CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY
KANPUR

Four Year Undergraduate Programme (FYUP)

ZOOLOGY

Syllabus of

4 YEAR B.Sc. (HONOURS)

4 YEAR B.Sc. (HONOURS WITH RESEARCH)

AND

4+1 YEAR (B.Sc. HONOURS/ B.Sc. HONOURS WITH RESEARCH + M.Sc.) IN ZOOLOGY

SESSION 2025-2026 ONWARDS

Prof. Sangeeta Avasthi
Convener of Zoology
C.S.J.M. University
Kanpur
(U.P.)

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Minutes of Virtual meeting of Board of Studies, Zoology on 17th May 2025,at 3.00pm to 4.00 pm

Link provided by Convener, Zoology, CSJM University, Kanpur

Convener-

1.**Prof. Sangeeta Avasthi,** In-charge, Zoology dept. AND College , Kanpur. U.P.

External Members-

2.**Prof. Gobardhan Das, Director, IISER. Bhopal**, By pass Road, Bhauri, Bhopal, M.P.

3.Prof. Rajnikant Mishra, Dept. of Zoology, BHU, Varanasi, U.P.

4.Prof. Suman Mishra, Dept. of Zoology, BBAU, Lucknow, U.P.

5.Prof. Banalata Mohanty, Dept. of Zoology, Allahabad University, Prayagraj, U.P.

Internal Members-

6.Prof. Atul Kumar Mishra, Dept. of Zoology DAV College, Kanpur,U.P.

7.Prof. Sandeep Shukla, Dept. of Zoology, DBS College, Kanpur, U.P.

8.Prof. Yogesh Baboo Dixit, Dept. of Zoology,Janta Mahavidyalaya, Ajitmal, Aurraiya, U.P.

Special invitee member-

9. Ms Puja Singh, Asst. Professor, Dept. of Zoology, AND College, Kanpur, U.P.

To start with, Prof. Sangeeta Avasthi, Convener, welcomed all the committee members by a brief introduction of each other.

She introduced the present course design and the proposed Four Years Undergraduate Programme (FYUP), course syllabus.

PROF. SANGEETA AVASTHI
CONVENER
SUBJECT OF ZOOLOGY
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Prof. Gobardhan Das, suggested that the course should be designed in a manner where student can get knowledge, of Genetic Engineering, Molecular Biology and different field of Biotechnology, for making them proficient in multidisciplinary field.

Prof. Banalata Mohanty expressed that for development of minor subjects, courses should be like, Animal forms and functions, Ecology and Evolution, Genetics and Development, Physiology and metabolism, so that students may get basic knowledge of subject Zoology.

Prof. Rajni Kant Mishra, suggested introduction of Biology course for non-biology students. He emphasised for inclusion of topics like hormones for biological importance, Economic Zoology and Anatomical studies of animals, Human Physiology and Biodiversity in the interest of students of all faculties.

Prof. Suman Mishra, proposed that we should not introduce any immature or diluted course at any level of major and minor subject. We can include invertebrates, vertebrate animal studies, Taxonomy, Gene Technology, Bioinformatics, Genetics & behaviour and some skill based courses.

Prof. Atul Kumar Mishra, suggested to introduce some skill based courses, like Apiculture, Aquaculture, Wild life conservation, Toxicology etc to enhance general awareness and knowledge, as these subjects have relevance in different existing and evolving competitive exams too.

Prof. Yogesh Baboo Dixit, expressed need to include basic course structure of Physiology and Biochemistry, Infectious disease, Public health and Hygiene.

Prof. Sandeep Shukla, recommended courses like Vermiculture, Sericulture, Health and Hygiene, Biodiversity and Waste management etc. for general interest of students.

Sangeeta Avasthi

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Ms Puja Singh Asst. Prof. expressed need to duly equip with essential infrastructure and necessary lab facility to duly complement such proposed added courses in the curriculum.

Finally, Prof, Sangeeta Avasthi Convener, BOS expressed gratitude to all the committee members for extending their valued inputs for joining and contributing to framework of the proposed syllabus of FYUP.

CONVENER	**SIGNATURE**
1. Prof. Sangeeta Avasthi	
EXTERNAL MEMBERS	
2. Prof. Gobardhan Das	
3. Prof. Rajni Kant Mishra	17/05/2025
4. Prof. Suman Mishra	17/5/25
5. Prof. Banalata Mohanty	17/05/2025
INTERNAL MEMBERS	
6. Prof. Atul Kumar Mishra	
7. Prof. Sandeep Shukla	
8. Prof. Yogesh Babu Dixit	
SPECIAL INVITEE MEMBER	
9. Miss. Puja Singh	

PROF. SANGEETA AVASTHI
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KANPUR

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

Year	Sem.		Course Code	Paper Title	Theory/Practical	Credits
1.	I		B050101T	Cytology, Genetics and Infectious Diseases	Theory	4
			B050102P	Cell Biology and Cytogenetics Lab	Practical	2
	II		B050201T	Biochemistry and Physiology	Theory	4
			B050202P	Physiological, Biochemical & Hematology Lab	Practical Field work	2
2.	III		B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	Theory	4
			B050302P	Bioinstrumentation & Molecular Biology Lab	Practical	02
	IV		B050401T	Gene Technology, Immunology and Computational Biology	Theory	04
			B050402P	Genetic Engineering and Counselling Lab	Practical/Field work	02
			B050403R	Research Project	Field work	03
3.	V		B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	Theory	04
			B050502T	Diversity of Chordates and Comparative Anatomy	Theory	04
			B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	Practical	02
	VI		B050601T	Evolutionary and Developmental Biology	Theory	04
			B050602T	Ecology, Ethology, Environmental Science and Wildlife	Theory	04
			B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology, Wildlife, Ethology	Practical	02
4.	VII	CORE	B050701T	NON- CHORDATA	Theory	4
		CORE	B050702T	BIOSYSTEMATICS AND EVOLUTIONARY BIOLOGY	Theory	4
		CORE	B050703T	CELL BIOLOGY AND GENETICS	Theory	4
		CORE	B050704T	QUANTITATIVE BIOLOGY, RESEARCH METHODOLOGY AND BIOINSTRUMENTATION	Theory	4
		PRACTICAL	B050705P	PRACTICAL	Practical	4
	VIII	**CORE**	B050801T	CHORDATA	Theory	4
		CORE	B050802T	ANIMAL PHYSIOLOGY AND BIOCHEMISTRY	Theory	4
		CORE	B050803T	REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY	Theory	4

		ELECTIVE	**B050804T**	APICULTURE	Theory	4
			B050805T	SERICULTURE	Theory	4
			B050806T	LAC- CULTURE	Theory	4
			B050807T	AQUACULTURE	Theory	4
		PRACTICAL	**B050808P**	PRACTICAL	Practical	4
5.	VII	CORE	**B050702T**	BIOSYSTEMATICS AND EVOLUTIONARY BIOLOGY	Theory	4
		CORE	**B050703T**	CELL BIOLOGY AND GENETICS	Theory	4
		CORE	**B050704T**	QUANTITATIVE BIOLOGY, RESEARCH METHODOLOGY AND BIOINSTRUMENTATION	Theory	4
		PRACTICAL	**B050704P**	PRACTICAL	Practical	4
		PROJECT	**B050905R**	RESEARCH PROJECT	Field work	4
	VIII	CORE	**B050802T**	ANIMAL PHYSIOLOGY AND BIOCHEMISTRY	Theory	4
		CORE	**B050803T**	REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY	Theory	4
		ELECTIVE	**B050804T**	APICULTURE	Theory	4
			B050805T	SERICULTURE	Theory	4
			B050806T	LAC- CULTURE	Theory	4
			B050807T	AQUACULTURE	Theory	4
		PRACTICAL	**B050808P**	PRACTICAL	Field work/lab work	**4**
		RESEARCH PROJECT	**B050809R**	RESEARCH PROJECT	Practical	4
6.	IX	CORE	**B050901T**	ETHOLOGY, BIODIVERSITY AND WILDLIFE CONSERVATION	Theory	4
		CORE	**B050902T**	MOLECULAR BIOLOGY, IMMUNOLOGY AND BIOINFORMATICS	Theory	4
		ELECTIVE	**B050903T**	WASTE MANAGEMENT AND SUSTAINABLE DEVELOPMENT	Theory	4
			B050904T	AGROCHEMICALS AND PEST MANAGEMENT	Theory	4
		ELECTIVE	**B050905T**	ENTOMOLOGY	Theory	4
			B050906T	PARASITOLOGY	Theory	4
			B050907T	ICHTHYOLOGY	Theory	4
			B050908T	ENDOCRINOLOGY	Theory	4
			B050909T	ENVIRONMENTAL BIOLOGY	Theory	4

			B050910T	ANIMAL CYTOGENETICS	Theory	4
			B050911P	PRACTICAL	Practical	4
			B050912R	RESEARCH PROJECT	Field work	4
	X	CORE	**B051001T**	ECOLOGY AND TOXICOLOGY	Theory	4
		ELECTIVE	**B051002T**	PUBLIC HEALTH AND HYGIENE	Theory	4
			B051003T	HUMAN NUTRITION AND THERAPEUTICS	Theory	4
		ELECTIVE	**B051004T**	MICROBIOLOGY	Theory	4
			B051005T	BIOTECHNOLOGY	Theory	4
		ELECTIVE	**B051006T**	APPLIED ENTOMOLOGY	Theory	4
			B051007T	CLINICAL PARASITOLOGY	Theory	4
			B051008T	APPLIED ICHTHYOLOGY	Theory	4
			B051009T	MOLECULAR ENDOCRINOLOGY	Theory	4
			B051010T	APPLIED ENVIRONMENTAL BIOLOGY	Theory	4
			B051011T	CLINICAL CYTOGENETICS	Theory	4
		PRACTICAL	**B051012T**	PRACTICAL	Practical	4
		RESEARCH PROJECT	**B051013T**	RESEARCH PROJECT	Field work	4

Proposed Year wise Structure of UG Program in Zoology

Programme/Year	Semester	Course Codes	Paper Title	Credits	Teaching Hours
1 Certificate Course in Medical Diagnostics & Public Health	I	B050101T	Cytology, Genetics and Infectious Diseases	04	60
		B050102P	Cell Biology & Cytogenetics Lab	02	60
	II	B050201T	Biochemistry and Physiology	04	60
		B050202P	Physiological, Biochemical & Hematology Lab	02	60
NOTE- This paper (Biochemistry and Physiology) can be included as Minor for those students who are not taking Zoology as Major subject.					
2 Diploma in Molecular Diagnostics and Genetic Counselling	III	B050301T	Molecular Biology, Bioinstrumentation & Biotechniques	04	60
		B050302P	Bioinstrumentation & Molecular Biology Lab	02	60
	IV	B050401T	Gene Technology, Immunology and Computational Biology	04	60
		B050402P	Genetic Engineering and Counselling Lab	02	60
		B050403R	RESEARCH PROJECT	03	45
NOTE- This paper (Gene Technology , Immunology and Computational Biology) can be included as Minor for those students who are not taking Zoology as Major subject					
3 Degree in Bachelor of Science	V	B050501T	Diversity of Non-Chordates, Parasitology and Economic Zoology	04	60
		B050502T	Diversity of Chordates and Comparative Anatomy	04	60
		B050503P	Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology	02	60
	VI	B050601T	Evolutionary and Developmental Biology	04	60
		B050602T	Ecology, Ethology, Environmental Science and Wildlife	04	60
		B050603P	Lab on Environmental Science, Behavioral Ecology, Developmental Biology Wildlife, Ethology	02	60

4. **B.Sc. Degree with** **Honours**	**VII**	CORE	**B050701T**	NON-CHORDATA	**4**	**60**
		CORE	**B050702T**	BIOSYSTEMATICS AND EVOLUTIONARY BIOLOGY	**4**	**60**
		CORE	**B050703T**	CELL BIOLOGY AND GENETICS	**4**	**60**
		CORE	**B050704T**	QUANTITATIVE BIOLOGY, RESEARCH METHODOLOGY AND BIOINSTRUMENTATION	**4**	**60**
		PRACTICAL	**B050705P**	PRACTICAL	**4**	**60**
	VIII	CORE	**B050801T**	CHORDATA	**4**	**60**
		CORE	**B050802T**	ANIMAL PHYSIOLOGY AND BIOCHEMISTRY	**4**	**60**
		CORE	**B050803T**	REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY	**4**	**60**
		ELECTIVE	**B050804T**	APICULTURE	**4**	**60**
			B050805T	SERICULTURE	**4**	**60**
			B050806T	LAC- CULTURE	**4**	**60**
			B050807T	AQUACULTURE	**4**	**60**
		PRACTICAL	**B050808P**	PRACTICAL	**4**	**60**
5. **B.Sc. Degree with Research**	VII	CORE	**B050701T**	BIOSYSTEMATICS AND EVOLUTIONARY BIOLOGY	**4**	**60**
		CORE	**B050702T**	CELL BIOLOGY AND GENETICS	**4**	**60**
		CORE	**B050703T**	QUANTITATIVE BIOLOGY, RESEARCH METHODOLOGY AND BIOINSTRUMENTATION	**4**	**60**
		PRACTICAL	**B050704P**	PRACTICAL	**4**	**60**
		PROJECT	**B050705R**	RESEARCH PROJECT	**4**	**60**
	VIII	CORE	**B050802T**	ANIMAL PHYSIOLOGY AND BIOCHEMISTRY	**4**	**60**
		CORE	**B050803T**	REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY	**4**	**60**
		ELECTIVE	**B050804T**	APICULTURE	**4**	**60**
			B050805T	SERICULTURE	**4**	**60**
			B050806T	LAC- CULTURE	**4**	**60**
			B050807T	AQUACULTURE	**4**	**60**
		Practical	**B050808P**	PRACTICAL	**4**	**60**
		PROJECT	**B050809R**	RESEARCH PROJECT	**4**	**60**
6.		CORE	**B050901T**	ETHOLOGY, BIODIVERSITY AND	**4**	**60**

M.SC. One year course	**IX**			WILDLIFE CONSERVATION		
		CORE	B050902T	MOLECULAR BIOLOGY, IMMUNOLOGY AND BIOINFORMATICS	**4**	**60**
		ELECTIVE	B050903T	WASTE MANAGEMENT AND SUSTAINABLE DEVELOPMENT	**4**	**60**
			B050904T	AGROCHEMICALS AND PEST MANAGEMENT	**4**	**60**
		ELECTIVE	B050905T	ENTOMOLOGY	**4**	**60**
			B050906T	PARASITOLOGY	**4**	**60**
			B050907T	ICHTHYOLOGY	**4**	**60**
			B050908T	ENDOCRINOLOGY	**4**	**60**
			B050909T	ENVIRONMENTAL BIOLOGY	**4**	**60**
			B050910T	ANIMAL CYTOGENETICS	**4**	**60**
		PRACTICAL	B050911P	PRACTICAL	**4**	**60**
		PROJECT	B050912R	RESEARCH PROJECT	**4**	**60**
	X	CORE	**B051001T**	ECOLOGY AND TOXICOLOGY	**4**	**60**
		ELECTIVE	**B051002T**	PUBLIC HEALTH AND HYGIENE	**4**	**60**
			B051003T	HUMAN NUTRITION AND THERAPEUTICS	**4**	**60**
		ELECTIVE	**B051004T**	MICROBIOLOGY	**4**	**60**
			B051005T	BIOTECHNOLOGY	**4**	**60**
		ELECTIVE	**B051006T**	APPLIED ENTOMOLOGY	**4**	**60**
			B051007T	CLINICAL PARASITOLOGY	**4**	**60**
			B051008T	APPLIED ICHTHYOLOGY	**4**	**60**
			B051009T	MOLECULAR ENDOCRINOLOGY	**4**	**60**
			B0510010T	APPLIED ENVIRONMENTAL BIOLOGY	**4**	**60**
			B0510011T	CLINICAL CYTOGENETICS	**4**	**60**
		PRACTICAL	**B0510012P**	PRACTICAL	**4**	**60**
		PROJECT	**B0510013R**	RESEARCH PROJECT	**4**	**60**

Subject prerequisite

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

Programme Objectives (POs)

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

Certificate Course in Medical Diagnostics & Public Health

B. Sc I Programme Specific Outcomes (PSOs)

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

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

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

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

Course outcomes:

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

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

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

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

Unit	**Topics**	**Total No. of Lectures (60)**
I	**Structure and Function of Cell Organelles I** • Plasma membrane: chemical structure—lipids and proteins • Cell-cell interaction: cell adhesion molecules. • Endo membrane system: endocytosis, exocytosis **Introduction to all national and international Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tribute to ancient and modern biology will be included as part of the Continuous Internal Evaluation (CIE)**	6

