, International Edition, 2000
3. Wilson and Foster, *Williams Text Book of Endocrinology* 10th edition, W.B. Saunders
4. Company Philadelphia, 2005
5. Lodish et al: *Molecular Cell Biology*: Freeman & Co, USA (2004).
6. Alberts et al: *Molecular Biology of the Cell*: Garland (2002).
7. Cooper: *Cell: A Molecular Approach*: ASM Press (2000).
8. Karp: *Cell and Molecular Biology*: Wiley (2002).
9. Watson et al. *Molecular Biology of the Gene*. Pearson (2004).
10. Sambrook et al. *Molecular Cloning Vols I, II, III*. CSHL (2001).
11. Primrose. *Molecular Biotechnology*. Panima (2001).
12. Clark & Switzer. *Experimental Biochemistry*. Freeman (2000)
13. Pagano et al. (2022) *Principles of biostatistics*
14. *Current Topics in Developmental Biology*: Roger A. Pedersen, Gerald P. Schatten, Elsevier. (1998).
15. *Developmental biology*: Werner A. Müller, Springer Science & Business Media. (2012).
16. *Human Embryology and Developmental Biology E-Book*: Bruce M. Carlson, Elsevier Health Sciences. (2018).
17. *Developmental Biology*: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II	Year: Five	Semester: Ninth
Subject: ZOOLOGY		
Course Code: -B050806R	Course Title: Paper 10: Research Project / Dissertation	
Credits: 04	Paper: Core Compulsory	
Max. Marks: 100	Min. Pass Marks:	
This course can be opted as an elective by the students of following subjects: Open to all		
Course prerequisites:	To study this course, a student must have	

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passed/opted Zoology in B.Sc. III

Subject: ZOOLOGY

Course Code: -B050901T

Course Title:

Paper 1: Animal diversity

Course Outcomes:

After completing this course, the students will be able to:

1. Demonstrate comprehensive identification abilities of non-chordate diversity
2. Explain structural and functional diversity of non-chordate
3. Explain evolutionary relationship amongst non-chordate groups
4. Get employment in different applied sectors
5. Students can start their own business i.e. self employments.
6. Enable students to take up research in Biological Science
7. Learn some important aspects of applied zoology in daily life.

Credits: 04

Paper: Core Compulsory

Max. Marks: 25+75

Min. Pass Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.

Unit	Topic	No. of Lectures
I	Protozoa: Nucleus, Reproduction Porifera: canal system Cnidaria: Polymorphism in Siphonophora, Nematocysts	15
II	Annelida: Adaptive radiation in Polychaetes. Trochophore larva Mollusca: Torison and detorison.	15

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III	Arthropoda: Tracheal System; Crustacean larvae and their significance. Insects as friends and foes	15
IV	Echinodermata: Water Vascular System; larval forms and their significance. Salient features and affinities of: Hemichordata, Urochordata, Cephalochordata, Cyclostomes	15
V	Origin of vertebrates Organization of Coelome: Protostomia and deuterostomia	15

Recommended Books:

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. Bisht. D.S., *Apiculture*, ICAR Publication.
9. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.
10. Jhingran. V.G. *Fish and fisheries in India*.
11. Khanna. S.S, *An introduction to fishes*
12. Boyd. C.E. & Tucker. C.S, *Pond aquaculture water quality management*,
13. Biswas. K.P, *Fish and prawn diseases*,
14. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
15. Lee, *Earthworm Ecology*
16. Stevenson, *Biology of Earthworms*
17. *Destructive and Useful Insects* by C. L. Metcalf
18. *Sericulture for Rural Development : Hanumappa* (1978), Himalaya Publication,
19. *Sriculture in India* Sarkar, D.C. (1988), CSB, Bangalore.
20. Harvey et al: *The Vertebrate Life* (2006)
21. Colbert et al: *Colbert's Evolution of the Vertebrates: A history of the backboned animals through time* (5th ed 2002, Wiley - Liss)
22. Hildebrand: *Analysis of Vertebrate Structure* (4th ed 1995, John Wiley)
23. Kenneth V. Kardong (2015) *Vertebrates: Comparative Anatomy, Function, Evolution* McGraw Hill
24. McFarland et al: *Vertebrate Life* (1979, Macmillan Publishing)
25. Parker and Haswell: *TextBook of Zoology, Vol. II* (1978, ELBS)
26. Romer and Parsons: *The Vertebrate Body* (6th ed 1986, CBS Publishing Japan)
27. Young: *The Life of vertebrates* (3rd ed 2006, ELBS/Oxford)
28. Weichert C.K and William Presch (1970). *Elements of Chordate Anatomy*, Tata McGraw Hills

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

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Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II	Year: Fifth	Semester: Ninth
Subject: ZOOLOGY		
Course Code: -B050902T	Course Title: Paper 2: Parasitology and Bioinformatics	
Course Outcomes: <i>After completing this course, the students will be able to:</i> 1. <i>Identify, describe and contrast unicellular parasites and parasitic worms.</i> 2. <i>Describe specific human and non-human parasitic diseases.</i> 3. <i>Prepare and observe live parasitic specimens and test students' own seropositivity for a particular parasitic infection.</i> 4. <i>Report on observations of biological specimens such as parasites.</i> 5. <i>Appraise the impacts of parasitic diseases on human societies.</i> 6. <i>Get introduced to computers and use of bioinformatics tools.</i> 7. <i>Take up research in biological sciences.</i> 8. <i>Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics.</i> 9. <i>Existing software effectively to extract information from large databases and to use this information in computer modeling.</i> 10. <i>Problem-solving skills, including the ability to develop new algorithms and analysis methods an understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries</i>		
Credits: 04		Paper: Core Compulsory