II	**Structure and Function of Cell Organelles II** • Cytoskeleton: microtubules, microfilaments, intermediate filaments • Mitochondria: Structure, oxidative phosphorylation and electron transport system • Peroxisome and ribosome: structure and function	**6**
III	**Nucleus and Chromatin Structure** • Structure and function of nucleus in eukaryotes • Chemical structure and base composition of DNA and RNA • DNA: Chromatin organization (Nucleosome and Solenoid structure), structure of chromosomes • Types of DNA (A, B & Z) and RNA (m, t and r)	**8**
IV	**Cell cycle, Cell Division and Cell Signaling** • Cell division: mitosis and meiosis • Cell cycle and its regulation, apoptosis Type and function. • Cell Signaling	**8**
V	**Mendelism and Sex Determination** • Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses • Complete and Incomplete Dominance • Penetrance and expressivity • Genic Sex-Determining Systems, Sex Determination in *Drosophila* • Sex-linked characteristics and Dosage compensation	**8**
VI	**Extensions of Mendelism, Genes and Environment** • Extensions of Mendelism: Multiple Alleles, Gene Interaction. • The Interaction Between Sex and Heredity • Cytoplasmic Inheritance. • Environmental Effects on Gene Expression	**8**
VII	**Human Chromosomes and Patterns of Inheritance** • Human karyotype • Chromosomal anomalies: Structural and numerical aberrations with examples • Pedigree analysis	**8**

VIII	**Infectious Diseases** • Introduction to pathogenic organisms: viruses (HIV, SARS-CoV-2), bacteria (Tuberculosis, Meningitis), fungi(Aspergillosis, Candidiasis), protozoa (Malaria, Sleeping Sickness), and worms (Ascariasis, Taeniasis). • Structure, life cycle, pathogenicity, including diseases causes, symptoms and control of common parasites: *Trypanosoma, Giardia and Wuchereria*	**8**

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA(2004).
2. Alberts et al: Molecular Biology of the Cell: Garland(2002).
3. Cooper: Cell: A Molecular Approach: ASM Press(2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman(2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson(2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, JanisKubyKuby Immunology. W H Freeman (2007).
8. Delves Peter J.,Martin Seamus J.,Burton Dennis R., RoittIvan M.Roitt's Essential Immunology, 13th Edition. Wiley Blackwell(2017).
9. Shetty Nandini Immunology Introductory Textbook. New Age International.(2005)
10. Chatteree : Parasitology, Medical Publisher (1980)
11. Gupta P.K. : Cell and Molecular Biology, Rastogi Publication (2017)
12. Pandey B.N: B.Sc.-Zoology Series-Cytology, Genetics & Mol. Genetics, Tata Mc Graw Hill (2012)
13. Sarkar B.: Cell Structure & Function, Medtech (2017)
14. Cell Biology and molecular biology by De Robertis
15. Genetics by P.K.Gupta
16. Genetics by Snustad and Simonds
17. Cell Biology by C.B. Powar

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

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

Further Suggestions: None

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

Course outcomes:

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

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

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

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

Unit	Topics	Total No. of Lectures (60)
I	1. To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue. 2. To study the different stages of Mitosis in root tip of onion. 3. To study the different stages of Meiosis in grasshopper testis. 4. To prepare molecular models of nucleotides, amino acids , dipeptides using bead and stick method. 5. To check the permeability of cells using salt solution of different concentrations.	15
II	1. Study of parasites (Protozoans, helminths) from permanent slides. 2. To learn the procedures for preparation of temporary and permanent stained/unstained slides.	15
III	1. Demonstration of mutant phenotypes of *Drosophila.* 2. Demonstration of polytene chromosomes. 3. Study of sex chromatin (Barr bodies) in buccal smear and hair bud cells(Human). 4. Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided. 5. To prepare family pedigrees	15

IV	**Virtual Labs (Suggestive sites)** https://www.vlab.co.inhttps://zoology san.blogspot.com www.vlab.iitb.ac.in/vlabwww.onlinelabs.inwww.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	**15**

Suggested Readings:

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

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

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

Further Suggestions: None

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

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

Course outcomes:

The student at the completion of the course will learn:

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

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

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

Unit	Topics
I	**Structure and Function of Biomolecules** • Structure and Biological importance of Carbohydrates (Mono saccharides, Disaccharides and Polysaccharides) • Lipids (saturated and unsaturated fatty acids, Tri- acylglycerols, Phospholipids, Glycolipids ,Steroids) • Structure, Classification and General properties of α- amino acids; Essential and non-essential aminoacids, Simple and conjugate proteins.
II	**Enzyme Action and Regulation** • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action • Isozymes, and Mechanism of enzyme action • Allosteric enzymes and their kinetics; Regulation of enzyme action

III	**Metabolism of Carbohydrates and Lipids** • Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, pentose phosphate pathway • Glycogenolysis and Glycogenesis • Lipids: β-oxidation of Palmitic acid	**8**
IV	**Metabolism of Proteins and Nucleotides** • Catabolism of amino acids: Transamination, Deamination , Urea cycle • Nucleotides biosynthesis	**6**
V	**Digestion and Respiration(in Humans)** • Structural organization and functions of gastrointestinal tract and associated glands • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood, Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration	**7**
VI	**Circulation and Excretion (in Humans)** • Components of blood and their functions • Haemostasis: Blood coagulation and its Mechanism • Blood groups: Rh factor, ABO and MN • Structure of heart • Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation • Structure of kidney and its functional unit; Mechanism of urine formation.	**8**
VII	**Nervous System and Endocrinology(in Humans)** • Structure of neuron, resting membrane potential • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers • Types of synapse • Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them • Classification of hormones; Mechanism of Hormone action and feedback inhibition	**8**

VIII	**Muscular System (in Humans)** Types of muscle; Ultra structure of skeletal muscle; muscle contraction; muscle twitch; summation and tetanus	7

Suggested Readings:

1. Nelson & Cox:Lehninger's Principles of Biochemistry: McMillan(2000)
2. Zubay*et al:* Principles of Biochemistry: WCB(1995)
3. Voet & Voet: Biochemistry Vols 1 & 2: Wiley(2004)
4. Lehninger Principles of Biochemistry by Nelson and Cox
5. Murray *etal:* Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott : Biochemistry and Molecular Biology: Oxford University Press
6. Guyton,A.C.&Hall,J.E.Textbook of Medical Physiology .XIEdition .Hercourt Asia PTELtd./W.B. Saunders Company.(2006).
7. Tortora , G.J.& Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
8. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
9. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates,(2004).
10. Chatterjee C C Human Physiology Volume 1 & 2. 11th edition. CBS Publishers (2016).
11. Singh H R & Kumar N. : Animal Physiology & Biochemistry, Vishal Publishing Delhi
12. Pandey B.N : B.Sc.-Zoology Series-Biochemistry Physiology & Endocrinology ,Tata McGraw Hill (2012)
13. Jain A K : Text book of Physiology, Avichal Publishing Comp New Delhi (2021)
14. Physiology by A.K. Berry

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

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

Further Suggestions: None

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

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

Course outcomes:

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

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

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

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

Unit	Topics	Total No. of Lectures (60)
I	1. Demonstration of estimation of haemoglobin using Sahli's haemoglobinometer 2. Preparation of haemin and haemochromogen crystals 3. Counting of RBCs and WBCs using Haemocytometer 4. To study different mammalian blood cell types using Leishman stain. 5. Recording of blood pressure using a sphygmomanometer 6. Recording of blood glucose level by using glucometer	20
II	1. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary ,Adrenal, Thyroid and Parathyroid 2. Demonstration of recording of simple muscle twitch with electrical stimulation(or Virtual) 3. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)	15

III	1. Ninhydrin test for aminoacids. 2. Benedict's test for reducing sugar and iodine test for starch. 3. Test for sugar and acetone in urine. 4. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 5. Action of salivary amylase under optimum conditions.	**10**

IV	**Virtual Labs (Suggestive sites)** 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu	**15**

Suggested Readings:

1. Cox, M.M and Nelson,D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg,J.M. ,Tymoczko, J.L. and Stryer , L.(2007).Biochemistry, VI Edition, W.H.Freeman and Co.,NewYork.
3. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
4. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
5. Victor P . Eroschenko.(2008). Di Fiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
6. Arey , L.B. (1974). Human Histology. IV Edition. W.B. Saunders.
7. Kesar , Saroj and Vashishta N.(2007).Experimental Physiology : Comprehensive Manual. Heritage Publishers, New Delhi
8. Jain A. K. : Manual of Practical Physiology, Arya publ.(2019)

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

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

Further Suggestions: None

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

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

Course outcomes:

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

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

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

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

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

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

Suggested Readings :

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

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

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

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

Class performance/Participation: 5 Marks

Further Suggestions: None

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

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

Course outcomes:

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

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

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

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

Unit	Topics	Total No. of Lectures (60)
I	1. To study the working principle and Simple, Compound and Binocular microscopes. 2. To study the working principle of various lab equipments such as pH Meter, Electronic balance, use of glass and micropipettes, Laminar flow, Incubator, Water bath, Centrifuge, Chromatography apparatus, etc.	15
II	1. To prepare solutions and buffers. 2. To measure absorbance in Colorimeter or Spectrphotometer. 3. Demonstration of differential centrifugation to fractionate different components in a mixture.	15
III	1. To prepare dilutions of Riboflavin and verify the principle of spectrophotometry. 2. To identify different amino acids in a mixture using paper chromatography. 3. Demonstration of DNA extraction from blood or tissue samples. 4. To estimate amount of DNA using spectrophotometer.	15

IV	**Virtual Labs (Suggestive sites)** www.labinapp.comwww.uwlax.eduw ww.labster.comwww.onlinelabs.inww w.powershow.in https://vlab.amrita.edu info@premiereducationaltechnologyies.com https://li.wsu.edu	**15**

Suggested Readings:

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

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

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

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

Further Suggestions: None

At the End of the whole syllabus any remarks/ suggestions: University must ensure incorporation of all04 units including virtual labs in practical evaluation.

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

Course outcomes:

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

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

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

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

Unit	Topics	Total No. of Lectures (60)
I	**Principles of Gene Manipulation** • Recombinant DNA Technology • Selection and identification of recombinant cells • Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation	10
II	**Applications of Genetic Engineering** • Single cell proteins • Biosensors, Biochips • Crop and live stock improvement, development of transgenics • Development of DNA drugs and vaccines	8
III	**DNA Diagnostics** • Genetic analysis of human diseases (Hemophilia, Colour blindness), Thalassemia , Cystic Fibrosis	4

IV	**Immune System and its Components** • Historical perspective of Immunology; Innate and Acquired Immunity, clonal selection, complement system • Structure and functions of different classes of immunoglobulins • Humoral immunity and cell mediated immunity • HLA complex: organization, class I and II HLA molecules	**10**
V	**Biostatistics I** • Calculations of mean, median, mode, variance, standard deviation • Concepts of coefficient of variation, Skewness, Kurtosis • Elementary idea of probability and application	**7**
VI	**Biostatistics II** • Data summarizing: frequency distribution, graphical presentation pie diagram, histogram • Tests of significance: one and two sample tests, t-test and Chi- square test	**7**
VII	**Basics of Computers** • Basics (CPU, I/O units) and operating systems • Concept of homepages and websites, World Wide Web, URLs, using search engines	**6**
VIII	**Bioinformatics** • Databases: nucleic acids genomes,Bibliography • Sequence analysis (homology): Sequence alignments-BLAST,CLUSTALW • Phylogenetic analysis	**8**

Suggested Readings:

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

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

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

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

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

Class performance/Participation: 5 Marks

Further Suggestions: None

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

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

Course outcomes:

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

- Understand the principles of genetic engineering with hands-on experiments in mutation detection, testing of infectious diseases like Covid19.
- Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
- Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.
- Use bioinformatics tools to find out evolutionary/phylogenetic relationship of organisms using gene sequences.
- Get employment in Hospitals/Diagnostic and forensic labs/Counsel families with genetic disorders.
- Enable students to take up research in biological sciences.

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

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

Unit	Topics	Total No. of Lectures (60)
I	1. Measure the pre and post clitellar lengths of earthworms and calculate mean, median, mode, standard deviation etc. 2. Measure the height and weight of all students in the class and apply statistical measures.	10
II	1. Determination of ABO Blood group 2. To perform bacterial culture and calculate generation time of bacteria. 3. To study Restriction enzyme digestion using teaching kits. 4. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits. 5. Demonstration of agarose gel electrophoresis for detection of DNA. 6. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins. 7. To calculate molecular weight of unknown DNA and protein fragments from gel pictures.	20

III	1. To learn the basics of computer applications 2. To learn sequence analysis using BLAST 3. To learn Multiple sequence alignment using CLUSTALW 4. To learn about Phylogenetic analysis using the programme PHYLIP. 5. To learn how to perform Primer designing for PCR using available softwares .	**15**
IV	**Virtual Labs (Suggestive sites)** 1. Gel Documentation System- https://youtu.be/WPpt3- FanNE 2. Colorimeter- https://youtu.be/v4aK6G0bGuU 3. PCR Part 1-https://youtu.be/CpGX1UFSl4A 4. PCR Part 2- https://youtu.be/6IcHAYPTAEw 5. DNA isolation Part 1- https://youtu.be/QE7Ul0JnY9A 6. DNA isolation part 2- https://youtu.be/- efr_HFeHxM 7. DNA curve-https://youtu.be/ubL8QxTeuG4 8. Spectrophotometer- https://youtu.be/ubL8QxTe4 9. Agarose Part 1- https://youtu.be/7gvHPFww--g 10. Agarose part 2- https://youtu.be/j_bOZCHNsSg 11. Use softwares like Primer3, NEB cutter 12. NCBI, BLAST, CLUSTAL W,PHYLIP	**15**

Suggested Readings:

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

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

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

Suggested Continuous Evaluation Methods:

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

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

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

Course outcomes:

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

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

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

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

Unit	Topics	Total No. of Lectures (60)
I	**Protozoa to Coelenterate** • Protozoa – *Paramecium* (Morphology and Reproduction) • Porifera – *Sycon* (Canal System) • Coelenterata – *Obelia* (Morphology and Reproduction)	7
II	**Ctenophora to Nemathelminthes** • Ctenophora – Salient features • Platyhelminthes - *Taenia* (Tape worm) (Morphology and Reproduction) • Nemathelminthes –*Ascaris lumbricoides* (Morphology and Reproduction)	7
III	**Annelida** • Annelida –*Hirudinaria* (Leech) (Morphology and Reproduction)	8

IV	**Arthropoda** • Arthropoda – *Palaemon* (Prawn) (Morphology, Appendages, Nervous System and Reproduction)	**8**
V	**Mollusca to Hemichordata** • Mollusca –*Pila*(Morphology, Shell, Respiration, Nervous System and Reproduction) • Echinodermata –*Pentaceros* (Morphology and Water Vascular System)	**8**
VI	**Vectors and pests** Life cycle and their control of following pests: Gundhi bug, Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control	**8**
VII	**Economic Zoology-1** Animal breeding and culture: Strategies of food sufficiency: Pisciculture	**7**
VIII	**Economic Zoology- 2** Sericulture, Apiculture, Lac-culture, Vermiculture	**7**

Suggested Readings:

1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell17
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. Mc Graw Hill
7. Invertebrates by R.L. Kotapal
8. Invertebrates by E.L Jordan and P.S. Verma
9. Non- chordates by H.C. Nigam
10. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla.Oxford
11. Parasitology-Chatterjee
12. Parasitology-Chakraborty
13. Thomos C. Chung. General Parasitology. Hardcourt Brace and Co. Ltd. Asia, New Delhi.
14. Gerard D. Schmidt and Larry S Roberts. Foundations of Parasitology. Mc Graw Hill.
15. Bisht. D.S., *Apiculture*, ICAR Publication.
16. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.
17. Jhingran. V.G. Fish and fisheries in India.,
18. Khanna. S.S, An introduction to fishes
19. Boyd. C.E. &Tucker. C.S, Pond aquaculture water quality management,
20. Biswas.K.P, Fish and prawn diseases,
21. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
22. Lee, Earthworm Ecology
23. Stevenson, Biology of Earthworms
24. Destructive and Useful Insects by C. L. Metcalf
25. Sericulture for Rural Development : Hanumappa (1978), Himalaya Publication,
26. Sriculture in India Sarkar, D.C. (1988), CSB, Bangalore
27. Economic Zoology by Shukla and Upadhyay

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

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

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

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

Course outcomes:

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

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

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

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

Unit	Topics	Total No. of Lectures (60)
I	**Origin of Chordates & Hemichordata** • Origin of Chordates. Classification of Phylum Chordata upto the class. • Hemichordata: General characteristics, classification and detailed study of *Balanoglossus* (Habit and Habitat, Morphology, Anatomy, Physiology and Development).	6
II	**Cephalochordata and Urochordata** • Cephalochordata : General characteristics, classification and detailed study of *Branchiostoma* (*Amphioxus*) (Habit and Habitat, Morphology, Anatomy, Physiology). • Urochordata : General characteristics, classification and detailed study of *Herdmania* (Habit and Habitat, Morphology, Anatomy, Physiology and Post Embryonic Development).	6

III	**Classification and General Characteristics of Vertebrates** • General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) up to the order with examples. • Poisonous and Non Poisonous Snakes and biting mechanism. • Neoteny and Paedogenesis • Migration in birds • Dentition in Mammals	**8**
IV	**Comparative Anatomy and Physiology of Vertebrates Integumentary System** Structure, functions and derivatives of integument **Skeletal System** Overview of axial and appendicular skeleton, Jaw suspensorium ,Visceral arches	**8**
V	**Digestive System** Alimentary canal and associated glands, Dentition	**8**
VI	**Respiratory System** Skin, gills, lungs and air sacs; Accessory respiratory organs	**8**
VII	**Circulatory System** General plan of circulation, evolution of heart and aortic arches **Urinogenital System** Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	**8**
VIII	**Nervous System** Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals **Sense Organs** Classification of receptors Brief account of visual and auditory receptors in man	**8**

Suggested Readings:

1. Harvey et al: The Vertebrate Life(2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002,Wiley -Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution Mc Graw Hill
5. Mc Farland et al: Vertebrate Life(1979, Macmillan Publishing)
6. Parker and Haswell: Text Book of Zoology, Vol. II (1978,ELBS)
7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
8. Young: The Life of vertebrates (3rd ed 2006,ELBS/Oxford)
9. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata Mc Graw Hills
10. Pandey B.N. & Mathur V. :Biology of Chordates, PHI Learning Pvt Ltd Delhi (2019)
11. Kotpal R.L. : Vertebrate Zoology (Hindi) Rastogi Publication (2019)
12. Vertebrates by E.L Jordan and P.S. Verma
13. Chordates by H.C. Nigam
14. Vertebrates by Sedwick Vol I, II, III

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

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

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

Further Suggestions: None

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

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

Course outcomes:

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

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

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

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

Unit	Topics	Total No. of Lectures (60)
I	1. Study of animal specimens of various animal phyla. 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.*	15
II	1. Study of animal specimens of various animal phyla 2. Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig). 3. To prepare stained/unstained slide of placoid scales. 1. Comparative study of bones of different vertebrates. 2. Comparative study of histological slides of different tissues of vertebrates.	15

III	1. Permanent Preparation of: *Euglena, Paramecium* 2. Study of prepared slides/specimens of *Entamoeba, Giardia, Leishmania, Trypanosoma, Plasmodium, Fasciola, Cotugnia, Taenia, Rallietina, Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma* 3. Permanent Preparation of *Cimex* (bed bug)/ *Pediculus* (Louse), *Haematopinus* (cattle louse), fresh water annelids, arthropods; and soil arthropods. 4. Larval stages of helminthes and arthropods. 5. Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly. Permanent preparation of ticks/ mites, abdominal gills of aquatic insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly. 6. Identification of pests. 7. Life history of silkworm, honeybee and lac insect. 8. Different types of important edible fishes of India. 9. Slides of plant nematodes. 10. Study of an aquatic ecosystem, its biotic components and food chain. 11. Project Report/ model chart making. 12. **Dissections** : through multimedia /models 13. **Cockroach** : Central nervous system 14. ***Wallago***: Afferent and efferent branchial vessels, Cranial nerves, Weberian ossicles.	**15**
IV	**Virtual Labs (Suggestive sites)** https://www.vlab.co.inhttps://zoologysan.blogspot.comwww.vlab.iitb.ac.in/vlabhttps://www.vlab.co.in https://zoologysan.blogspot.comwww.vlab.iitb.ac.in/vlabwww.onlinelabs.inwww.powershow.comhttps://vlab.amrita.eduhttps://sites.dartmouth.edu	**15**

Suggested Readings:

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

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

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

Suggested Continuous Evaluation Methods:

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

Further Suggestions: None

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

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

Course outcomes:

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

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

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

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

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

IV	**Species Concept and Extinction** • Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric) • Mass extinction (Causes, Names of five major extinctions	**7**
V	**Gamete Fertilization and Early Development** • Gametogenesis, Fertilization • Cleavage pattern • Amphibian Gastrulation and fatemaps	**6**
VI	**Developmental Genes** • Genes and development • Molecular basis of development in drosophila	**8**
VII	**Early Vertebrate Development** • Early development of vertebrates (fish, birds & mammals) • Metamorphosis, regeneration and stem cells • Environmental regulation of development	**8**
VIII	**Late Developmental Processes** • The dynamics of organ development: Development of eye, • Metamorphosis: the hormonal reactivation of development in amphibians • Regeneration: salamander limbs, Hydra • Aging: the biology of senescence	**8**

Suggested Readings:

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

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

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

Class performance/Participation:5 Marks

Further Suggestions: None

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

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

Course outcomes:

The student at the completion of the course will learn:

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

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

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

Unit	Topics	Total No. of Lectures (60)
I	**Introduction to Ecology** • History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors	4
II	**Organization of Ecosystem** • Levels of organization, Laws of limiting factors, Study of physical factors, • Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion, Exponential and logistic growth, • Types of ecosystems with one example in detail, Food chain, Food web, Energy flow through the ecosystem, Strategies for clean drinking water. • Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle	12

III	**Community Ecology** Community characteristics: species richness, dominance, diversity, abundance, Ecological succession with one example	**7**
IV	**Environmental Hazards** • Sources of Environmental hazards • Climate changes • Greenhouse gases and global warming • Acid rain, Ozone layer destruction	**7**
V	**Effects of Climate Change** • Effect of climate change on public health • Hazardous waste; Sources, types and their ill effects, Solid waste management, waste handling and disposal • Management of Biomedical, Nuclear and Thermal waste • Environmental disaster: Bhopal gas tragedy.	**6**
VI	**Behavioural Ecology and Chronobiology** • Origin and history of Ethology, • Instinct vs. Learnt Behaviour • Associative learning, classical and operant conditioning, Habituation, Imprinting, • Circanual and circadian rhythms; Tidal rhythms and Lunar rhythms • Chrono medicine	**8**
VII	**Introduction to Wild Life** • Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.	**8**
VIII	**Protected areas** • National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve	**8**

Suggested Readings:

1. Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall.
2. Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
3. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs ,2016, Pearson Education Inc.
4. Elements of Ecology. T.M. Smith and R.L. Smith, 2014, Pearson Education Inc.
5. Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
6. Environment. Raven, Berg, Johnson, 1993, Saunders College Publishing.
7. Essentials of Ecology. G.T. Miller, Jr. & Scott. E. Spoolman, 2014, Brooks/Cole, Cengage Learning.
8. Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley- Blackwell publisher ,Oxford.
9. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M.Oxford University Press, UK.
10. Fundamentals of Ecology. E.P. Odum & Gray. W. Barrett, 1971,Saunders
11. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
12. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.
13. Bookhout, .A.(1996).Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
14. Sutherland, W.J.(2000).The Conservation Handbook :Research, Management and Policy. Blackwell Sciences
15. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.
16. Singh H R & Kumar N, Ecology and Environment Science, Vishal Publishing Delhi

Course Books published in Hindi language and by authors, other than those mentioned above, as suggested by teachers may be prescribed by the Universities and Colleges

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

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

Suggested Continuous Evaluation Methods:

House Examination/Test: 10 Marks

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

Class Performance/Participation: 5 Marks

Further Suggestions: None

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

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

Course outcomes:

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

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

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

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

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

IV	**Virtual Labs (Suggestive sites)** https://www.vlab.co.in https://zoologysan.blogspot.comwww.vlab.iitb.ac.in/vlab	15

Suggested Readings:

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

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This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 from Arts/Commerce/Science

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

Further Suggestions: None

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

NON -CHORDATA			
Paper Code: B050702T	**Year - Fourth**	**Semester : Seventh**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Concepts of Protista Classification of an organism (Whittaker) Body Covering and skeleton of Protozoa, Ultrastructure Nucleus and reproduction in Protozoa, Locomotion and Osmoregulation in Protozoa, Nutrition in Protozoa	15
II	Nutrition and Digestion: Patterns of feeding and digestion in lower metazoan Filter feeding in Protozoans, Polychaeta, Molluscs and Echinoderms Cell type, Canal System, Skeleton and Reproduction in Porifera Nematocysts, Polymorphism, Metagenesis, Corals and Coral reefs, Origin of Metazoan General Organization of Trematoda & Cestoda, Parasitic Adaptations in Helminthes	15
III	Economic importance of Nematodes in Plants and Animals Invertebrate Larvae: Larval forms of free-living invertebrates, Larval forms of Cestodes and Trematodes Evolutionary Significance of Trochophore Larva, Adaptive radiation in Polychaetes Organization and affinities of Onychophora, Larval forms and Parasitism of Crustacea, Respiratory organs in Arthropods	15
IV	Modifications of Foot in Mollusca, Shell types in Mollusca Torsion in Gastropoda, Detortion, Respiration in Mollusca, Nervous System in Mollusca of Deuterostomia, Water Vascular System in Echinodermata Salient features and affinities of Rotifera, Ctenophora and Phoronida	15

Suggested books:

1. Hyman, L.H. The Invertebrate Vol.-I & II
2. Barrington, EJU: Invertebrate structure and function
3. Ruppert, Edward E., Fox, Richard S. & Barnes, Robert D. Invertebrate Zoology: A Functional Evolutionary Approach
4. Pechenik, Jan A. Biology of the Invertebrates
5. Non-Chordata – Meglitsch Paul A
6. Parker T.J. and Haswell, W.A. Text book of Zoology Vol. – I
7. Jargenstein, G. Evolution of Metazoan Life
8. Moore: An Introduction to the Invertebrates

Biosystematics and Evolutionary Biology			
Paper Code: B050702T	**Year- Fourth**	**Semester : Seventh**	**Total marks : 100**
Credits : 04		**Total no of lectures: 60**	

Unit	Topic	Total No. of Lectures
I	Basic Concept of Animal Taxonomy, A Historical review, taxonomic terms, Classification and Nomenclature; Phenon; taxon and category, α, β *and* γ Taxonomy Recent trends in Taxonomy: Chemotaxonomy, Cytotaxonomy, Serotaxonomy, Molecular Taxonomy Microtaxonomy: Species concepts, nominalistic species concepts, biological species concept and evolutionary species concept	15
II	Macrotaxonomy: Phenetics, Cladistics and Phylogenetic Variations in Systematics, Taxonomic Procedures, Keys Importance of application of systematics in Biology International Code of Zoological nomenclature (ICZN), Type concept, Law of priority, The present Scenario and the global taxonomic initiatives	15
III	Various Evolutionary theories, Natural Selection and its types, molecular signatures of natural selection. Adaption: its evolutionary analysis, Speciation: allopatric, sympatric, parapatric, peripatric. Elemental Forces of evolution: Mutation, genetic drift, Isolation	15
IV	Hardy-Weinberg law and its application, Conditions for the maintenance of genetic equilibrium, genetic death, probability and Goodness of fit Polygenic inheritance, Molecular phylogenies, Molecular clock, Molecular tools in phylogeny	15

Suggested books:

1. Principles of Systematic Zoology by Ernst Mayr
2. Principles of Animal Taxonomy by G.G. Simpson
3. Schuh, R.T., and A.V.Z. Brower. Biological Systematics: Principles and Applications
4. Wiley, E. O. and B. S. Lieberman. Phylogenetics: Theory and Practice of Phylogenetic Systematics
5. Animal Taxonomy by H. E. Goto
6. Evolution: An Introduction by S.C. Stearns and R.F. Hoekstra
7. Evolution by N. H. Barton et. al.
8. Ridley, M: Evolution
9. Schuh, R.T., and A.V.Z. Brower. Biological Systematics: Principles and Applications
10. Futuyma: Evolutionary Biology
11. Lull, R.S. Organic Evolution
12. Hartl and Clarke: Principles of Population Genetics

Cell Biology and Genetics

Paper Code: B050703T	Year - Fourth	Semester - Seventh	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**Cellular membrane and cytoskeleton:** An overview of membrane functions, Chemical composition of cell membrane. Structure and functions of membrane proteins: Integral protein, peripheral membrane proteins and lipid-anchored membrane proteins. Membrane models. Movement of substances across cell membranes: Diffusion, active transport, uniport, symport and antiport Microtubules, Intermediate filaments and Microfilaments: Structure, Functions and assembly, Endomembrane system (ER-GC), Ribosome, Targeting and sorting of proteins: Processing through endomembrane system, Targeting of cytosolic proteins	15
II	**Mitochondria**: Structure, Assemblies of respiratory chain & Fo-F1 ATPase, Oxidative phosphorylation, ATP and other high energy phosphate compounds **Nucleolus**: Structure and biogenesis of ribosomes, Cell Signalling: Cell-cell interaction, Chemical mediators, Cell surface and intracellular receptors, Regulation of signalling pathways, JAK-STAT pathway, MAP Kinase pathway, Apoptosis **Cell division**: Mitosis, Role of maturation promoting factor, regulation of cell cycle, chromosomal movement, Exit from mitosis, Cytokinesis Meiosis: Overview, Chromosome pairing and recombination	15
III	**Genetics-I:** Mendel's laws and their chromosomal basis, Extensions of Mendelism: Dominance relationships, Epistasis, Pleiotropy, Expressivity and penetrance. Methods of gene mapping: 3-point test cross in Drosophila, Gene mapping in human by linkage analysis in pedigrees, Tetrad analysis in Neurospora Gene Mutation: Types of gene mutations, Methods for detection of induced mutations, P-element insertional mutagenesis in Drosophila, DNA damage and repair, mechanism of Homologous recombination	15
IV	**Genetics II:** Nature of the gene and its functions: Evolution of the concept of gene, Fine structure of gene, Regulation of gene activity in lac and trp operons of E. coli, organization of a typical eukaryotic gene, Mobile DNA, enhancers and silencers; non-coding genes, Organization and function of mitochondrial DNA Recombinant DNA technology: Restriction enzymes, Plasmid and phage vectors for cloning, Genomic and cDNA libraries; detection of genes and their products	15

Suggested books:

1.Becker et. al.: The World of the Cell 2. The Cell: A Molecular Approach by Cooper and Hausman. 3. Cell and Molecular Biology by Karp 4. Molecular Biology of the Cell by Alberts et al. 5. Molecular Cell Biology by Lodish et al 6. Genetics by Benjamin A. Pierce 7. Concepts of Genetics by William S. Klug, M.
R. Cummings 8. Lewin: Gene XII 9. Genome 3 by T. A. Brown 10. Principles of gene manipulation and genomics by R.M. Twyman and S.B. Primrose 11. Genetics by Peter J. Russell 12. Watson: Molecular Biology of the Gene 13. Cells by Wong 14. Cell Biology by Pollard et al 15. Genetics a molecular approach by T.A. Brown 16. Cell and molecular biology by Sheeler and Bianchi

Quantitative Biology, Research Methodology and Bioinstrumentation

Paper Code: B050704T	Year - Fourth	Semester- Seventh	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	Measures of central tendency: Mean, Median and Mode Measures of Dispersion: Range, Mean Deviation, Standard Deviation, Coefficient of Variations, Correlation and Regression Testing of Hypothesis: Null Hypothesis & Alternative Hypothesis, Type I and Type II Error, Level of Significance Test of Significance: Parametric tests (Paired and unpaired t-test, Z-test, F-test) & non-Parametric tests (Chi-square test and Mann-Whitney U-test) Probability: Probability theory: Binomial distribution, Poisson distributions Analysis of Variance (ANOVA): One way and two-way	15
II	Research Design, Data Collection, Data Presentation: Classification and Tabulation of Data. Diagrammatic and Graphical Presentation of Data: Bar Diagram, Histogram, Frequency Polygon, Pie-diagram, Analysis of Data Literature survey: sources, print and digital Types of Research: Descriptive vs Analytical; Applied vs Basic; Qualitative vs Quantitative; Conceptual vs Empirical; Survey vs Experimental Interpretation, report writing and Publication, Ethical aspects of biological research	15
III	Microscopy: Light, Phase contrast, Transmission & electron microscopy, Fluorescence microscopy, freeze fracture electron microscopy, different fixation and staining techniques for EM Principal of spectrophotometry (UV & Visible), PH meter and GM Counter Electron Spine Resonance & Nuclear Magnetic Resonance spectroscopy Centrifugation: Isolation of DNA, RNA and Proteins Chromatography: Paper Chromatography, TLC, HPLC Electrophoresis: one dimensional & two-dimensional Polymerase change reaction (PCR), DNA sequences, Microtome, Laminar flow	15
IV	**Histochemical and Immunotechniques:** Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques (FISH and GISH) **Electrophysiological methods:** Patch-clamp recording, ECG, CAT, fMRI, PET, MRI	15

Suggested books:

1-Boyer: Modern Experimental Biochemistry and Molecular biology 2. Switzer and Garrity: Experimental Biochemistry 3. Wilson and Walker: Practical Biochemistry 4. Plumer: An Introduction to Practical Biochemistry Holme and Peck: Analytical Biochemistry 5. Antonisamy, B., Christopher S. and Samuel, P. P. Biostatistics: Principles and Practice 6. Pagana, M. and Gavreau, K. Principles of Biostatistics 7. Zar, Jerrold H. Biostatistical Analysis 8. Walliman, N. Research Methods-The Basics 8. Kothari, C. R. Research Methodologies-Methods and Techniques 9. Dawson, C. Practical Research Methods 10. Booth, W.C., Colomb, G.G. and Williams, J.M. (2003). The Craft of Research 11. Physical Biochemistry by David M. Freifelder

PRACTICAL			
Paper Code: B050705P	**Year - Fourth**	**Semester- Seventh**	**Total marks : 100 (25+75)**

The duration of the practical examination will be 04 hours. The distribution of marks in End Semester Examination (ESE) will be as follows-

1.	Exercises based on Non Chordata (B050701T)	20
2.	Exercises based on Biosystematics and Evolutionary biology (B050702T)	05
3.	Exercises based on Cell biology and Genetics (B050703T)	05
4.	Exercises based on Quantitative biology, research methodology & Bioinstrumentation (B050704T)	10
5.	Identify and comment upon spot 1-10 (10 spots)	15
6.	Viva-voce	10
7.	Practical record	10
	Grand Total =	**75**

Distribution of marks of Continuous Internal Assessment (CIA):

1.	Examination	15
2.	Seminar/Presentation/Assignment/Quizzes…	10
	Grand Total =	**25**

B. Sc Semester- VII

Zoology Practical Examination (ESE) - 20....