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Max. Marks: 25+75		Min. Pass Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.		
Unit	Topic	No. of Lectures
I	Parasites and parasitism: General consideration, Type of parasites and hosts, Symbiosis and commensalisms. Molecular interaction between host and parasite and evasion of immunity.	15
II	Protozoan parasites: Distribution, habit and habitat, structure, life cycle and diseases caused by <i>Entamoeba histolytica</i> , <i>Leishmania donovani</i> , <i>Plasmodium</i> and <i>Trypanosoma brucei</i>	15
III	Helminth parasites: General characters, organization and larval forms of Platyhelminthes and Nematelminthes Distribution, habit and habitat, structure, life cycle and diseases caused by <i>Echinococcus granulosus</i> , <i>Schistosoma haematobium</i> , <i>Wuchereria bancrofti</i>	15
IV	Basic concept of bioinformatics: Concept of digital laboratory Basics of information technology for biologist Basic features and management systems of Nucleic acid sequences databases.	15
V	Introduction to data retrieval systems, Search engines, Entrez, protein identification resource; BLAST, FASTA	10
Recommended Books: 1. Thomas C. Chung. General Parasitology. Hardcourt Brace and Co. Ltd. Asia, New Delhi. 2. Gerard D. Schmidt and Larry S Roberts. Foundations of Parasitology. McGraw Hill. 3. Burton J et al. (2018) Human Parasitology 4. Parasitology- Chatterjee 5. Parasitology- Chakraborty 6. Xiong J (2006) Essential Bioinformatics, publisher Cambridge University Press 7. Westhead et al Bioinformatics: Instant Notes. Viva Books (2003).		
This course can be opted as an elective by the students of following subjects:		
Open to all		
Suggested Continuous Evaluation Methods:		

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Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III.

Note: Select any one of the elective course code B050903T and B050904T.

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II		Year: Fifth	Semester: Ninth
Subject: ZOOLOGY			
Course Code: -B050903A		Course Title: Paper 3: Environmental Biology	
Course Outcomes: After completing this course, the students will be able to: 1. Complexities and interconnectedness of various environmental levels and their functioning. 2. Global environmental issues, their causes, consequences and amelioration. 3. About the molecules, cells, and systems of biological timing systems. 4. Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons. 5. To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing.			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	<i>Ecosystem: Components of ecosystem, Energy flow in terrestrial and aquatic ecosystems and mineral cycling (CNP)</i>	15	
II	<i>Population ecology: Characteristics of a population and growth curve, Population regulation</i>	15	
III	<i>Ecological succession, Concept of climax. Community structure, Levels of species diversity</i>	15	

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	environmental factors, circadian rhythms.	
IV	Absorption and distribution of toxicants-portals of entry-skin, gastro intestinal tract, gills and respiratory system. Bio-distribution, biomagnification biotransformation of xenobiotics- brief introduction to Phase-I and Phase-II reactions.	15
V	Reactions of toxins with target molecules- Covalent binding, Non-covalent binding, Hydrogen abstraction, Electron transfer, Enzymatic reactions Elimination of toxicants-renal, hepatic, DMES, pulmonary systems, milk, egg and foetus.	15

Recommended Books:

1. Kent C (1998) *Basics of Toxicology*
2. Klaassen C. D. And Watkins J. B. (2021) *Casarett & Doull's Essentials of Toxicology*
3. Lee BM et al. (2017) *Lu's Basic Toxicology Fundamentals, Target Organs, and Risk Assessment*

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II	Year: Four	Semester: Ninth
Subject: ZOOLOGY		
Course Code: - B050904P	Course Title: Paper 5: Zoology Practical	
Course Outcomes:		

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Programme/Class: Bachelor's Degree (with Research)/M.Sc. II		Year: Fifth	Semester: Ninth
Subject: ZOOLOGY			
Course Code: -B050903B		Course Title: Paper 4: Principles of Toxicology	
Course Outcomes: After completing this course, the students will be able to: 1. Understand the core concepts of the science of toxicology, including hazard identification, exposure assessment, dose-response assessment and an understanding of the mechanisms of action and effects of toxic chemicals at multiple levels of biological organization. 2. Understand the role for the science of toxicology in society, including the importance of risk analysis, management and communication. Students will be able to identify and discuss contemporary issues in toxicology. 3. Learn technical aspects and experimental approaches in toxicological research, testing and risk assessment. 4. Competent in scientific analysis and communication, including the ability to analyze relationships, draw appropriate conclusions supported by data, and articulate in writing and orally a critical perspective using evidence as support. 5. Completing the programme students are well qualified to pursue entry levels in scientific employment in different industries.			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	Definition, history, scope & sub-divisions of toxicology. Dose-effect and dose-response relationship- acute toxicity, chronic toxicity reversible & irreversible effects.	15	
II	Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins.	15	
III	Factors affecting toxicity – species and strain, age, sex, nutritional status, hormones,	15	

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	Concept of habitat and niche, Edges and ecotones effects.	
IV	Conservation and management of natural resources Biodiversity: benefits and threats Endangered species management and biodiversity protection Concept of biodiversity Hotspots	15
V	Environmental health and toxicology Types of environmental health hazards Pollution: air, water, solid waste and radioactive Bioaccumulation and biomagnification	15

Recommended Books:

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

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

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After completing this course, the students will be able to:

1. Demonstrate comprehensive identification abilities of chordate and non- chordates diversity
2. understand structural and functional diversity of chordates and non- chordates
3. Learn evolutionary relationship amongst chordates and non- chordates
6. Learn complexities and interaction of various environmental levels and their functioning.
7. Understand about the global environmental issues, their causes, consequences and improvement.
8. Learn about the interactions of molecules, cells, and systems of biological timing.
9. Learn how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
10. To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing.
11. Identify, describe and contrast unicellular parasites and parasitic worms.
12. Understand specific human and non-human parasitic diseases.
13. Prepare and observe live parasitic specimens and test students' own seropositivity for a particular parasitic infection.
14. Report on observations of biological specimens such as parasites.
15. Appraise the impacts of parasitic diseases on human societies.
16. Hands on practice of computers and use of bioinformatics tools.
17. Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics.
18. Learn existing software effectively to extract information from large databases and to use this information in computer modeling.
19. Enable students to take up research in biological sciences.
20. Generate self employment.

Credits: 04

Paper: Core Compulsory

Max. Marks: 25+75

Min. Pass Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.