Date: Batch: Duration: 4 hrs Max. Marks: **75**

Question Paper

Q.No.1. Dissect the animal provided (.....) so as to expose its nervous system as clearly as possible. Display your dissection suitably. (*Aplysia/ Mytilus/Sepia/Squilla*) **10**

Q. No. 2. Make a suitable permanent stained preparation of ..... from the material / animal..... .....provided. **10**

Q. No. 3. Identify and comment upon spots. (1-10) **15**

Q. No. 4. Any one exercise based on Biosystematics and Evolutionary biology (One invertebrate +one vertebrate) **05**

Q. No. 5. Any one exercise from Cell biology and Genetics **05**

Q. No. 6. Any one exercise from Quantitative biology and Bioinstrumentation **10**

Q. No. 7. Viva-voce **10**

Q. No.8. Practical record/ Collection/ Chart **10**

Spots: (Museum specimens:4 and Slides:6)

1.

2.

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10.

Detailed Syllabus of Semester -VII

B050701T Non -Chordates

1. **Major Dissection-**

   Aplysia- Nervous System

   Mytilus – Nervous System

   Sepia - Nervous System

   Squilla – Nervous System

2. **Minor Dissection –**

   Palaemon- Nervous System

   Pila - Nervous System

   Lamellidens - Nervous System

3. **Take out and Mount- (Permanent Preparation):**

   Pheretima – Nerve ring, Septal nephridia, ovary

   Palaemon – Appendages, Statocyst, Hastate plate

   Pila- Osphradium, Radula

   Cockroach- Salivary glands, testes, ovary, Gizzard

   Lamellidens- Gill lamella

4. ***Mounting materials to be provided:***

   Porifera: Gemmule of *Spongilla*, Spongin fibres

   Spicules

   Coelenterata: *Obelia* colony, *Hydra*, *Sertularia*,

   Companularia

   Arthropoda: *Daphnia*, Zoea larva, Mysis larva,

   Pediculus, *Cimex*

5. Study of Museum Specimens and Prepared slides

B050702T Biosystematics and Evolutionary biology:

1. Adaptive modifications in feet of birds and mouth parts of insects (from slides)
2. Embryological evidence of evolution (through charts)
3. Serial homology in appendages of *Palaemon*
4. Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit)
5. Evolution of Horse – through models
6. Study of adaptation and its significance in following animals-
   (i) *Physalia*
   (ii) *Taenia*
   (iii) *Ascaris*
   (iv) *Fasciola*
   (v) *Hirudinaria*
   (vi) *Limulus*
   (vii) *Peripatus*

(viii) *Antedon*
(ix) *Petromyzon*
(x) *Pristis*
(xi) *Chimaera*
(xii) *Exocoetus*
(xiii) *Anabas*
(xiv) *Neoceratodus*
(xv) *Rhacophorus*
(xvi) *Chamaeleon*
(xvii) *Draco*
(xviii) *Struthio*
(xix) *Tachyglossus*
(xx) *Macropus*

Biosystematics:

Specimen collection, preservation and identification (Any one animal from any phyla of animal kingdom)

B050703T Cell biology and Genetics:

1. Study of different stages of Mitosis and Meiosis (Prepared slides)
2. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
3. Temporary/permanent squash preparation of giant chromosome
4. Analysis of Pedigree charts
5. Genetical exercises based on Test cross, Dihybrid cross, Sex-linked inheritance
6. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome)

B050704T Quantitative biology, Research methodology and Bioinstrumentation:

I. **Microtomy**: Preparation of Blocks, section cutting, and stretching by wax methods and staining of vertebrate tissues by double staining methods
II. **Microscope and its practical uses**- Simple microscope, Compound microscope, Binocular microscope, Phase contrast microscope, Electron microscope
III. **Common biological instruments in laboratory:** Practical use Chromatography, Electrophoresis, pH meter, Colorimeter
IV. General method of microscopic preparation, single and double staining methods
V. Method of preparation of fixatives, stains and useful reagents used in a laboratory

Quantitative biology:

1. Measures of central tendencies (Arithmetic means, Median, Mode, Standard deviation and Numerical based on them)
2. Mean deviation, test of significance (t-test and Chi-square test) numerical problems based on them
3. Corelation coefficient
4. Analysis of varience

Chordata

Paper Code: B050801T	Year - Fourth	Semester – Eighth	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	Origin and general characters of Chordata: Classification of class Amphibia, Reptilia, Aves and Mammalia General organization and affinities of Protochordata: Hemichordata, Urochordata, Cephalochordata , Retrogressive metamorphosis in ascidian larva General organization and affinities of Ostracoderms, Cyclostomes and Dipnoi General organization of Fishes, Swim Bladder and their functional significance, Parental care, Migration	16
II	**Amphibia:** Origin of tetrapods, General organization of Anura, Neoteny, Peculiarities of Urodela, Peculiarities and affinities of Apoda, Adaptive Radiation **Reptilia:** Skull in Reptiles, Origin and evolution, Adaptive radiation, General organization and affinities of Chelonia, Crocodilia, Squamata, Rhynchocephalia	16
III	**Aves** Origin and evolution, Flightless birds, Palate in birds and their importance, Modification of beaks, feet in birds, Migration in Birds, Adaptations for flight, Parental care, Adaptive radiation	14
IV	**Mammalia:** Origin of mammals, Adaptive radiation of Mammalia, Structural peculiarities and phylogenetic relations of Prototheria and Metatheria, Uterus modifications, Aquatic mammals, Stomach in ruminants	14

Suggested books:

1. The life of vertebrates by Young
2. Vertebrates; their structure and life by W. B. YAPP
3. Vertebrate biology by RT ORR
4. Vertebrate Biology by D. Linzey
5. The Biology of Hemichordata and protochordata by Barrington
6. Textbook of Zoology Vertebrates by Parkar and Haswell
7. An Introduction to The Vertebrates by L A Adams
8. Studies on the structure and development of vertebrates by EDWIN S. GOODRICH
9. Harvey et al: The Vertebrate Life
10. Hildebrand: Analysis of Vertebrate Structure
11. Colbert's Evolution of the Vertebrates
12. McFarland et al: Vertebrate Life
13. Romer and Parsons: The Vertebrate Body
14. Vertebrates: Comparative Anatomy, Function, Evolution by Kenneth V. Kardong

Animal Physiology and Biochemistry

Paper Code: B050802T	Year - Fourth	Semester – Eighth	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**Physiology of Digestion:** Digestion and absorption of proteins, Digestion and absorption of carbohydrates Digestion and absorption of lipids, Regulation of digestion and absorption **Physiology of Circulation:** Composition of blood, Haemopoiesis, Blood Coagulation, Heart, Origin and conduction of cardiac impulse, Cardiac cycle and its regulation **Physiology of Respiration:** Respiratory organs and Respiratory pigments, lung air volumes, transport and exchange of gases, Respiratory centers: organization and function **Physiology of Muscles:** contraction and relaxation of skeletal muscle and Smooth muscle	15
II	**Physiology of Excretion:** Three basic modes of excretion, Urine formation, Counter current mechanism, Regulation of body fluid and electrolyte, Hormonal regulation **Neurophysiology:** Neurons, Axonal transmission, Synaptic transmission, action potential, neural control of muscle tone and posture, neurotransmitters **Physiology of Endocrine System:** Overview of endocrine glands, Mechanism of action of hormones **Physiology of Thermoregulation:** comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. **Physiology of Vision and Hearing**	15
III	Chemical bonds, biomolecules, pH, Acids and Bases, Buffers, Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, biological energy transducers **Carbohydrates:** Classification, nomenclature and functions, Synthesis and breakdown of glycogen and glucose **Lipids:** Structures and types of saturated and unsaturated fatty acids. Lipid metabolism: Biosynthesis of fatty acids, oxidation of fatty acids (β- oxidation) and carnitine shuttle Ketogenesis: biosynthesis and utilization of ketone bodies. Regulation of ketogenesis	15
IV	**Enzymes**: Nomenclature, classification, action, Enzyme kinetics, Mechanism of enzyme action, Coenzymes, Ribozymes, Isoenzymes, DNA enzymes and half-life of enzymes, Enzyme Inhibition: competitive and non-competitive inhibition **Proteins**: Structures, classification and properties of amino acids, Primary, secondary, tertiary and quaternary structure of proteins, Biosynthesis of proteins Secondary Metabolites: Alkaloids, Terpenoids	15

Suggested books: Principles of Animal Physiology by Moyes and Schulje 2. Animal physiology by SCHMIDT 3. Eckert animal physiology mechanisms and adaptations 4. Ganong's Review of Medical Physiology 5. Guyton and Hall: Textbook of Medical Physiology 6 Principles of Biochemistry 7. Biochemistry Vols 1 & 2 by Voet & Voet 8. Animal physiology by Hill, Richard W., et al. 9. Human Physiology Volume 1 & 2. By Chatterjee C C 10. Lehninger's Principles of Biochemistry 11. Biochemistry Vols 1 & 2 by Voet & Voet

Reproductive and Developmental Biology

Paper Code: B050803T	Year - Fourth	Semester- Eighth	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**Human Reproductive system:** Structure and function of male reproductive organs; Formation of sperm and fertility of individual. Structure and function of female reproductive organs; Sexual differentiation, Formation of sperm; Formation of ova. Physiology of ovulation, menstrual cycle; Nutrition and stress influences on the ovulatory cycle, Amniocentesis **Puberty**: control of the onset; stages; delayed and precocious puberty Process of fertilization; Implantation and formation of the foetus and placenta; Pregnancy, Labour and birth, lactation and neonatal life; Reproductive Ageing; Menopause	15
II	**Evolution of reproductive mechanism and regulation:** Evolution of human reproductive strategy; Evolutionary impact on behaviour; Sexuality hormonal effects on maternal-infant bonding **Reproductive Health:** Sexual dysfunctions, sexually transmitted diseases; Cancers of the reproductive system; Adenomyosis: gland-like growth into myometrium; Birth Control; Assisted Reproduction Technologies; Intrauterine devices (IUD), endometriosis, fibroids, Endometritis: chronic infection of uterus, congenital uterine anomalies; Ovarian cysts, pelvic varicosities	15
III	**Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants. Fertilization, Cleavage, Morula, Blastula and Gastrula, Standard techniques and methods of experimental embryology: vital dying, extirpation, isolation, transplantation and grafting.	15
IV	**Morphogenesis and organogenesis:** Organizers: characteristics and physiology, axes and pattern formation in *Drosophila*, amphibia and chick; vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development in vertebrates Metamorphosis: Hormonal control of metamorphosis, metamorphosis and genetics Malignancy: teratogens, carcinogens, oncogenes, neoplasia	15

Suggested books:

1.Langman's Medical Embryology by Thomas W.S. 2. Larsen's Human Embryology by Gary C.S.; et al. 3. Developmental Biology by Gilbert, S.F. 3. Encyclopaedia of Reproduction by Ernst Knobil and Jimmy D. Neill 4. The biology of reproduction by Giuseppe Fusco and Alessandro Minelli 5. Biology of reproduction by Peter J. Hogarth 6. Essential Developmental Biology by Jonathan M. W. Slack 7. Developmental biology by Werner A. Müller 8. Principle of development by Wolpert 9. Developmental biology by N. J. BERRILL 10. Developmental biology by John W. Saunders 11. Principles of developmental biology by Wilt & Hake 12. Essential developmental biology by J M W Slack

Apiculture

Paper Code: B050804T	Year - Fourth	Semester- Eighth	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**Introduction to Apiculture:** History of Apiculture, Systematics, Honey Bee species, Honey Bee morpho-anatomy, Colony organization, Polymorphism, Caste system, Division of labour, Honey Bee flora – importance, propagation - congenial conditions for starting up of apiculture. Migratory Bee Keeping - designing floral Calendar, Improved Agricultural practices - crop pollination - Pesticides impact on Honey bees Foraging and Honey flow periods, social behaviour of Honey Bees, Bee as pollinators: Crop improvement: Quality and yield through honeybee pollination	15
II	**Apiculture as an occupation:** Extent of Apiculture in Uttar Pradesh and India, Limitations on the development of Apiculture, Advantages of extensive Apiculture, Bee keeping equipment - introduction to types of bee boxes - BIS standard Tools used in apiculture. Bee breeding multiplication of colonies - Queen reaching technique. **Honey:** Production, Properties and application: Production of Honey by honeybee within its stomach using plant nectar, application in various fields - other valuable by products of honey bees Honey - its medicinal properties - application in various fields - other valuable by products of honey bees	15
III	**Steps in Apiculture:** Purchase of a colony, the Apiary site, how to manage a colony, the manipulation of a colony, Honey extraction & handling - Quality control standards - Honey testing kit Processing of honey, Other Bee products: Bees wax, Pollens, Royal Jelly, Propolis and Bee venom **Control of Honeybee Diseases**: Bee enemies and diseases: Introduction, Enemies of honeybees – Wax Moth, Ants, Wasps, Microbes, Pests; Diagnosis and identification. Bacterial, viral, fungal and protozoan diseases; Mites attacking honeybees. Establishment of a colony. planned pollination services	15
IV	**Apiculture techniques and Apiary management:** Routine management, Seasonal management, Migratory beekeeping, Harvesting and marketing of Honey bee products. Important Institutions pertinent to Apiculture: National Bee Board, Honey Bee research and Training Institute, Apiaries. Economics in small scale and large-scale bee keeping. Economic Value of Commercial Beekeeping. Preparing bankable bee keeping project: Steps involved in starting a beekeeping project, Funding sources for beekeeping projects.	15

Suggested books:

1 .Abrol, D. P. Bees and Beekeeping 2. Withhead, S. B. Honey bees and their management 3. Dharam singh and Singh, D. P. A. Handbook of Beekeeping 4. Mishra R.C. Honey bees and their management in India 5. Singh, S. Beekeeping in India 6. Gupta, J.K., Sharma, H K and Thakur, R K. Practical Manual on Beekeeping 7. Bisht D.S., Apiculture 8. David Cramp. The complete step by step book of Beekeeping 9. Pradip, V. Jabde. Text book of Applied Zoology

Sericulture

Paper Code: B050805T	Year - Fourth	Semester- Eighth	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**An Introduction to Sericulture** History of sericulture, systematic, Exotic and indigenous races of silkworm, Mulberry silk worm, feeding habit of silk worm, life history of various species of silk worm, Tassar silk worm, Eri silk worm, Life cycle of mulberry silk worm (Bombyx-mori)	15
II	**Historical Review of Sericulture** Extent of sericulture in the global part in the world Silk Industry in various part of India, World silk production World map and silk road, spread of Sericulture to Europe, South Korea, Japan, India and other countries. Sericultural practices in tropical and temperate climate, Silk production in East Area, Silk production in China & Japan, Silk production in India and Malaysia Various Silk research institute and Regional Silk stations	15
III	**Advances of extensive Sericulture** Basic requirement of tools for starting Silk Industries. Getting started in Silk Industry planning before start of sericulture Industry. Tools used for sericulture. Climatic conditions, soil conditions for plantation, Manuring, fertilizers at the time of Silk Production, Rearing of Silk Worm, Polyhedrosis of Silk worm	15
IV	**Sericulture techniques and Sericulture management** Marketing of various Silk products, National Sericulture Board (NSB) Sericulture Institute and training institute in India, Economic Importance of Silk, Status of Sericulture Industry in India, Distribution of Silk Industry in India, Sericulture Industry and Human welfare, Function of Central Silk Board and their Co-ordination in various parts of India	15

Suggested books:

1. Manual on sericulture: Rome: Food and Agriculture Organization of the United Nations
2. Ullal, S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture
3. Jolly, M. S. Appropriate Sericultural Techniques
4. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1
5. Narasimhanna, M. N. Manual of Silkworm Egg Production
6. Sengupta, K. (1989) A Guide for Bivoltine Sericulture

Lac culture			
Paper Code: B050806T	**Year - Fourth**	**Semester- Eighth**	**Total marks : 100**
Credits : 04		**Total no of lectures: 60**	

Unit	Topic	Total No. of Lectures
I	An Introduction to Lac Culture: Historical review of Lac culture Various products of lac and their commercial value Extent of Lac culture in the world. Lac Producing places in India Distribution of Lac in the global area	15
II	Biology of silkworm: Systematic position of lac insect in animal kingdom Morphology and Anatomy of lac insect. Difference between male and female lac insects Life history various species of lac insect i.e., Tachardia-lacca (Laccifer	15
III	Various Host Plants of lac insects, Common host plants of India and other countries, names of various Host plants of lac insects, Cultivation of lac, Inoculation period Type of inoculation, Swarming of lac insects	15
IV	Harvesting of lac, Harvesting period and types of harvesting Lac cultivation and Recent plant of lac cultivation. Lac Industry and processing of lac industry Properties of Lac. Physical and chemical composition of Lac, Enemies of lac cultivation, Lac Industry of India, Economic Importance	15

Suggested books:

1. Text Book of Applied Zoology by Jabde, P.V.
2. Insects by Mani, M.S.
3. Lac-Culture in India by N Ghorai
4. Lac Cultivation in India by Patrick Moore Glover

Aquaculture

Paper Code: B050807T	Year - Fourth	Semester- Eighth	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	Major cultivable species for aquaculture. A knowledge of inland water bodies suitable for culture in India Culture of Indian Major Carps. Exotic carps of freshwater, Hatcheries and their management. Culture technology – Fresh Water mullets, crabs, shrimps, mariculture muscles and oyster. Water quality requirements for Aquaculture. Role of temperature, PH, Salinity dissolved oxygen, Ammonia, nitrate Nitrite, Phosphate, BOD, COD. Aquaculture engineering, house hatchery, ponds, Recirculating system.	15
II	Bundh breeding and induced breading of carb by hypohysation and use of synthetic hormones. Preparation and management of Indian Major carps, culture prods – nursery, rearing and production ponds. Fresh Seed technology, Natural collection and bundh breeding	15
III	Culture of Giant fresh water prawn *Macrobrachium* spp.-seed collection, formation source, hatchery management. Culture of tiger shrimp, *Penaeus monodon* and *Litopenaeus vannamei* Culture of brackish water fish – *Osteobrama belangeri* Culture of pearl oysters. Fresh water and marine aquaria Breeding of aquarium fishes.	15
IV	Role of genetics in aquaculture Gynogenesis, androgenesis, Sex reversal and breeding. Production of transgenic fish Fish health – infection and diseases in fish common fish pathogens Culture of sea weeds, major commercial importance seaweed species. Methods of crab culture. Culture of ornamental fishes, Culture of airbreathing fishes in India Culture of molluscs, Environmental impact of aquaculture	15

Suggested books:

1. Aquaculture Principles and Practices by Pillay.
2. Fish ponds in Farming systems: Zigpp, V.D., Veereth J.A.J. Tri, L.Q., Van Mensvoort, MEF. boswa, R.H. and Beveridge.
3. Aquaculture and Fisheries by Dunham
4. Hute, M. and Kahn, Textbook of fish culture
5 Introduction to Aquaculture by Matthew Landau
6 Aquaculture By: John E. Bardach
7 Textbook of Fish Culture by Marcel Heut

PRACTICAL			
Paper Code:B050808P	**Year - Fourth**	**Semester- Eighth**	**Total marks : 100 (25+75)**

The duration of the practical examination will be 04 hours. The distribution of marks in End Semester Examination (ESE) will be as follows-

1. Exercises based on Chordata (B050801T)	20
2. Exercises based on Animal physiology and biochemistry (B050802T)	05
3. Exercises based on reproductive biology and developmental biology(B050803T)	05
4. Exercises based on B050804T/B050805T/B050806T/B050807T	10
5. Identify and comment upon spots 1-10 (10 spots from B050801T)	15
6.Viva – voce	10
7. Practical Record	10
Grand Total	**= 75**

Distribution of marks of Continuous Internal Assessment (CIA):

1. Examination	15
2. Seminar/Presentation/Assignment/Quizzes…	10
Grand Total =	**25**

B.Sc. Semester-VIII

Zoology Practical Examination (ESE) - 20....

Date: Batch: Duration: 4 hrs Max. Marks: **75**

Question Paper

Q.No.1. Dissect the animal provided (.....) so as to expose its nervous system/Neck nerves as clearly as possible. Display your dissection suitably. (*Scoliodon*/ *Wallago*/Sting ray/Rat) **10**

Q. No. 2. Make a suitable permanent stained preparation of ..... from the material / animal... ..... provided. **10**

Q. No. 3. Identify and comment upon spots. (1-10)

Q. No. 4. Any one exercise based on Animal Physiology and biochemistry

Q. No. 5. Any one exercise from Reproductive and Developmental biology

Q. No. 6. Any one exercise from Apiculture/Sericulture/Lac culture/Aquaculture

Q. No. 7. Viva-voce

Q. No.8. Practical record/ Collection/ Chart

Spots: (Museum specimens:4 and Slides:6)

1.

2.

3.

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10.

Detailed Syllabus of Semester -VIII

B050801T Chordata:

1.Major Dissections-

Scoliodon -Cranial nerves
Wallago - Cranial nerves
Sting ray – Cranial nerves
Rat – Neck nerves

2. Minor Dissections-

Wallago- Weberian ossicles
Scoliodon – Afferent, Efferent, Internal ear, Scroll valve
Amphioxus – Oral hood, Velum, Pharyngeal wall

3.Mounting materials to be provided/take out and mount-

Protochordates- *Salpa*, *Oikopleura*, *Doliolum*
Scoliodon- Ampullae of Lorenzini, Placoid scales
Herdmania – Branchial wall, Neural gland complex, Section of test, Spicules
Cartilage – free-hand sections of frog's hyoid and suprascapula, stain with Haematoxylin

4.Osteology- Bony fish (*Labeo*), Amphibia (Frog), Reptilia (*Varanus*), Aves (Fowl), Mammalia (Rabbit/Rat), Jaw suspension in vertebrates

5.Histology of various organs-prepared slides

6.Study of Museum specimens and prepared slides of Chordates

B050802T Animal physiology and biochemistry:

Animal physiology-

1. To prepare haemin crystals from blood sample
2. To measure the human blood pressure
3. To estimate the amount of haemoglobin in human blood using Haemoglobinometer
4. To study the phenomenon of Knee-jerk reflex
5. To count the blood cells (RBCs & WBCs) by Haemocytometer
6. To determine the human blood groups
7. To determine the clotting time of human blood

Biochemistry-

1. Identification and/or separation of different amino acids in a mixture by ascending Paper chromatography
2. Test for amylase
3. Test of Carbohydrates
4. Test for protein
5. Test of lipids
6. Test of acetone

B050803T Reproductive and developmental biology:

1. .Histological sections- Testis, Ovary, Epididymis, accessory glands, Uterus (Proliferative and secretory stages) -Prepared slides
2. Study of histology of endocrine glands (Pituitary, Thyroid, Adrenal, Islets Of Langerhans)
3. Study of whole mounts and sections of developmental stages of frog through permanent
4. Slides/Models: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
5. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation

B050804T Apiculture:

1. Specimen study of different castes of honey bee species
2. Collection and identification of different honey bee species Viz. *Apis serana indica, A. dorsata. A. mellifera, A. Florae*
3. Life cycle study of honey bees
4. Study of leg modification in workers
5. Temporary mount preparation of mouth parts of honey bees
6. Temporary mount preparation of sting apparatus of honey bees
7. Demonstration of honey testing methods like blot method, burning method and alkali method etc.
8. Study of different bee hives and allied implements used in bee keeping
9. Identification of various enemies of Honey bees
10. Study of different tools used in apiculture
11. Visit to any Apiary for the study of different steps of Bee keeping

B050805T Sericulture:

1. Study of various species of Silkworm and their distribution through chart/specimen in a laboratory
2. Study of life cycle of silkworm in an open field/in a laboratory
3. Observation of feeding habit (Larva) on mulberry leaves in an ideal laboratory condition
4. Prepare a research project on various Silk research institutes and regional silk stations in India
5. Study of various tools and equipment used in Sericulture
6. Study of properties of different types silk produced by different species
7. Visit to any sericulture site for the study of Silk Industry, Silk production and to understand all the steps of sericulture

B050806T Lac culture:

1. Study of global distribution of Lac insects i.e.; *Tachardia lacca* through chart/models
2. Study of male and female Lac insects through museum specimen
3. Study of life history of Lac insect
4. Study of Indian host plants of Lac insects and their scientific names through charts
5. Study of the composition and properties of Lac
6. Study of enemies of lac cultivation or abiotic and biotic factors, precautions to

be taken for better cultivation of Lac

7. Visit a place of Lac Industry to understand the cultivation of Lac insects, inoculation, swarming period and harvesting

B050807T Aquaculture:

1. Preparation and of an aquarium in a laboratory study of aquarium fishes with Zoological and common names
2. Visit a local pond and collect the edible fresh water fishes and culture in an aquarium
3. Study of types and management of fish culture i.e.; breeding, hatching, nursery, rearing and stocking ponds in nearby place/with the help of charts/models
4. Estimation of organic matter of bottom soil
5. Visit to local fish seed production centre and local fish farms
6. Collection of pond, river or ditches water for the study of physico-chemical analysis of water
7. Collect a fresh water sample from the local fresh water habitat for the study of microscopic organisms like protozoans, Daphnia, coelenterates etc. for identification in laboratory

Biosystematics and Evolutionary Biology			
Paper Code: B050702T	**Year- Fourth**	**Semester :IX(Ninth)**	**Total marks : 100**
Credits : 04		**Total no of lectures: 60**	

Unit	Topic	Total No. of Lectures
I	Basic Concept of Animal Taxonomy, A Historical review, taxonomic terms, Classification and Nomenclature; Phenon; taxon and category, α, β *and* γ Taxonomy Recent trends in Taxonomy: Chemotaxonomy, Cytotaxonomy, Serotaxonomy, Molecular Taxonomy Microtaxonomy: Species concepts, nominalistic species concepts, biological species concept and evolutionary species concept	15
II	Macrotaxonomy: Phenetics, Cladistics and Phylogenetic Variations in Systematics, Taxonomic Procedures, Keys Importance of application of systematics in Biology International Code of Zoological nomenclature (ICZN), Type concept, Law of priority, The present Scenario and the global taxonomic initiatives	15
III	Various Evolutionary theories, Natural Selection and its types, molecular signatures of natural selection. Adaption: its evolutionary analysis, Speciation: allopatric, sympatric, parapatric, peripatric. Elemental Forces of evolution: Mutation, genetic drift, Isolation	15
IV	Hardy-Weinberg law and its application, Conditions for the maintenance of genetic equilibrium, genetic death, probability and Goodness of fit Polygenic inheritance, Molecular phylogenies, Molecular clock, Molecular tools in phylogeny	15

Suggested books:

1. Principles of Systematic Zoology by Ernst Mayr
2. Principles of Animal Taxonomy by G.G. Simpson
3. Schuh, R.T., and A.V.Z. Brower. Biological Systematics: Principles and Applications
4. Wiley, E. O. and B. S. Lieberman. Phylogenetics: Theory and Practice of Phylogenetic Systematics
5. Animal Taxonomy by H. E. Goto
6. Evolution: An Introduction by S.C. Stearns and R.F. Hoekstra
7. Evolution by N. H. Barton et. al.
8. Ridley, M: Evolution
9. Schuh, R.T., and A.V.Z. Brower. Biological Systematics: Principles and Applications
10. Futuyma: Evolutionary Biology
11. Lull, R.S. Organic Evolution
12. Hartl and Clarke: Principles of Population Genetics

Cell Biology and Genetics

Paper Code: B050703T	Year - Fourth	Semester - IX(Ninth)	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**Cellular membrane and cytoskeleton:** An overview of membrane functions, Chemical composition of cell membrane. Structure and functions of membrane proteins: Integral protein, peripheral membrane proteins and lipid-anchored membrane proteins. Membrane models. Movement of substances across cell membranes: Diffusion, active transport, uniport, symport and antiport Microtubules, Intermediate filaments and Microfilaments: Structure, Functions and assembly, Endomembrane system (ER-GC), Ribosome, Targeting and sorting of proteins: Processing through endomembrane system, Targeting of cytosolic proteins	15
II	**Mitochondria**: Structure, Assemblies of respiratory chain & Fo-F1 ATPase, Oxidative phosphorylation, ATP and other high energy phosphate compounds **Nucleolus**: Structure and biogenesis of ribosomes, Cell Signalling: Cell-cell interaction, Chemical mediators, Cell surface and intracellular receptors, Regulation of signalling pathways, JAK-STAT pathway, MAP Kinase pathway, Apoptosis **Cell division**: Mitosis, Role of maturation promoting factor, regulation of cell cycle, chromosomal movement, Exit from mitosis, Cytokinesis Meiosis: Overview, Chromosome pairing and recombination	15
III	**Genetics-I:** Mendel's laws and their chromosomal basis, Extensions of Mendelism: Dominance relationships, Epistasis, Pleiotropy, Expressivity and penetrance. Methods of gene mapping: 3-point test cross in Drosophila, Gene mapping in human by linkage analysis in pedigrees, Tetrad analysis in Neurospora Gene Mutation: Types of gene mutations, Methods for detection of induced mutations, P-element insertional mutagenesis in Drosophila, DNA damage and repair, mechanism of Homologous recombination	15
IV	**Genetics II:** Nature of the gene and its functions: Evolution of the concept of gene, Fine structure of gene, Regulation of gene activity in lac and trp operons of E. coli, organization of a typical eukaryotic gene, Mobile DNA, enhancers and silencers; non-coding genes, Organization and function of mitochondrial DNA Recombinant DNA technology: Restriction enzymes, Plasmid and phage vectors for cloning, Genomic and cDNA libraries; detection of genes and their products	15

Suggested books:

1.Becker et. al.: The World of the Cell 2. The Cell: A Molecular Approach by Cooper and Hausman. 3. Cell and Molecular Biology by Karp 4. Molecular Biology of the Cell by Alberts et al. 5. Molecular Cell Biology by Lodish et al 6. Genetics by Benjamin A. Pierce 7. Concepts of Genetics by William S. Klug, M.R. Cummings 8. Lewin: Gene XII 9. Genome 3 by T. A. Brown 10. Principles of gene manipulation and genomics by R.M. Twyman and S.B. Primrose 11. Genetics by Peter J. Russell 12. Watson: Molecular Biology of the Gene 13. Cells by Wong 14. Cell Biology by Pollard et al 15. Genetics a molecular approach by T.A. Brown 16. Cell and molecular biology by Sheeler and Bianchi