Unit	Topic	No. of Lectures
	Candidates must produce at the time of practical examination their preparations, collection and practical record books containing a complete record of the laboratory work done during the session. The practical work shall comprise: 1. Study of animal specimens of various animal phyla of non-chordate. 2. To prepare permanent stained slide of septal nephridia of earthworm. 3. To take out the nerve ring of earthworm. 4. To take out hastate plate from Palaemon. 5. Permanent Preparation of Euglena, Paramecium, amoeba, Oplina. 6. Permanent Preparation of Cimex (bed bug)/ Pediculus	20

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	(Louse), <i>Haematopinus</i> (cattle louse), fresh water annelids, arthropods; and soil arthropods. - Larval stages of helminths and arthropods. - 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. <i>Chironomus</i> larva, dragonfly and mayfly nymphs, preparation of antenna of housefly. - Identification of pests. - Life history of silkworm, honeybee and lac insect. - Dissect out the aristotle's lantern of sea urchin (<i>Echinus</i>) - Demonstrate the nervous system of Cockroach, <i>Palaemon</i>, <i>Squilla</i>, <i>Pila</i>, <i>Unio</i>, <i>Aplysia</i>, <i>Loligo</i>, <i>Sepia</i>, <i>Octopus</i>.	
II	- Study of animal specimens of various animals of phyla Chordata. - Comparative study of histological slides of different tissues of vertebrates. - To prepare stained/unstained slide of placoid scales. - Comparative study of bones of different vertebrates. <i>Scoliodon</i>: Afferent and efferent branchial vessels, Cranial nerves - Study on use and ethical handling of model organisms (Mice, rats, rabbit and guinea pig).	20
III	- Calculation of similarity index between different communities - Calculation of concentration of dominance for different communities - Calculation of Shannon Weiner Index of diversity in different communities - Determination of salinity and chlorinity in water samples - Determination of moisture content and total organic matter in soil sample - Determination of dissolved oxygen - Determination of free CO₂ in water sample - Determination of the thermal stratification and circulation period of a water body - Study of an aquatic ecosystem, its biotic components and food chain. - Estimation of pesticides in food brewages - Heavy metal analysis in contaminated food material - Study the biodegradation of waste discharged from food industry - Determination of NOAEL, LOAEL, LC₅₀, LD₅₀ using different drugs, heavy metals, pesticides, insecticides with the help of different animal models. - 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>Taenia</i>,	20

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Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma

Recommended Books:

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

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

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Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

1. A complete record of practical exercises in Zoology lab done during the session must be produced by the candidates in three separate record books at the time of practical examination.
2. Total duration of practical examination will be 6 hours spread over one day.

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II	Year: Fifth	Semester: NINTH
Subject: ZOOLOGY		
Course Code: - B050905R	Course Title: Paper 7: Research Project / Dissertation & Thesis Writing	
Credits: 04	Paper: Core Compulsory	
Max. Marks: 100	Min. Pass Marks:	
<i>This course can be opted as an elective by the students of following subjects: Open to all</i>		
Course prerequisites:	<i>To study this course, a student must have passed/opted Zoology in B.Sc. III</i>	

Group -I

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II	Year: Fifth	Semester: Tenth
Subject: ZOOLOGY		
Course Code: -B051001A	Course Title: Applied Ichthyology	
Course Outcomes: After completion of the course the students will acquire the knowledge of:		

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1. Identify diagnostic features of lineages of fishes distributed worldwide.
2. Analyze the anatomy, physiology, and reproductive biology of fishes, including information related to feeding, sensory systems, locomotion, and reproduction.
3. Synthesize information from primary literature on fish taxonomy, ecology, and evolution.
4. Learn principles of phylogeny to understand fish adaptations.
5. Familiar with principals of ecology, anatomy and behavior of fishes.
6. Learn culture of fishes and eradication of predatory and weed fishes.

Credits: 04

Paper: Core Compulsory

Max. Marks: 25+75

Min. Pass Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.

Unit	Topic	No. of Lectures
I	Inland capture fishery resources of India: Riverine fisheries: resources, exploitation, regulation Fish ponds: characteristics of ponds, control of weed and predators. Planktons in relation to fish production.	10
II	Fertilization and management of fishery pond: spawning, hatcheries, rearing, stocking, transport, and mortality of fish fry. Fish culture systems: composite culture, cage culture, pen culture.	10
III	Principal and importance of fish preservation: traditional and advanced methods of fish preservation, sun drying, salting, pickling, smoking, chilling, frying and canning etc. Crafts and Gears: Important traditional and modern crafts used for fish catch in inland and marine water,	12
IV	Application of biotechnology in aquaculture: Sex manipulation, chromosomal manipulation, gene engineering. Transgenic fishes Production of monosex and sterile fishes and their significance in aquaculture.	12
V	Factors responsible for induced breeding: Hypophysation, Use of different, synthetic and natural hormones, their formulation and mechanism of action, Bundh breeding, Hapa breeding, Hatchery breeding	12

Recommended Books:

1. Gupta SK and Gupta PC (2006) General and applied Ichthyology: Fish and Fisheries
2. Gill T (2018) Report on Ichthyology

3. Richardson J (2015) Ichthyology
4. Keenan T (2018) Ichthyology, An introduction to Fish Science
5. Srivastava, C.B.L. A. textbook of Fishery Science and Indian Fisheries.
6. Lagler et. Al. Ichthyology
7. Norman, J.R. A History of Fishes.
8. Kyle, H.M.A. Biology of Fishes
9. Khanna, S.S. An Introduction to Fishes.
10. Jhingram V.G. (1997) Fish and Fisheries of India

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

Open to all

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II		Year: Fifth	Semester: Tenth
Subject: ZOOLOGY			
Course Code: -B051001B		Course Title: Cellular Organization & Fundamental Processes: Cell Structure	
Course Outcomes: After completing this course, the students will be able to: 1. Learn to identify different types of cells in a liquid medium. 2. Learn to observe the types of cell movement. 3. Learn to identify and separate the cell organelles. 4. Recognize the elements of cytoskeleton 5. Learn to recognize the cell surface structures 6. Use the gain knowledge and understanding in research in biological sciences.			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	Molecular organization of eukaryotic chromosomes; Chromosome compaction (Nucleosome, solenoid); Organization and significance of heterochromatin	20	

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II	<i>Specialized chromosomes: Structural organization and functional significance of polytene chromosomes in cells of dipterans, lampbrush chromosomes of vertebrate oocytes and salivary gland of Drosophila</i>	
III	<i>Cell signaling: Signaling through membranes receptors (G protein coupled receptors, Receptor Tyrosine kinase); intracellular receptors (signaling of steroid molecules)</i>	15
IV	<i>Communication between cells and their environment: Interaction of cells with extracellular matrix and other cells; Integrin, selectins and cadherins, cellular junction</i>	10
V	<i>Cytoskeleton: structure and dynamics of microfilaments, intermediate filaments and microtubules.</i> <i>Cell cycle and its regulation; Cell aging</i>	15

Recommended Books:

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).