Quantitative Biology, Research Methodology and Bioinstrumentation

Paper Code: B050704T	Year - Fourth	Semester- IX(Ninth)	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	Measures of central tendency: Mean, Median and Mode Measures of Dispersion: Range, Mean Deviation, Standard Deviation, Coefficient of Variations, Correlation and Regression Testing of Hypothesis: Null Hypothesis & Alternative Hypothesis, Type I and Type II Error, Level of Significance Test of Significance: Parametric tests (Paired and unpaired t-test, Z-test, F-test) & non-Parametric tests (Chi-square test and Mann-Whitney U-test) Probability: Probability theory: Binomial distribution, Poisson distributions Analysis of Variance (ANOVA): One way and two-way	15
II	Research Design, Data Collection, Data Presentation: Classification and Tabulation of Data. Diagrammatic and Graphical Presentation of Data: Bar Diagram, Histogram, Frequency Polygon, Pie-diagram, Analysis of Data Literature survey: sources, print and digital Types of Research: Descriptive vs Analytical; Applied vs Basic; Qualitative vs Quantitative; Conceptual vs Empirical; Survey vs Experimental Interpretation, report writing and Publication, Ethical aspects of biological research	15
III	Microscopy: Light, Phase contrast, Transmission & electron microscopy, Fluorescence microscopy, freeze fracture electron microscopy, different fixation and staining techniques for EM Principal of spectrophotometry (UV & Visible), PH meter and GM Counter Electron Spine Resonance & Nuclear Magnetic Resonance spectroscopy Centrifugation: Isolation of DNA, RNA and Proteins Chromatography: Paper Chromatography, TLC, HPLC Electrophoresis: one dimensional & two-dimensional Polymerase change reaction (PCR), DNA sequences, Microtome, Laminar flow	15
IV	**Histochemical and Immunotechniques:** Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques (FISH and GISH) **Electrophysiological methods:** Patch-clamp recording, ECG, CAT, fMRI, PET, MRI	15

Suggested books:

1- Boyer: Modern Experimental Biochemistry and Molecular biology 2. Switzer and Garrity: Experimental Biochemistry 3. Wilson and Walker: Practical Biochemistry 4. Plumer: An Introduction to Practical Biochemistry Holme and Peck: Analytical Biochemistry 5. Antonisamy, B., Christopher S. and Samuel, P. P. Biostatistics: Principles and Practice 6. Pagana, M. and Gavreau, K. Principles of Biostatistics 7. Zar, Jerrold H. Biostatistical Analysis 8. Walliman, N. Research Methods-The Basics 8. Kothari, C. R. Research Methodologies-Methods and Techniques 9. Dawson, C. Practical Research Methods 10. Booth, W.C., Colomb, G.G. and Williams, J.M. (2003). The Craft of Research 11. Physical Biochemistry by David M. Freifelder

PRACTICAL			
Paper Code: B050705P	**Year - Fourth**	**Semester- IX(Ninth)**	**Total marks : 100 (25+75)**

The duration of the practical examination will be 04 hours. The distribution of marks in End Semester Examination (ESE) will be as follows-

1 .Exercises based on Biosystematics and Evolutionary biology (B050702T)	20
2. Exercises based on Cell biology and Genetics (B050703T)	20
3. Exercises based on Quantitative biology, research methodology & Bioinstrumentation (B050704T)	10
4. Viva-voce	15
5. Practical record	10
Grand Total =	**75**

Distribution of marks of Continuous Internal Assessment (CIA):

1. Examination	15
2. Seminar/Presentation/Assignment/Quizzes…	10
Grand Total =	**25**

B. Sc Semester- IX (Ninth)

Zoology Practical Examination (ESE) - 20....

Date: Batch: Duration: 4 hrs Max. Marks: **75**

Question Paper

Q. No. 1.	Any one exercise based on Biosystematics and Evolutionary biology	**20**
Q. No. 2.	Any one exercise from Cell biology and Genetics	**20**
Q. No. 3.	Any one exercise from Quantitative biology and Bioinstrumentation	**10**
Q. No. 4.	Viva-voce	**15**
Q. No.5.	Practical record/ Collection/ Chart	**10**

Detailed Syllabus of Semester -IX (Ninth)

B050702T Biosystematics and Evolutionary biology:

7. Adaptive modifications in feet of birds and mouth parts of insects (from slides)
8. Embryological evidence of evolution (through charts)
9. Serial homology in appendages of *Palaemon*
10. Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit)
11. Evolution of Horse – through models

Biosystematics:

Specimen collection, preservation and identification (Any one animal from any phyla of animal kingdom)

B050703T Cell biology and Genetics:

1. Study of different stages of Mitosis and Meiosis (Prepared slides)
2. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
3. Temporary/permanent squash preparation of giant chromosome
4. Analysis of Pedigree charts
5. Genetical exercises based on Test cross, Dihybrid cross, Sex linked inheritance
6. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome)

B050704T Quantitative biology, Research methodology and Bioinstrumentation:

VI. **Microtomy**: Preparation of Blocks, section cutting, and stretching by wax methods and staining of vertebrate tissues by double staining methods

VII. **Microscope and its practical uses**- Simple microscope, Compound microscope, Binocular microscope, Phase contrast microscope, Electron microscope

VIII. **Common biological instruments in laboratory:** Practical use Chromatography, Electrophoresis, pH meter, Colorimeter

IX. General method of microscopic preparation, single and double staining methods

X. Method of preparation of fixatives, stains and useful reagents used in a laboratory

Quantitative biology:

1. Measures of central tendencies (Arithmetic means, Median, Mode, Standard deviation and Numerical based on them)
2. Mean deviation, test of significance (t-test and Chi-square test) numerical problems based on them
3. Corelation coefficient
4. Analysis of varience

Animal Physiology and Biochemistry

Paper Code: B050802T	Year - Fourth	Semester – X(Tenth)	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**Physiology of Digestion:** Digestion and absorption of proteins, Digestion and absorption of carbohydrates Digestion and absorption of lipids, Regulation of digestion and absorption **Physiology of Circulation:** Composition of blood, Haemopoiesis, Blood Coagulation, Heart, Origin and conduction of cardiac impulse, Cardiac cycle and its regulation **Physiology of Respiration:** Respiratory organs and Respiratory pigments, lung air volumes, transport and exchange of gases, Respiratory centers: organization and function **Physiology of Muscles:** contraction and relaxation of skeletal muscle and Smooth muscle	15
II	**Physiology of Excretion:** Three basic modes of excretion, Urine formation, Counter current mechanism, Regulation of body fluid and electrolyte, Hormonal regulation **Neurophysiology:** Neurons, Axonal transmission, Synaptic transmission, action potential, neural control of muscle tone and posture, neurotransmitters **Physiology of Endocrine System:** Overview of endocrine glands, Mechanism of action of hormones **Physiology of Thermoregulation:** comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. **Physiology of Vision and Hearing**	15
III	Chemical bonds, biomolecules, pH, Acids and Bases, Buffers, Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, biological energy transducers **Carbohydrates:** Classification, nomenclature and functions, Synthesis and breakdown of glycogen and glucose **Lipids:** Structures and types of saturated and unsaturated fatty acids. Lipid metabolism: Biosynthesis of fatty acids, oxidation of fatty acids (β- oxidation) and carnitine shuttle Ketogenesis: biosynthesis and utilization of ketone bodies. Regulation of ketogenesis	15
IV	**Enzymes**: Nomenclature, classification, action, Enzyme kinetics, Mechanism of enzyme action, Coenzymes, Ribozymes, Isoenzymes, DNA enzymes and half-life of enzymes, Enzyme Inhibition: competitive and non-competitive inhibition **Proteins**: Structures, classification and properties of amino acids, Primary, secondary, tertiary and quaternary structure of proteins, Biosynthesis of proteins Secondary Metabolites: Alkaloids, Terpenoids	15

Suggested books: Principles of Animal Physiology by Moyes and Schulje 2. Animal physiology by SCHMIDT 3. Eckert animal physiology mechanisms and adaptations 4. Ganong's Review of Medical Physiology 5. Guyton and Hall: Textbook of Medical Physiology 6 Principles of Biochemistry 7. Biochemistry Vols 1 & 2 by Voet & Voet 8. Animal physiology by Hill, Richard W., et al. 9. Human Physiology Volume 1 & 2. By Chatterjee C C 10. Lehninger's Principles of Biochemistry 11. Biochemistry Vols 1 & 2 by Voet & Voet

Reproductive and Developmental Biology

Paper Code: B050803T	Year - Fourth	Semester- X(Tenth)	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**Human Reproductive system:** Structure and function of male reproductive organs; Formation of sperm and fertility of individual. Structure and function of female reproductive organs; Sexual differentiation, Formation of sperm; Formation of ova. Physiology of ovulation, menstrual cycle; Nutrition and stress influences on the ovulatory cycle, Amniocentesis **Puberty**: control of the onset; stages; delayed and precocious puberty Process of fertilization; Implantation and formation of the foetus and placenta; Pregnancy, Labour and birth, lactation and neonatal life; Reproductive Ageing; Menopause	15
II	**Evolution of reproductive mechanism and regulation:** Evolution of human reproductive strategy; Evolutionary impact on behaviour; Sexuality hormonal effects on maternal-infant bonding **Reproductive Health:** Sexual dysfunctions, sexually transmitted diseases; Cancers of the reproductive system; Adenomyosis: gland-like growth into myometrium; Birth Control; Assisted Reproduction Technologies; Intrauterine devices (IUD), endometriosis, fibroids, Endometritis: chronic infection of uterus, congenital uterine anomalies; Ovarian cysts, pelvic varicosities	15
III	**Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants. Fertilization, Cleavage, Morula, Blastula and Gastrula, Standard techniques and methods of experimental embryology: vital dying, extirpation, isolation, transplantation and grafting.	15
IV	**Morphogenesis and organogenesis:** Organizers: characteristics and physiology, axes and pattern formation in *Drosophila*, amphibia and chick; vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development in vertebrates Metamorphosis: Hormonal control of metamorphosis, metamorphosis and genetics Malignancy: teratogens, carcinogens, oncogenes, neoplasia	15

Suggested books:

1.Langman's Medical Embryology by Thomas W.S. 2. Larsen's Human Embryology by Gary C.S.; et al. 3. Developmental Biology by Gilbert, S.F. 3. Encyclopaedia of Reproduction by Ernst Knobil and Jimmy D. Neill 4. The biology of reproduction by Giuseppe Fusco and Alessandro Minelli 5. Biology of reproduction by Peter J. Hogarth 6. Essential Developmental Biology by Jonathan M. W. Slack 7. Developmental biology by Werner A. Müller 8. Principle of development by Wolpert 9. Developmental biology by N. J. BERRILL 10. Developmental biology by John W. Saunders 11. Principles of developmental biology by Wilt & Hake 12. Essential developmental biology by J M W Slack

Apiculture

Paper Code: B050804T	Year - Fourth	Semester- X (Tenth)	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**Introduction to Apiculture:** History of Apiculture, Systematics, Honey Bee species, Honey Bee morpho-anatomy, Colony organization, Polymorphism, Caste system, Division of labour, Honey Bee flora – importance, propagation - congenial conditions for starting up of apiculture. Migratory Bee Keeping - designing floral Calendar, Improved Agricultural practices - crop pollination - Pesticides impact on Honey bees Foraging and Honey flow periods, social behaviour of Honey Bees, Bee as pollinators: Crop improvement: Quality and yield through honeybee pollination	15
II	**Apiculture as an occupation:** Extent of Apiculture in Uttar Pradesh and India, Limitations on the development of Apiculture, Advantages of extensive Apiculture, Bee keeping equipment - introduction to types of bee boxes - BIS standard Tools used in apiculture. Bee breeding multiplication of colonies - Queen reaching technique. **Honey:** Production, Properties and application: Production of Honey by honeybee within its stomach using plant nectar, application in various fields - other valuable by products of honey bees Honey - its medicinal properties - application in various fields - other valuable by products of honey bees	15
III	**Steps in Apiculture:** Purchase of a colony, the Apiary site, how to manage a colony, the manipulation of a colony, Honey extraction & handling - Quality control standards - Honey testing kit Processing of honey, Other Bee products: Bees wax, Pollens, Royal Jelly, Propolis and Bee venom **Control of Honeybee Diseases**: Bee enemies and diseases: Introduction, Enemies of honeybees – Wax Moth, Ants, Wasps, Microbes, Pests; Diagnosis and identification. Bacterial, viral, fungal and protozoan diseases; Mites attacking honeybees. Establishment of a colony. planned pollination services	15
IV	**Apiculture techniques and Apiary management:** Routine management, Seasonal management, Migratory beekeeping, Harvesting and marketing of Honey bee products. Important Institutions pertinent to Apiculture: National Bee Board, Honey Bee research and Training Institute, Apiaries. Economics in small scale and large-scale bee keeping. Economic Value of Commercial Beekeeping. Preparing bankable bee keeping project: Steps involved in starting a beekeeping project, Funding sources for beekeeping projects.	15

Suggested books:

1 .Abrol, D. P. Bees and Beekeeping 2. Withhead, S. B. Honey bees and their management 3. Dharam singh and Singh, D. P. A. Handbook of Beekeeping 4. Mishra R.C. Honey bees and their management in India 5. Singh, S. Beekeeping in India 6. Gupta, J.K., Sharma, H K and Thakur, R K. Practical Manual on Beekeeping 7. Bisht D.S., Apiculture 8. David Cramp. The complete step by step book of Beekeeping 9. Pradip, V. Jabde. Text book of Applied Zoology

Sericulture

Paper Code: B050805T	Year - Fourth	Semester- X (Tenth)	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	**An Introduction to Sericulture** History of sericulture, systematic, Exotic and indigenous races of silkworm, Mulberry silk worm, feeding habit of silk worm, life history of various species of silk worm, Tassar silk worm, Eri silk worm, Life cycle of mulberry silk worm (Bombyx-mori)	15
II	**Historical Review of Sericulture** Extent of sericulture in the global part in the world Silk Industry in various part of India, World silk production World map and silk road, spread of Sericulture to Europe, South Korea, Japan, India and other countries. Sericultural practices in tropical and temperate climate, Silk production in East Area, Silk production in China & Japan, Silk production in India and Malaysia Various Silk research institute and Regional Silk stations	15
III	**Advances of extensive Sericulture** Basic requirement of tools for starting Silk Industries. Getting started in Silk Industry planning before start of sericulture Industry. Tools used for sericulture. Climatic conditions, soil conditions for plantation, Manuring, fertilizers at the time of Silk Production, Rearing of Silk Worm, Polyhedrosis of Silk worm	15
IV	**Sericulture techniques and Sericulture management** Marketing of various Silk products, National Sericulture Board (NSB) Sericulture Institute and training institute in India, Economic Importance of Silk, Status of Sericulture Industry in India, Distribution of Silk Industry in India, Sericulture Industry and Human welfare, Function of Central Silk Board and their Co-ordination in various parts of India	15

Suggested books:

1. Manual on sericulture: Rome: Food and Agriculture Organization of the United Nations
2. Ullal, S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture
3. Jolly, M. S. Appropriate Sericultural Techniques
4. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1
5. Narasimhanna, M. N. Manual of Silkworm Egg Production
6. Sengupta, K. (1989) A Guide for Bivoltine Sericulture

Lac culture			
Paper Code: B050806T	**Year - Fourth**	**Semester- X(Tenth)**	**Total marks : 100**
Credits : 04		**Total no of lectures: 60**	

Unit	Topic	Total No. of Lectures
I	An Introduction to Lac Culture: Historical review of Lac culture Various products of lac and their commercial value Extent of Lac culture in the world. Lac Producing places in India Distribution of Lac in the global area	15
II	Biology of silkworm: Systematic position of lac insect in animal kingdom Morphology and Anatomy of lac insect. Difference between male and female lac insects Life history various species of lac insect i.e., Tachardia-lacca (Laccifer	15
III	Various Host Plants of lac insects, Common host plants of India and other countries, names of various Host plants of lac insects, Cultivation of lac, Inoculation period Type of inoculation, Swarming of lac insects	15
IV	Harvesting of lac, Harvesting period and types of harvesting Lac cultivation and Recent plant of lac cultivation. Lac Industry and processing of lac industry Properties of Lac. Physical and chemical composition of Lac, Enemies of lac cultivation, Lac Industry of India, Economic Importance	15

Suggested books:

1. Text Book of Applied Zoology by Jabde, P.V.
2. Insects by Mani, M.S.
3. Lac-Culture in India by N Ghorai
4. Lac Cultivation in India by Patrick Moore Glover

Aquaculture

Paper Code: B050807T	Year - Fourth	Semester- X (Tenth)	Total marks : 100
Credits : 04		Total no of lectures: 60	

Unit	Topic	Total No. of Lectures
I	Major cultivable species for aquaculture. A knowledge of inland water bodies suitable for culture in India Culture of Indian Major Carps. Exotic carps of freshwater, Hatcheries and their management. Culture technology – Fresh Water mullets, crabs, shrimps, mariculture muscles and oyster. Water quality requirements for Aquaculture. Role of temperature, PH, Salinity dissolved oxygen, Ammonia, nitrate Nitrite, Phosphate, BOD, COD. Aquaculture engineering, house hatchery, ponds, Recirculating system.	15
II	Bundh breeding and induced breading of carb by hypohysation and use of synthetic hormones. Preparation and management of Indian Major carps, culture prods – nursery, rearing and production ponds. Fresh Seed technology, Natural collection and bundh breeding	15
III	Culture of Giant fresh water prawn *Macrobrachium* spp.-seed collection, formation source, hatchery management. Culture of tiger shrimp, *Penaeus monodon* and *Litopenaeus vannamei* Culture of brackish water fish – *Osteobrama belangeri* Culture of pearl oysters. Fresh water and marine aquaria Breeding of aquarium fishes.	15
IV	Role of genetics in aquaculture Gynogenesis, androgenesis, Sex reversal and breeding. Production of transgenic fish Fish health – infection and diseases in fish common fish pathogens Culture of sea weeds, major commercial importance seaweed species. Methods of crab culture. Culture of ornamental fishes, Culture of airbreathing fishes in India Culture of molluscs, Environmental impact of aquaculture	15

Suggested books:

5. Aquaculture Principles and Practices by Pillay.
6. Fish ponds in Farming systems: Zigpp, V.D., Veereth J.A.J. Tri, L.Q., Van Mensvoort, MEF. boswa, R.H. and Beveridge.
7. Aquaculture and Fisheries by Dunham
8. Hute, M. and Kahn, Textbook of fish culture
8 Introduction to Aquaculture by Matthew Landau
9 Aquaculture By: John E. Bardach
10 Textbook of Fish Culture by Marcel Heut

PRACTICAL			
Paper Code:B050808P	**Year - Fourth**	**Semester- X (Tenth)**	**Total marks : 100 (25+75)**

The duration of the practical examination will be 04 hours. The distribution of marks in End Semester Examination (ESE) will be as follows-

1. Exercises based on Animal physiology and biochemistry (B050802T)	20
2. Exercises based on reproductive biology and developmental biology(B050803T)	20
3. . Exercises based on B050804T/B050805T/B050806T/B050807T	10
4. Viva – voce	15
5. Practical Record	10

Grand Total = 75

Distribution of marks of Continuous Internal Assessment (CIA):

1. Examination 15
2. Seminar/Presentation/Assignment/Quizzes… 10

Grand Total = 25

B.Sc. Semester -X

Zoology Practical Examination (ESE) - 20....

Date: Batch: Duration: 4 hrs Max. Marks: **75**

Question Paper

Q. No. 1. Any one exercise based on Animal Physiology and biochemistry

Q. No. 2. Any one exercise from Reproductive and Developmental biology

Q. No. 3. Any one exercise from Apiculture/Sericulture/Lac culture/Aquaculture

Q. No. 4. Viva-voce

Q. No.5. Practical record/ Collection/ Chart

Detailed Syllabus of Semester - X

B050802T Animal physiology and biochemistry:

Animal physiology-

8. To prepare haemin crystals from blood sample
9. To measure the human blood pressure
10. To estimate the amount of haemoglobin in human blood using Haemoglobinometer
11. To study the phenomenon of Knee-jerk reflex
12. To count the blood cells (RBCs & WBCs) by Haemocytometer
13. To determine the human blood groups
14. To determine the clotting time of human blood

Biochemistry-

7. Identification and/or separation of different amino acids in a mixture by ascending Paper chromatography
8. Test for amylase
9. Test of Carbohydrates
10. Test for protein
11. Test of lipids
12. Test of acetone

B050803T Reproductive and developmental biology:

1. .Histological sections- Testis, Ovary, Epididymis, accessory glands, Uterus (Proliferative and secretory stages) -Prepared slides
2. Study of histology of endocrine glands (Pituitary, Thyroid, Adrenal, Islets Of Langerhans)
3. Study of whole mounts and sections of developmental stages of frog through permanent
4. Slides/Models: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
5. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation

B050804T Apiculture:

1. Specimen study of different castes of honey bee species
2. Collection and identification of different honey bee species Viz. *Apis serana indica, A. dorsata. A. mellifera, A. Florae*
3. Life cycle study of honey bees
4. Study of leg modification in workers
5. Temporary mount preparation of mouth parts of honey bees
6. Temporary mount preparation of sting apparatus of honey bees

7. Demonstration of honey testing methods like blot method, burning method and alkali method etc.
8. Study of different bee hives and allied implements used in bee keeping
9. Identification of various enemies of Honey bees
10. Study of different tools used in apiculture
11. Visit to any Apiary for the study of different steps of Bee keeping

B050805T Sericulture:

8. Study of various species of Silkworm and their distribution through chart/specimen in a laboratory
9. Study of life cycle of silkworm in an open field/in a laboratory
10. Observation of feeding habit (Larva) on mulberry leaves in an ideal laboratory condition
11. Prepare a research project on various Silk research institutes and regional silk stations in India
12. Study of various tools and equipment used in Sericulture
13. Study of properties of different types silk produced by different species
14. Visit to any sericulture site for the study of Silk Industry, Silk production and to understand all the steps of sericulture

B050806T Lac culture:

1. Study of global distribution of Lac insects i.e.; *Tachardia lacca* through chart/models
2. Study of male and female Lac insects through museum specimen
3. Study of life history of Lac insect
4. Study of Indian host plants of Lac insects and their scientific names through charts
5. Study of the composition and properties of Lac
6. Study of enemies of lac cultivation or abiotic and biotic factors, precautions to be taken for better cultivation of Lac
7. Visit a place of Lac Industry to understand the cultivation of Lac insects, inoculation, swarming period and harvesting

B050807T Aquaculture:

8. Preparation and of an aquarium in a laboratory study of aquarium fishes with Zoological and common names
9. Visit a local pond and collect the edible fresh water fishes and culture in an aquarium
10. Study of types and management of fish culture i.e.; breeding, hatching, nursery, rearing and stocking ponds in nearby place/with the help of charts/models
11. Estimation of organic matter of bottom soil

12. Visit to local fish seed production centre and local fish farms
13. Collection of pond, river or ditches water for the study of physico-chemical analysis of water
14. Collect a fresh water sample from the local fresh water habitat for the study of microscopic organisms like protozoans, Daphnia, coelenterates etc. for identification in laboratory

Ethology, Biodiversity and Wildlife Conservation			
Paper Code: B050901T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	**Introduction to Ethology:** Patterns of behaviour: Kinds of behaviour: foraging behaviour, Territorial behaviour. Mate selection and courtship behaviour. Parental care, defensive behaviour. Allelomimetic and maladaptive (abnormal) behaviour. Stereotyped Behaviours (Taxes, kinesis and Reflexes) History of behavioural studies, Proximate and ultimate causes of behavioural evolution, Methods and recording of a behavior, Types of stimuli invoking response: internal and external cues. Biological rhythm **Learning and memory**: Conditioning, Habituation, Insight Learning, Associative and Non-associative Learning, Reasoning, Molecular basis of learning and memory Perception of the environment – Mechanical, Electrical, Chemical, olfactory, auditory and visual	16
II	**Communication**: modes, evolution, Deceit versus honest, specificity of songs, adaptive value **Social behaviour and kin selection:** Aggregations – schooling in fishes, stocking in birds, lending in mammals. Group selection, Hamilton's rule for kin selection, altruism and inclusive fitness **Reproductive behaviour:** Courtship, sexual selection, Intra and intersexual, Pre– and post–copulatory, Cryptic female choice, Different mating systems **Parental care:** origin and evolution, Patterns, Parent–offspring conflict, Sibling conflict **Territorial behaviour:** Evolution and Adaptive value, Types of territories	15
III	**Biodiversity:** concepts and hierarchical levels, Levels of Biodiversity : Species diversity, Genetic diversity, Ecosystem diversity, Species richness and evenness, α- biodiversity, β-biodiversity, Biodiversity, causes of loss of biodiversity, Conservation of biodiversity, Measures of Species diversity: species richness indices such as Margalef's index, Menhinick's index, Species proportional abundance based indices: Simpson's index, Shannon's index, Biodiversity Hot Spots, Red Data book and its significance, Biodiversity at Global, National and Local level	15
IV	**Wildlife Conservation:** Wild life as a resource, Wild life conservation: In situ and ex-situ, Protected area: classification (National parks, sanctuaries) and management, Management of endangered species and different animal projects, Conservation strategies: IUCN, Criteria and technology, IBWL; WWF. Wild life (Protection) Act 1972: Salient Features, Short comings of the Act, Amendments	14

Suggested books:

1.Animal Behaviour by McFarland, D. 2. Animal Behaviour: An Evolutionary Approach by Alcock, J. 3. Principles of animal behavior by Dugatkin, L. A 4. Animal behavior by Breed,M. D., & Moore, J. 5. An Introduction to Animal Behaviour by Aubrey Manning and Marian Stamp Dawkins 6. The behaviour of animals by Bolhuis, J. J., Giraldeau, L. A 7. Methods and Practice in biodiversity Conservation by David Hawks worth 8. A Text Book of Biodiversity by K.V. Krishnamurthy 9. Wildlife of India, V.B. Saharia 10.Wildlife Management Manual by Robert Giles 11. Threatened Birds of India by Asad A. Rahmani

Molecular Biology, Immunology and Bioinformatics			
Paper Code: B050902T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Chromosomal organization of genes: chromatin structure (nucleosome, solenoid, super solenoid), DNA Replication (in prokaryotes and eukaryotes), Significance of anti-parallel arrangement of DNA strands, role of primer, exonuclease activity of DNA polymerase III, End replication problem, Fidelity and termination of replication, DNA repair and recombination Transcription in prokaryotes and eukaryotes and RNA polymerases Post transcription modification- RNA splicing and processing (5' capping, Poly A adenylation), mRNA editing, inhibitors of transcription.	15
II	Translation (initiation, elongation, termination), control of eukaryotic translation, Effect of antibiotics on protein synthesis, Post translational modifications, protein folding, protein sorting. Regulation of Gene action in prokaryotes and eukaryotes, Operon system: lac, trp, arabinose operons, Intracellular protein degradation, Gene silencing, RNAi Cancer: Fibrosis, cirrhosis, characteristics of transformed cells, protoncogene, c- oncogenes, angiogenesis and metastasis. Tumour suppressor gene (p53) and Two-Hit hypothesis. Apoptosis: definition, intrinsic and extrinsic pathway.	15
III	Innate and acquired immunity. Cells and tissues of the immune system. Immunoglobulins: Structure, types and functions; Monoclonal antibodies. Antibody: affinity, avidity, diversity, Organization & Expression of Immunoglobulin genes. Primary and Secondary Ab responses. Humoral and Cell Mediated Immune response, Maturation and differentiation of T-cells and B cells Structure of MHC molecules and its types Structure and functions of cytokines and the complement system (classical, alternative, lectin) Hyper sensitivity and Vaccines Autoimmunity and Acquired immuno Deficiency disease	15
IV	Introduction and scope of bioinformatics: concept of digital laboratory. Basics of information technology, computer, operating systems, network. Concept of internet protocol (TCP/IP), hypertext, home-page, web-page and uniform resource locators (URL). Introduction to data archiving systems (FASTA format, Accession, and GI-Number). Introduction to data retrieval systems, Search engines, Entrez, sequence retrieval system (SRS) and protein identification resource (PIR), Sequence alignments (BLAST and Clustal W) and phylogenetic trees (PHYLIP). Applications of bioinformatics: Clinical informatics, Cheminformatic resources and pharmacoinformatics	15

Suggested books:

1.Frifelder, D. Molecular Biology 2. Molecular biology of the cell by Albert's et al. 3. Lewin, B. Genes XII 4. Immunology by Kuby 5. Essential Immunology by J.M. Roitt 6. Immunology by E. Benjamini, R. Coico and G. Sunshine 7. Introduction to Bioinformatics: A theoretical and practical Approach by Stephen A. Krawetz, David D. Wombli, 8. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. 9. Lodish Molecular Cell Biology 10. Watson Molecular Biology of the Gene 11. Molecular biology by Robert F. Weaver 12. Molecular biology by David P. Clark

Waste management and sustainable development			
Paper Code: B050903T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Waste Management and global Health and its implications in Environmental sanitation. Significance of Recycling to waste management, The Environmental impacts of waste Disposal, Types of waste, management evaluating the global of impact of waste management. The impact of solid waste on business Environment. impact of waste management on Economic growth of India. The effectiveness of rural waste management. Recycling of Electronic (E-waste) in India. The waste management and benefits of Renewable Energy. The public perception regarding the waste management.	**15**
II	Properties of solid waste: Physical and chemical. Solid waste management: Sources, segregation, collection, transportation and disposal Disposal technology: composting (Aerobic, anaerobic and mechanical), Incineration, Sanitary land fill. Hazardous Waste management: classification, treatment technologies, Biomedical wastes and their management	**15**
III	Sustainable Development, Biosafety, Environmental movements. Sustainable development and green technology. Public awareness of Environment problems, Role of Government for sustainable development. Role of NGO's. Ecological foot print. Organizations, International effects	**15**
IV	Concepts of sustainable development, components of sustainable development, Goals of sustainable development. Example of sustainable development: Solar Energy; wind energy, crop rotation, sustainable construction. Elements of sustainable development. Environmental laws and Acts, national Environmental policy Convention on biological diversity. Rain Water Harvesting, Ground water recharge, ECO cities.	**15**

Suggested books:

1. Manual on Sewage and Sewage treatment by Ministry of works and Housing, New Delhi
2. Introduction to environmental Engineering and Science by Gilbert, M. M.
3. Environmental Engineering by Kiely, G.
4. Handbook of Environmental Management and technology by Gwendolyn Holmes et.al.
5. Environmental Engineering by Howard, P. et al.

Agrochemicals and Pest Management			
Paper Code: B050904T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	**Concept of pest:** Definition, classification, morphology and internal systems; Plant pests –weeds, bacteria, fungi, Viruses, nematodes, molluscs, Arthropods, birds, mammals etc.; Causes of outbreak of pest, growth and development; Classification based on nature of damage: Public health pests, Agricultural pests, Domestic pests, Animal husbandry pests, Structural pests	**15**
II	**Agrochemicals/ nutrients for increasing the health of plants:** Manures: types, composition and value, sources of manures, Compost-Different composting technologies-Mechanical compost plants-Vermicomposting-Green Manures-Oil cakes, Sewage Sludge-Biogas plant slurry. Chemical fertilizers: Classification and value. N- fertilizers: Manufacturing of Ammonium Sulphate, Ammonium Chloride, Ammonium Nitrate and urea; P- fertilizers: sources, processing rock phosphate, bones for bone meal preparation; K- fertilizers: sources, Potassium Chloride, Potassium Sulphate and Potassium Nitrate; Biofertilizers: Classification and value; *viz*., *Rhizobium*, *Azotobacter*, *Azolla*, Blue Green Algae, VAM	**16**
III	**Agrochemicals for pest management:** Conventional chemicals/ pesticides based on target species: Acaricides, Fungicides, Rodenticides, Nematicides, Molluscicides, Fumigants and Repellents; Based on chemical nature: Organophosphates; Organochlorines, Carbamates etc.; Structure, chemical name, physical and chemical properties; Degradation metabolism, Mode of action, uses, toxicity; Application of Pesticides, devices used; dose estimation for field application.	**14**
IV	**Botanicals and other biopesticides:** Potential pesticidal plants; Plant extracts and Bio-organisms: Azadirachtin and its role in pest control; Other biopesticides: Pyrethrins, Pyrethroids, Rotenone, Nicotine and Nicotinoids. Growth inhibitors or physiological antagonists, chemo-sterilants; pheromones and attractants; Insect growth regulators, juvenile hormones, moulting hormones; Chitin synthesis inhibitors. Moulting Inhibitors. BT methodology, genetically modified and transgenic plants.	**15**

Suggested books:

1. Phytochemical Biopesticides by Koul, O. and Dhaliwal, G.S
2. Insect pest management by Dent, D.
3. Fundamentals of Plant Pest Control by Roberts, D.A.
4. Biological Control of Insect Pests and Weeds by De Bach, P.
5. Entomology and pest management by Pedigo, L.P.
6. Agricultural insect pests of the tropics and their control by Hill, D.S.
7. Agricultural pests of India and south East Asia by Atwal, A. S.