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
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Internal Class test		15 Marks	
Course prerequisites:		To study this course, a student must have passed/opted Zoology in B.Sc. III	
Programme/Class: Bachelor's Degree (with Research)/M.Sc. II		Year: Fifth	Semester: Tenth.
Subject: ZOOLOGY			
Course Code: -B051001C		Course Title: General and Clinical endocrinology	
Course Outcomes: After completing this course, the students will be able to: 1. Learn the roles of the endocrine system in maintaining homeostasis, integrating growth and development, responding to environmental insults and promoting successful reproduction. 2. Understand the definition of a hormone in terms of its general properties. 3. Learn the different classes and chemical structures of hormones. 4. Identify the glands, organs, tissues and cells that synthesize and secrete hormones, hormone precursors and associated compounds. 5. Learn the synthesis and modes of secretion of hormones. 6. Understand how the secretion of hormones is regulated, including the principles of negative and positive feedback mechanisms. 7. Clinical outcomes are broadly agreed, measurable changes in health or quality of life that result from our care.			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic		No. of Lectures
I	Aims and scope of endocrinology Pineal gland; Biosynthesis of Melatonin; sleep disorders, and jet lag; Pituitary gland General organization;Hormones and their functions;Diseases and disorders related to Pituitary gland		15
II	Thyroid gland General organization;Hormones and their functions;Diseases and disorders		15

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	related to Thyroid gland; Parathyroid gland; General organization; Hormones and their functions; Diseases: osteoporosis and tetany	
III	Endocrine pancreas General organization; Hormones and their functions; Disease: diabetes mellitus (type I and type II); Adrenal gland; General organization; Hormones and their functions; Diseases and disorders related to Adrenal gland	15
IV	Testis General organization of testes, Sertoli Cell and Leydig Cell; Biosynthesis and functions of hormones; Male infertility; Cryptorchidism; Ovary; General organization; Biosynthesis and functions of hormones	15
V	Female infertility: Polycystic ovary disease, hirsutism, and hyperandrogenism; GI Hormones: Types & Functions	

Recommended Books:

1. William's Text Book of Endocrinology: Shlomo Melmed, Kenneth S. Polonsky, P. Reed Larsen
2. Guyton's text book of Medical Physiology
3. Besser & Thorner (2002). Comprehensive clinical endocrinology. Mosby
4. Rimoin et al (2002). Principles & Practice of Medical Genetics, Vol I-III. Churchill
5. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
6. Chester-Jones et al: Fundamentals of Comparative Endocrinology (1987, Plenum Press)
7. Gorbman et al: Comparative Endocrinology (1983, John Wiley)
8. Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)
9. Schreibman & Pang: Vertebrate Endocrinology Vol I-IV, Fundamentals & Biomedical
10. Implications (1985 & onwards, Academic Press)

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have

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passed/opted Zoology in B.Sc. III

Group -II

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II		Year: Fifth	Semester: Tenth
Subject: ZOOLOGY			
Course Code: -B051002A		Course Title: Fish Physiology and fish pathology	
Course Outcomes: After completing this course, the students will be able to learn the: 1. Understand many valuable insights to inform fish conservation and management. 2. To develop in-depth knowledge of fish physiology 3. Learn the structure of the central organs of the body, and explain how they function. 4. Understand to explain how different fish groups are adapted to function optimally in their environment. 5. Learn to interpret simple physiological results, and able to write a report after completing a laboratory task. 6. Understand the laboratory task able to interpret and present simple physiological results			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	Nutrition: food and feeding habits associated glands, digestion and absorption Circulatory system: heart structure and blood vessels & its physiology	12	
II	Respiration: Structure and function of gills gill rackers and their uses, counter current mechanism, Accessory respiratory organ and physiological adaptation in air breathing fishes. Swim bladder.	12	
III	Excretion: Kidney structure and modifications, nitrogenous excretory products, urine formation. Osmo-regulation: Osmoregulation in fresh water and marine fishes.	12	

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IV	Reproductive behavior and pheromones Sexuality: intersex, bisexuality, hermaphroditism Parental care	12
V	Fish pathology, prophylaxis and therapy: Protozoan diseases of fish Helminth parasites of fish Fungal diseases of fish Bacterial diseases of fish Viral diseases of fish Nutritional diseases of fish	12

Recommended Books:.

1. Jhingram V.G. (1997) *Fish and Fisheries of India*
2. Khanna S S (2014) *Textbook of Fish Biology and Fisheries*
3. Hoar W.S. (1971) *Fish Physiology*
4. Farrell A.P. (2011) *Encyclopaedia of Fish Physiology: From Genome to Environment*
5. Evans (2014) *The Physiology of Fishes*
6. Gong and Korzh (2004) *Fish Development and Genetics: The Zebrafish and Medaka Fish Model*
7. Khanna and Singh (2014) *Textbook of Fish Biology and Fisheries*
8. Lagler, Bardach, Miller and May Passino: *Ichthyology* (2003, Wiley)
9. Mishra: *Records of Indian Museum an aid to the identification of the common commercial fishes of India and Pakistan, Vol. 5 (Part I-IV) (1962)*
10. Norman and Greenwood: *A History of Fishes* (3rd ed 1975, Ernest Bvenn Limited)
11. Pillay: *Aquaculture: Principles and Practices Fishing News Books* (2005, First Indian reprint)
12. Srivastava: *A Textbook of Fishery Science and Indian Fisheries* (1985, Kitab Mahal)

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

Programme/Class:	Year:	Semester:
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Bachelor's Degree (with Research)/M.Sc. II		Fifth	Tenth
Subject: ZOOLOGY			
Course Code: -B051002B		Course Title: Cell Energetics & Immunology	
Course Outcomes:			
After completing this course, the students will be able to gain the knowledge of:			
1. To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates. 2. How simple molecules together form complex macromolecules. 3. To understand the thermodynamics of enzyme catalyzed reactions. 4. Mechanisms of energy production at cellular and molecular levels. 5. To understand systems biology and various functional components of an organism. 6. To explore the complex network of these functional components. 7. To comprehend the regulatory mechanisms for maintenance of function in the body. 8. Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features. 9. 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: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	Bioenergetics: Laws of energy changes (concept of entropy, free energy), Free radicals and redox couples, coupled reactions. Concept of metabolic pathways Energy transduction: glucose and fatty-acids as energy source	10	
II	Special cell function: Immune competent cells; Differentiation of B lymphocytes and humoral immune response, Differentiation of T lymphocytes and cellular immune response; Complement System	20	
III	Polyclonal antibody, Types, structure and function; antibody diversity; Monoclonal antibody, hybridomas; Function of monoclonal antibody.	10	
IV	Antigen Processing and Presentation, Antigen presenting cells, Major	20	

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	<i>Histocompatibility Complex (MHC), MHC Restriction of Lymphocytes., Hypersensitivity</i>	
V	<i>Cancer: Cytological characteristics of transformed cells, cancer causing agents. Molecular Biology of cancer: tumor suppressor genes and oncogenes</i>	

Recommended Books:

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. Watson et al. *Molecular Biology of the Gene. Pearson (2004).*
7. Sambrook et al. *Molecular Cloning Vols I, II, III. CSHL (2001).*
8. Primrose. *Molecular Biotechnology. Panima (2001).*
9. Clark & Switzer. *Experimental Biochemistry. Freeman (2000)* Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby Kuby *Immunology. W HFreeman (2007).*
10. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. *Roitt's Essential Immunology,*
11. 13th Edition. *Wiley Blackwell (2017).*
12. Shetty Nandini *Immunology Introductory Textbook. New Age International. (2005)*

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II	Year: Fifth	Semester: Tenth
Subject: ZOOLOGY		
Course Code: -B051002C	Course Title:	

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Comparative Endocrinology

Course Outcomes:

After completing this course, the students will be able to:

1. Understand how the endocrine system is functioning in comparative aspect.
2. Learn the structures and molecular modes of action of a large variety of vertebrate and invertebrate hormones and understand how metazoan hormones and their functional mechanisms have evolved.
3. Understand how hormones can regulate animal behaviour.
4. Learn scientific information to write a report or to perform practical experiments demonstrating specific hormonal functions.
5. To aware of the scientific and ethical guidelines to be taken into account for good endocrine research.
6. Understanding of the physiological importance of hormones, as well as on their possible use and abuse in animals and humans.

Credits: 04

Paper: Core Compulsory

Max. Marks: 25+75

Min. Pass Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.

Unit	Topic	No. of Lectures
I	Basic concept of neurosecretion. Neurosecretory system in invertebrates with special reference to insects. Comparative anatomy and functions of hypothalamic neurosecretory centers in different groups of vertebrates (fish to birds).	12
II	Comparative anatomy of neurohypophysis and its hormones in different groups of vertebrates (fish to birds) Median eminence: structure and functions in different groups of vertebrates (fish to birds) Structure and functions of adenohypophysis General organization in different groups of vertebrates (fish to birds) Cell types and functions (fish to birds)	
III	Functions of pars intermedia in non-mammalian vertebrates Comparative aspects of the Epiphysial Complex (fish to birds) Comparative anatomy, cellular characteristics and functions of thyroid gland in	12

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	<i>different groups of vertebrates emphasizing the role of thyroid hormones in amphibian metamorphosis.</i>	
IV	<i>Cellular organization and functions of parathyroid hormones. Cellular organization and functions of endocrine pancreas. Comparative anatomy, histology and functions of adrenal glands (interregal/cortex and chromaffin tissue/medulla) in different groups of vertebrates (fish to birds).</i>	12
V	<i>Gonad as endocrine organ Anatomical and histological organization of testis and ovary (from fish to birds) Functions of testicular and ovarian hormones. Endocrine control of osmoregulation in vertebrates with special reference to fish Nonapeptides: localization and regulation of secretion, mechanism of action</i>	12

Recommended Books:

1. William's Text Book of Endocrinology: Shlomo Melmed, Kenneth S. Polonsky, P. Reed Larsen
2. Guyton's text book of Medical Physiology
3. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
4. Gorbman et al: Comparative Endocrinology (1983, John Wiley)
5. Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)
6. Schreibman & Pang: Vertebrate Endocrinology Vol I-IV, Fundamentals & Biomedical Implications (1985 & onwards, Academic Press)
7. Chester-Jones et al: Fundamentals of Comparative Endocrinology (1987, Plenum Press)

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

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Group -III

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II		Year: Fifth	Semester: Tenth
Subject: ZOOLOGY			
Course Code: -B051003A		Course Title: Fish Taxonomy & Specialized Organs	
Course Outcomes: After completion of the course the students will acquire the knowledge of: 7. Identify diagnostic features of lineages of fishes distributed worldwide. 8. Analyze the anatomy, physiology, and reproductive biology of fishes, including information related to feeding, sensory systems, locomotion, and reproduction. 9. Synthesize information from primary literature on fish taxonomy, ecology, and evolution. 10. Learns principles of phylogeny to understand fish adaptations. 11. Familiar with principals of ecology, anatomy and behavior of fishes. 12. Learn culture of fishes and eradication of predatory and weed fishes.			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	<i>Classification of fish up to orders as proposed by L.S. Berg (1940). Taxonomic study of marine and freshwater fishes.</i>	10	
II	<i>Comparison of different genera& species of orders Beloniformes, Clupeiformes, Mugiliformes, perciformes</i>	10	
III	<i>Comparison of different genera& species of orders Cypriniformes mastacembeliformes, channiformes</i>		
IV	<i>Integument: General organization of skin, barbels and types of scales. Specialised organ: Lateral line system, electric organ ,poison glands, weberian ossicles and swim bladder</i>	10	
V	<i>Endocrine glands: Pineal, hypophysis, thyroid, adrenal, ultimobranchial body, corpuscles of stannous and urophysis</i>	12	

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Recommended Books:

11. Gupta SK and Gupta PC (2006) *General and applied Ichthyology: Fish and Fisheries*
12. Gill T (2018) *Report on Ichthyology*
13. Richardson J (2015) *Ichthyology*
14. Keenan T (2018) *Ichthyology, An introduction to Fish Science*
15. Srivastava, C.B.L. *A textbook of Fishery Science and Indian Fisheries.*
16. Lagler et. Al. *Ichthyology*
17. Norman, J.R. *A History of Fishes.*
18. Kyle, H.M.A. *Biology of Fishes*
19. Khanna, S.S. *An Introduction to Fishes.*
20. Jhingram V.G. (1997) *Fish and Fisheries of India*

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II	Year: Fifth	Semester: Tenth
Subject: ZOOLOGY		
Course Code: -B051003B	Course Title: Chromosomes, Patterns of Inheritance & Extension of Mendelism	
Course Outcomes: After completing this course, the students will be able to gain the knowledge of: 10. To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates. 11. How simple molecules together form complex macromolecules. 12. To understand the thermodynamics of enzyme catalyzed reactions. 13. Mechanisms of energy production at cellular and molecular levels. 14. To understand systems biology and various functional components of an organism. 15. To explore the complex network of these functional components. 16. To comprehend the regulatory mechanisms for maintenance of function in the body. 17. Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features. 18. 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: 04	Paper: Core Compulsory	
Max. Marks: 25+75	Min. Pass Marks:	

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Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.		
Unit	Topic	No. of Lectures
I	Structure and types of chromosomes. Chromosomal anomalies: structural and numerical aberrations with examples Human karyotype, Pedigree analysis	10
II	Patterns of inheritance: Autosomal dominant, autosomal recessive, X-linked recessive, X-linked dominant. Cytoplasmic inheritance	20
III	Extensions of Mendelism: multiple allele, Gene interaction (Epistasis, Lethal, Pleiotropic, Complementary & Duplicate)	10
IV	Sex- influenced and sex- limited characteristics. Genome imprinting; Expressivity & penetrance	
V	Interaction between gene and environment: Environmental effects on gene expression, inheritance of continuous characteristics	20

Recommended Books:

13. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
14. Alberts et al: Molecular Biology of the Cell: Garland (2002).
15. Cooper: Cell: A Molecular Approach: ASM Press (2000).
16. Karp: Cell and Molecular Biology: Wiley (2002).
17. Watson et al. Molecular Biology of the Gene. Pearson (2004).
18. Watson et al. Molecular Biology of the Gene. Pearson (2004).
19. Sambrook et al. Molecular Cloning Vols I, II, III. CSHL (2001).
20. Primrose. Molecular Biotechnology. Panima (2001).
21. Clark & Switzer. Experimental Biochemistry. Freeman (2000) Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby Kuby Immunology. W H Freeman (2007).
22. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology,
23. 13th Edition. Wiley Blackwell (2017).
24. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005)

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

Open to all

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Programme/Class: Bachelor's Degree (with Research)/M.Sc. II		Year: Fifth	Semester: Tenth
Subject: ZOOLOGY			
Course Code: -B051003C		Course Title: Molecular Endocrinology and Mammalian Reproductive System	
Course Outcomes: After completing this course, the students will be able to: 1. Understand the molecular mechanisms by which steroid hormones activate nuclear receptors to provoke their biological effects. 2. Learn the molecular mechanisms by which peptide hormones activate cell surface receptors to provoke their biological effects. 3. Learn how androgens and estrogens are involved in cancers, as in the prostate and breast respectively. 4. Understand how the actions of peptide and steroid hormones are involved in different diseases. 5. Understand to construct pathways of the endocrine systems that link control and production of hormones in specific tissues with the actions of these hormones in their respective target organs.			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	Classification of hormones on the basis of chemical nature Mechanism of hormone actions Action of peptide and glycol-peptide hormones Classification of Membrane receptors G-proteins mediated hormonal actions Cyclic AMP signaling cascade PKC signaling pathway Mechanism of actions of steroid hormones (genomic and nongenomic pathways)	15	
II	Control of hormone secretion	15	

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	<i>Synthesis, processing, and sorting of pre-prohormone precursor</i>	
	<i>Regulation of secretory pathway with reference to thyroxine</i>	
	<i>Feedback regulation: General Concept</i>	
III	<i>Testis</i> <i>Spermatogenesis and its hormonal regulation; Male sterility; Parameters of male sterility; Origin and cause of male sterility; Azoospermia; Oligozoospermia</i>	15
IV	<i>Reproductive cycles</i> <i>Estrus and Menstrual cycle; Control of seasonal reproductive cycle by environmental cues (photoperiod and temperature); Regulation of ovarian function</i> <i>Ovarian steroids in regulation of:</i> • <i>Pre-ovulatory condition</i> • <i>Oocyte maturation</i> • <i>Corpus luteum</i> • <i>Follicular atresia</i> • <i>Hormonal control of pregnancy and implantation</i>	15
V	<i>Reproductive pheromones</i> <i>Pheromones in regulation of estrous cycle, puberty and pregnancy</i> <i>Human reproductive pheromones</i>	
Recommended Books: 1. Norris: <i>Vertebrate Endocrinology</i> (4th ed 2007, Elsevier) 2. Schreibman & Pang: <i>Vertebrate Endocrinology Vol I-IV, Fundamentals & Biomedical Implications</i> (1985 & onwards, Academic Press) 3. Bolander F F (2004) <i>Molecular Endocrinology</i> 4. Guyton's text book of <i>Medical Physiology</i> 5. Bronson F.H. (1991) <i>Mammalian Reproductive Biology</i>		

PRACTICAL

Programme/Class:	Year:	Semester:
Bachelor's Degree (with Research)/M.Sc. II	Fifth	Tenth
Subject: ZOOLOGY		

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Course Code: -B051004P		Course Title: Practical (Fish and Fisheries Special)	
Course Outcomes:			
After completing this course, the students will be able to:			
1. Learn the knowledge necessary for professional or academic work in the field of aquaculture and fisheries. This includes knowledge in the areas of ecology, oceanography, biology, physiology, health, reproduction, nutrition, behavior, and genetics of fishes. 2. Learn to evaluate the importance of diversity, equity, and justice, as well as the role of social factors (e.g. culture, economics, policy) on aquaculture and fisheries from local to global scales. 3. Learn the basic technical skills necessary for work in aquaculture and fisheries. 4. Create local and global solutions to complex challenges in fish and fisheries and able to generate self employment. 5. Learn to critically evaluate the effect of fishing gear on target and non-target organisms and ecosystems via data analysis.			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic		No. of Lectures
I	1. Seasonal analyses of pond water by measuring the following physico-chemical properties: 1.1 Dissolved CO₂ content 1.2 O₂ content 1.3 Alkalinity 1.4 pH 2. Study of locally available weed and predatory fishes 3. Study of locally available larvivorous fishes 4. Collection, mounting and study of helminth parasites infecting locally available fishes 5. Identification of locally available fishes of economic importance 6. Determination of feeding habit of important edible fishes by morphological analyses of their buccopharyngeal region 7. Determination of feeding habit of carps and catfishes by analyses of their gut contents.		20
II	1. Dissection and display of afferent and efferent branchial vessels of a carp and a catfishes 2. Preparation of permanent stained slides of skin, gills, spleen, digestive tract (stomach and intestine), liver, gonads of <i>Heteropneustes fossilis</i> or <i>Clarias batrachus</i> 3. Determination and comparison of hemoglobin content of water-		20

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	breathing and air breathing fish 4. Study of ventilation rate and surfacing activity of a air-breathing fish under different experimental conditions	
III	1. Determination of fecundity in major carp and catfish 2. Determination of fertilization rate of carp 3. Determination of final oocyte maturation by scoring germinal vesicle breakdown 4. Study of functional morphology of testes and ovary by preparing permanent stained slides belonging to different reproductive phases 5. Determination of gonosomatic index and hepatosomatic index and their relations with regard to gonadal and body growth 5. Demonstration of induced breeding at a seed production centre 6. Visit to a fish farm and hatchery 7. Study of length weight relationship of major carp and catfish	20

Recommended Books:

1. Datta Munshi, J.S. and M.P. Srivastava. Natural History of Fishes and Systematic of Fresh water Fishes of India. 2006 Narendra Publ. House, New delhi
2. Gupta S.K. and Gupta P.C. General and Applied Ichthyology.
3. Srivastava, C.B.L. A. textbook of Fishery Science and Indian Fisheries.
4. Lagler et. al. Ichthyology
5. Norman, J.R. A History of Fishes.
6. Kyle, H.M.A. Biology of Fishes
7. Khanna, S.S. An Introduction to Fishes.
8. Jhingran, V.G. Fish and Fisheries of India.
9. Bardach. Aquaculture.
10. Aggarwal, S.C. Fishery Management.
11. Govindan, T.K. Fish Processing Technology.
12. Beavan, C.R. Handbook of Freshwater fishes of India.
13. Bal and Rao, Marine Fisheries.

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

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1. A complete record of practical exercises in Fish and Fisheries Special done during the session must be produced by the candidates in three separate record books at the time of practical examination.
 2. Total duration of practical examination will be 6 hours spread over one day.

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II		Year: Fifth	Semester: Tenth
Subject: ZOOLOGY			
Course Code: -B051004P		Course Title: Practical (Cell Biology Special)	
Course Outcomes: After completing this course the students will be able to learn about: 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. 7. Learn the PCR techniques 8. Perform basic hematological laboratory testing. 9. Distinguish normal and abnormal hematological laboratory findings to predict the diagnosis of hematological disorders and diseases. 10. Understand the basic principles of microscopy, working of different types of microscopes			
Credits: 04		Paper: Core Compulsory	
Max. Marks: 25+75		Min. Pass Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.			
Unit	Topic	No. of Lectures	
I	1. Study of different stages of mitosis with the help of onion root tip 2. Study of different stages of meiosis with the help of grasshopper testis 3. Laboratory preparation of following models using beads and wire - Adenosine triphosphate (ATP), DNA and RNA bases, Nucleosides, Nucleotides 4. Study of permanent slides of different cells and cell organelles	20	

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	- To study the different types of cell such as buccal epithelial cells, nerve cells, striated muscle cell using Methylene blue. - To study the mitochondria using Janus Green B.	
II	- Mammalian blood smear preparation for the study of drumstick as Sex chromatin test in rat/human. - Enumeration of red blood cells and white blood cells using haemocytometer - Study of normal human karyotype - Study of sex chromatin (Barr body) in human female from buccal epithelial and hair bud cells using Methylene blue - Preparation of polytene chromosome from salivary gland cell of <i>Drosophila</i> and <i>Chironomus</i> - Study of colchicinised metaphase chromosomes in bone marrow of rodent by air dry method - Study of permanent slides for the following - Dicentric bridge in the anaphase I chromosomes of grasshopper - Inversion in polytene chromosomes - Autoradiography detection of transcription in polytene chromosomes - Lampbrush chromosomes of <i>Triturus</i> oocyte - G-banded and C-banded metaphase chromosomes - Chromatid exchanges and chromosomal anomalies - Sister chromatid exchanges	20
III	- Study of chromatin by Feulgen staining - Demonstration of PCR - Study of 'fixation' and 'staining' techniques. - Study of microscopy techniques. - Paper chromatography. - Agarose gel, SDS-PAGE and disc electrophoresis. - Replicon organization by DNA-fibre autoradiography - Study of cellular ultrastructure by means of electron micrographs - Working and applications of tools: B-Counter, ELISA reader and autoanalyser/ spectrophotometer and image analyzer	20

Recommended Books:

- 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).
- Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby *Immunology*. W H Freeman (2007).
- Sambrook et al. *Molecular Cloning Vols I, II, III*. CSHL (2001).
- Alberts et al: *Essential Cell Biology* (1998, Garland)
- Bostock & Sumner: *Eukaryotic Chromosome* (1987, North-Holland)

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9. DeRobertis & DeRobertis: Cell and Molecular Biology (1987, Lee & Febiger)
10. Karp: Cell and Molecular Biology (2002, John Wiley & Sons)
11. Pollard & Earnshaw: Cell Biology (2002, Saunders)

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

1. A complete record of practical exercises in Cell Biology Special done during the session must be produced by the candidates in three separate record books at the time of practical examination.
2. Total duration of practical examination will be 6 hours spread over one day.

Programme/Class: <i>Bachelor's Degree (with Research)/M.Sc. II</i>	Year: <i>Fifth</i>	Semester: <i>Tenth</i>
Subject: ZOOLOGY		
Course Code: -B051004P	Course Title: <i>Practical (Endocrinology Special)</i>	
Course Outcomes: After completing this course the students will be able to learn about: <i>1. To use simple and compound microscopes.</i> <i>2. Learn to handle different animal models</i> <i>3. Learn to understand the blood transfusion mechanism</i> <i>4. Understand the function of different peptides and steroid hormones in animal behavior</i> <i>5. Learn the level of different hormones in different physiological conditions</i> <i>6. Learn the different classes and chemical structures of hormones.</i> <i>7. Identify the glands, organs, tissues and cells that synthesize and secrete hormones, hormone precursors and associated compounds.</i>		
Credits: 04	Paper: Core Compulsory	
Max. Marks: 25+75	Min. Pass Marks:	

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Total No. of Lectures-Tutorials-Practical (in hours per week): 6-0-0.

Unit	Topic	No. of Lectures
I	1. Handling and maintenance of rat in laboratory 2. Demonstrate the endocrine glands and reproductive organs in mammals 3. Surgical ablations of testis, ovary, adrenal and thyroid in mammals 4. Study of oestrous cycle of rat by vaginal smear preparation 5. Study of the following using permanent slides 5.1 Endocrine glands and reproductive organs (testis and ovary) of mammals 5.2 Thyroid of mammals 5.3 Adrenal homologues (interrenal and chromaffin tissues) in mammals 5.4 Cell types of pituitary gland in mammals 5.5 Hypothalamo-neurohypophyseal system of a mammal in situ preparation	20
II	1. Histological study of different endocrine glands (Pituitary, Thyroid, Parathyroid, Adrenal, Thymus, Gonads and Pancreas). 2. Microtomy to prepare stained, permanent mounts of different endocrine glands 3. Study of estrous cycle of rat 4. Sperm count and mobility assay 5. Eosin-Nigrosin staining of live and dead spermatozoa 6. To detect the presence of human chorionic gonadotropin hormone 7. Preparation of melanophore index of rasbora fish scale due to the effect of adrenalin hormone 8. Demonstration of ELISA-based hormone assay 9. Endocrine glands of rat (Location through models, Charts) 10. Endocrine disorders (Photographs)	20
III	1. Dissection of endocrine glands in vertebrate and invertebrates (suitable insect such as cockroach, grasshopper, dipterans larvae) 2. Determination of proteins, /cholesterol/ sugar level using spectrophotometer 3. Separation of plasma proteins using electrophoresis 4. Microtomy of endocrine material (tissue fixation, processing, paraffin block preparation, sectioning, staining and mounting) 5. Study of slides of endocrine material from different animals 6. Identification of chemical structures of peptides and steroid hormones 7. Study of electron micrographs 8. Estimation of hormones in blood 9. Study of comparative structure of endocrine glands of selected vertebrates and invertebrates	20
Recommended Books:		

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1. Norris and Car (2020) *Vertebrate Endocrinology*
2. Hadley, M.C.: *Endocrinology*, Prentice Hall, International Edition, 2000
3. Wilson and Foster, *Williams Text Book of Endocrinology* 10th edition, W.B. Saunders
4. Company Philadelphia, 2005
5. Lodish et al: *Molecular Cell Biology*: Freeman & Co, USA (2004).
6. ~~William's Text Book of Endocrinology: Shlomo Melmed, Kenneth S. Polonsky, B. Reed Larsen~~
7. Guyton's text book of *Medical Physiology*
8. Besser & Thorner (2002). *Comprehensive clinical endocrinology*. Mosby
9. Rimoin et al (2002). *Principles & Practice of Medical Genetics*, Vol I-III. Churchill
10. Bentley: *Comparative Vertebrate Endocrinology* (1998, Cambridge University Press)
11. Chester-Jones et al: *Fundamentals of Comparative Endocrinology* (1987, Plenum Press)
12. Gorbman et al: *Comparative Endocrinology* (1983, John Wiley)
13. Norris: *Vertebrate Endocrinology* (4th ed 2007, Elsevier)
14. Schreibman & Pang: *Vertebrate Endocrinology Vol I-IV, Fundamentals & Biomedical Implications* (1985 & onwards, Academic Press)

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

Open to all

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on Project/ Assignment and Internal Class Test. The marks shall be as follows:

Project/Assignment	10 Marks
Internal Class test	15 Marks
Course prerequisites:	To study this course, a student must have passed/opted Zoology in B.Sc. III

1. A complete record of practical exercises in *Endocrinology Special* done during the session must be produced by the candidates in three separate record books at the time of practical examination.
2. Total duration of practical examination will be 6 hours spread over one day.

Programme/Class: Bachelor's Degree (with Research)/M.Sc. II	Year: Fifth	Semester: Tenth
Subject: ZOOLOGY		
Course Code: - B0501005R	Course Title:	

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	Paper 7: Research Project / Dissertation & Thesis Writing
Credits: 04	Paper: Core Compulsory
Max. Marks: 100	Min. Pass Marks:
<i>This course can be opted as an elective by the students of following subjects:</i> Open to all	
Course prerequisites:	<i>To study this course, a student must have passed/opted Zoology in B.Sc. III</i>

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