Entomology			
Paper Code: B050905T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Classification of insects up to order and suborders. Introduction to primitive insects and fossil insects, cause of success of insects. Insect integument: Structure, composition and functions, Biochemistry of sclerotization, Functional morphology: Head: Sutures and area of the cranium, Tentorium, Gnathal appendages (antenna and mouth parts), thorax: Pterothorax, Legs and their modification Wing types, abdomen and appendages, head segmentation, wing venation. Flight muscles and its functions, Origin and evolution of insects	**15**
II	Digestive system: Alimentary canal and physiology of digestion. Circulatory system: Anatomy, physiology; composition of haemolymph. Respiratory system: Structure and physiology Excretory system: Functional architecture	**15**
III	Nervous system: Structure and physiology. Neuro endocrine system. Sense organs: Chemoreceptors, mechanoreceptors, photoreceptors, sound and light producing organs, visual organs and physiology of vision. Reproductive system: Structure and physiology	**15**
IV	Detailed classification of the following orders emphasizing selected super families and families: Orthoptera, Isoptera, Coleoptera, Homoptera, Hemiptera, Lepidoptera, Diptera and Hymenoptera. Economic importance of these orders. Social life in Isoptera and Hymenoptera. Caste determination in social insects	**15**

Suggested books:

1. Chapman RF. The Insects: Structure and Function
2. David BV & Ananthkrishnan TN. General and Applied Entomology
3. Duntson PA. The Insects: Structure, Function and Biodiversity.
4. Evans JW. Outlines of Agricultural Entomology
5. Richards OW & Davies RG. Imm's General Text Book of Entomology
6. Snodgross RE. Principles of Insect Morphology

Parasitology			
Paper Code: B050906T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	**Introduction to Parasitology** General introduction; basic definitions and concepts; Animal associations (phoresy, symbiosis, mutualism, symbiosis, parasitism) Types of hosts and parasites; Host specificity; Parasitic adaptations **Taxonomy and diversity** Morphological taxonomic characters of major parasite groups, Kinds of taxonomic literature and databases and their uses, Process of typification and different zoological types, international code of Zoological Nomenclature (ICZN), Biodiversity of parasites at global and national level	**15**
II	**Ecology, evolution, sampling and processing of parasites** Parasites population dynamics, Dimensions and saturation of niches of parasites Parasite manipulation of host behaviour Host–parasite coevolution, Host–parasite interactions (tissue damage, tissue changes, immunological adaptations of parasitism) Collection, fixation and preservation of ectoparasites, Collection, fixation and preservation of endoparasites, Staining protocols Preparation of temporary and permanent 'whole mounts', Histological techniques	**15**
III	**Protozoan Parasites of Man and domestic animals:** General account, morphology, life-cycle of: *Entamoeba histolytica* and *Giardia lamblia* Haemoflagellates: *Trypanosoma* spp, *Leishmania* spp. *Trichomonas* spp. **Trematode Parasites of Man and domestic animals:** **Monogenea** General morphology, biology, life-cycle of: *Diplozoon , Polystoma* **Digenea** General morphology, biology, life-cycle of: *Schistosoma* sp *Fasciolopsis buski, Paragonimus westermani, Dicrocoelium dendriticum*	**15**
IV	**Cestode Parasites of Man and domestic animals:** General morphology, biology, life-cycle of: Intestinal tapeworms (*Taenia solium, Diphyllobothrium latum, Hymenolepis nana*) **Nematode Parasites of Man and domestic animals:** General morphology, biology, life-cycle of: *Ancylostoma duodenale, Wuchereria bancrofti, Dracunculus medinensis, Trichinella spiralis, Onchocerca volvulus* **Arthropoda** Arthropods as vectors of human pathogens, Biting dipterans (mosquitoes, tsetse flies) Non-biting dipterana (common house fly), Fleas, lice, Acarians (ticks and mites)	**15**

Suggested books:

1. Foundation of Parasitology by GD Schmidt LS Roberts 2. General Parasitology by TC Cheng 3. Helminths, Arthropods and Protozoa of domesticated animals by EJL Soulsby 4. Parasitology: The Biology of animal parasites by ER Noble GA Noble 5. Animal Parasitology by JD Smyth 6. General Parasitology by Dogiel, V. A 7. The Trematoda by Dawes, B

Ichthyology			
Paper Code: B050907T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Evolutionary Classification (Prepared by Berg and Romer) and its demerits, classification by modern approach, ostracoderms, placoderms. Origin and Evolution of elasmobranchs and bony fishes Origin and Adaptive Radiation of various groups Fish fauna in India with special reference to U.P. and Bihar	15
II	Identification of fishes, study and preparation of identification key of the fish with suitable diagram, Fin formula, local and biological names. Study of differentiating character of pair of fishes with special reference to Fin formula with suitable diagram, local and biological names. Fish decomposition and rigor Mortis	15
III	Zoogeography, distribution of fishes; discontinuous distribution Local fish fauna – food fishes, forage fishes, predatory fishes, insectivorous fishes and wood fishes. Fish preservation and processing Fish genetic resources: Fish Biodiversity, Stock (concept and structuring), Fish chromosome and karyotyping, Chromosome Banding, Chromosome Manipulation (Gynogenesis, Androgenesis and Polyploidy)	15
IV	Zoogeography, distribution of fishes; discontinuous distribution Local fish fauna – food fishes, forage fishes, predatory fishes, insectivorous fishes and wood fishes. Fish preservation and processing Fish genetic resources: Fish Biodiversity, Stock (concept and structuring), Fish chromosome and karyotyping, Chromosome Banding, Chromosome Manipulation (Gynogenesis, Androgenesis and Polyploidy)	15

Suggested books:

1. Freshwater Fishery Biology by Lagler KF, Bardach, JE, Miller, RR, Passino DRM
2. Fish Physiology by Hoar WS, Randall DJ and Donaldson EM
3. Fundamentals of Fish Taxonomy by Jayaram KC
4. An introduction to Ichthyology by Moyle PB.
5. Handbook of Fish Biology and Fisheries by Paul J.B. Hart and John D. Reynolds
6. Fish and Fisheries of India by Jhingran VG.
7. Ecology and Inland waters and Estuaries by Reid GR.

Endocrinology			
Paper Code: B050908T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04		**Total no of lectures: 60**	

Unit	Topic	Total No. of Lectures
I	**Introduction to endocrinology:** History, characteristics and classification of hormones, Evolution of Endocrine glands, Cytological and histochemical organization of endocrine cells General organization of Neuro-endocrine organs: Hypothalamo-hypophyseal system, Hormones from Hypothalamus: Chemistry and Physiological actions Regulation of hypothalamic hormone secretion **Pituitary gland**: development, comparative anatomy and cytology, regulation of Pituitary hormone secretion, Hormones from Adenohypophysis: Chemistry and Physiological action, POMC related peptides. Hormones from Pars intermedia and Pars nervosa: Chemistry and Physiological action	**15**
II	**Pineal Gland, Thyroid and Parathyroid gland:** Biological clock and Pineal gland, Synthesis and regulation of melatonin, regulation of Pineal gland by SCN and vice-versa, physiological actions of melatonin Thyroid Gland: Histology Thyroid hormones- Chemistry, secretion, transport, physiological and metabolic functions, physiological functions of Parathormone ANF, Leptin and obesity, hormone and calcium homeostasis	**15**
III	**Adrenal gland:** Anatomy, histology, adrenal cortex, Corticosteroids: structure, nomenclature and function, Renin-Angiotensin System Adrenal medulla: Sympatho-adrenal system, general adaptation syndrome, catecholamine: structure, nomenclature and function **Endocrine Pancreas**: Anatomy and cytology, Insulin: structure, regulation of insulin secretion and physiological actions, Glucagon: structure and physiological actions, Diabetes mellitus-types and management **GI Tract Hormones**: types, source and functions	**15**
IV	**Gonadal Hormones**: Male and Female Sex corticoids: Structure and functions, spermatogenesis, oogenesis. Hormonal regulation of reproductive cycle: Estrus cycle, menstrual cycle, ovulation, foetal -placental unit, hormonal control of pregnancy, parturition and lactation Pathophysiology of Pituitary, Thyroid, Parathyroid, Adrenal glands Ultimobranchial body, Corpuscles of stannius, Urophysis., Insect hormones and their functions	**15**

Suggested books:

1. Freshwater Fishery Biology by Lagler KF, Bardach, JE, Miller, RR, Passino DRM
2. Fish Physiology by Hoar WS, Randall DJ and Donaldson EM
3. Fundamentals of Fish Taxonomy by Jayaram KC
4. An introduction to Ichthyology by Moyle PB.
5. Handbook of Fish Biology and Fisheries by Paul J.B. Hart and John D. Reynolds
6. Fish and Fisheries of India by Jhingran VG.
7. Ecology and Inland waters and Estuaries by Reid GR.

Animal Cytogenetics			
Paper Code: B050910T	**Year - FIRST**	**Semester : FIRST**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	General characteristics of living beings. Cell theory and Cell cycle - mitosis and meiosis. Cell Membrane – modifications and physiology, chemical composition and structure; permeability and transport; plasma membrane specializations (microvilli, cilia, glycocalyx, junctions). Protoplasm -Chemical and physical nature.	15
II	Cell organelles Ultrastructure, chemical composition, function and significance: Nucleus, and all organelles including lysosomes, centrosome and plasmids. Cilia, flagella, basal bodies and Parthenogenesis. Cytoskeleton and cell motility. Cell metabolism - Energy metabolism and biosynthesis of carbohydrates, proteins; lipids, nucleic acids, and their catabolism	15
III	Chromosomes - Giant chromosomes, Isochromosomes, heterochromatin, euchromatin, chromosome proteins, arrangement of chromatin in chromosomes, Nomenclature of mammalian chromosomes; Banding and karyotypes Chromosomal aberrations- Deletion, duplication, translocation and numerical aberration. Sex determination - Primary and secondary sex characters; sex chromosome structure and mechanisms of sex determination, sex chromatin and Y body	15
IV	DNA replication, transcription and translation of genetic information. Transformations of matter and energy demand: catabolism, anabolism, metabolism, Autotrophy, heterotrophy, metabolic pathways and chemical energy. Basic techniques for morphological analysis of cells and tissues; tools and sample preparation for microscopic and sub microscopic analysis	15

Suggested books:

1. Cell Biology by Gerald Carp
2. The Cell by Cooper and Hausman
3. Molecular Biology of Cell by Lodish
4. Cell and Molecular Biology by De Robertes
5. Molecular Cell Biology by Alberts
6. Culture of Animal Cells by Freshney
7. Gene XI by Lewin B.
8. Genetics by Benjamin A. Pierce

B050911P **Practical** **Max. Marks 100 (75+25)**

E

The duration of the practical examination will be 04 hours. The distribution of marks will be as follows-

Section A:

1.	Exercises based on B050901T	10
2.	Exercises based on B050902T	10
3.	Exercises based on B050903T/ B050904T	10

Section B: (Specialization)

Exercise based on B050901T/ B050902T/ B050903T/ 50904T	45

Grand Total = 75

Distribution of marks of Continuous Internal Assessment (CIA):

1. Examination..... 15
2. Seminar/Presentation/Assignment/Quizzes... 10

Grand Total = 25

M.Sc. Semester-I

Zoology Practical Examination (ESE)- 20....

Date: Batch: Duration: 4 hrs Max. Marks: 75

Question Paper

Section -A

Q.No.1. Any one exercise based on Ethology or Biodiversity **10**

Q. No. 2. Any one exercise based on Molecular biology/Immunology **10**

Q. No. 3. Any one exercise based on waste management and sustainable development/ Agrochemicals and Pest Management **10**

Section-B (Entomology)

Q. No. 4. Dissect the animal provided (.....) so as to expose its nervous system/digestive system/reproductive system as clearly as possible. Display your dissection suitably. (Cockroach/ *Gryllotalpa*/ Grasshopper/ *Apis*/ *Vespa*) **10**

Q. No. 5. Comment upon Insecticide Application Equipment given **05**
05

Q. No. 6. Identify and comment upon spots. (1-10) **15**

Q. No. 7. Viva-voce **10**

Q. No.8. Practical record/ Collection/ Chart **05**

Section-B (Parasitology)

Q. No. 4. Make a suitable permanent stained preparation of any Protozoan provided. Identify it **05**

Q. No. 5. Make a suitable permanent stained preparation of any Cestode provided. Identify it **05**

Q. No. 6. Make a suitable permanent stained preparation of any Trematode provided. Identify it **05**

Q. No. 7. Make a suitable temporary glycerine preparation of any Nematode provided. Identify it **05**

Q. No. 8. Identify and comment upon spots. (1-10) **10**

Q. No. 9. Viva-voce **10**

Q. No.10. Practical record/ Collection/ Chart **05**

Section-B (Ichthyology)

Q. No. 4. Dissect the animal provided (.....) so as to expose its **08**
Cranial nerves/pituitary gland as clearly as possible. Display your dissection suitably.
(Mystus/Dasyatis/Labeo/Torpedo)

Q. No. 5. Make a suitable permanent stained preparation of .....from the **04**
material / animal... .....provided

Q. No. 6. Identify and comment upon the **specimen A** (Local fish) **specimen B** (Estuarine/ Marine Fish) **04**

Q. No. 7. Any one exercise from Physiological and Biological experiments **04**

Q. No. 8. Identify and comment upon spots. (1-10) **10**

Q. No. 9. Viva-voce **10**

Q. No.10. Practical record/ Collection/ Chart **05**

Section-B (Endocrinology)

Q. No. 4. Dissect the animal provided (.....) so as to expose its **10**
Any one endocrine gland as clearly as possible. Display your dissection suitably.

Q. No. 5. Make a suitable permanent stained preparation of ..... from the **05**
material / animal... .....provided

Q. No. 6. Any one exercise based on Immunohistochemistry/Scatchard analysis/RIA **05**

Q. No. 7. Identify and comment upon spots. (1-10) **10**

Q. No. 8. Viva-voce **10**

Q. No.9. Practical record/ Collection/ Chart **05**

Section-B (Environmental Biology)

Q. No. 4. Estimation of Soil/water quality (Chemical) **10**

Q. No. 5. Estimation of Plankton number in a given sample (Qualitative and Quantitative) 10

Q. No. 6. Any one exercise based on determination of frequency of individual species **10**

Q. No.7. Viva-voce **10**

Q. No.8. Practical record/ Collection/ Chart **10**

Section-B (Animal Cytogenetics)

Q. No. 4. Make a suitable stained preparation of Polytene chromosomes from the animal provided	**05**
Q. No. 5. Make a suitable stained (Methyl Green pyronin Y) preparation of nucleolus/Chromatin	**05**
Q. No. 6. Make a suitable stained preparation of mitochondria using Janus green	**05**
Q. No. 7. Make a suitable preparation of stages of Meiosis using squash technique	**05**
Q. No. 8. Identify and comment upon spots. (1-10)	**10**
Q. No. 9. Viva-voce	**10**
Q. No.10. Practical record/ Collection/ Chart	**05**

Detailed Syllabus of Semester III

B050901T Ethology, Biodiversity and Wildlife Conservation

1. To study phototaxis in *Pheretima* and house fly
2. To study geotaxis behaviour in earthworm
3. To study olfactory behaviour in house fly
4. To construct an ethogram
5. Nests and nesting habits of the birds and social insects
6. To measure the species diversity through species richness indices
7. Identification and study of common insects, fish, birds, mammals of a particular area
8. Sampling methods (including diversity assessment) for invertebrates (Insects, snails) and vertebrates (birds)
9. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report

B050902T Molecular Biology, Immunology and Bioinformatics

1. Preparation of ball and stick model for B-DNA molecule (A=T and G=C base pairs)
2. Isolation of genomic DNA by ethanol precipitation method
3. Identification of various stages of meiosis in the testes of grasshopper
4. Study and interpretation of electron micrographs/ photograph showing (a) DNA replication (b) Transcription (c) Split genes
5. Detection of polytene chromosome in salivary gland cells of the larvae of the *Chironomus*
6. To stain mitochondria in human cheek epithelial cells using Janus green
7. Histological study of spleen, thymus and lymph nodes through slides/photographs
8. Principles, experimental set up and applications of immuno-electrophoresis, ELISA, RIA, FACS

B050903T Waste management and sustainable development

1. Prepare a model/chart showing the importance of rain water harvesting
2. Diagrammatic presentation of recycling of plastic in an ideal condition through a chart/model
3. Visit to a solar plant to learn their working
4. Visit to a wind mill at village area to learn and make project about wind energy
5. To collect the underground water from various surrounding sites and test the physico-chemical properties for the domestic and agricultural use
6. To study acidity and alkalinity of sample water by methyl orange and phenolphthalein
7. To determine Cl, SO4, NO3 in soil and water samples from different locations
8. Study of solid waste management through charts

B050904T Agrochemicals and Pest management

1. Identification of common natural enemies of crop pests (Parasitoids, predators, microbes)
2. Study the damage caused by the commonly occurring insect pests – Infected

plant/plant parts

3. Sampling of fertilizers and pesticides
4. Quick tests for identification of common fertilizers, Identification of anion and cation in fertilizer
5. To study and identify various formulations of insecticide available in the market

B050905T Entomology:

(A) Major Dissection:

Digestive system, Nervous system, reproductive system of following insects-

1. Cockroach
2. *Gryllotalpa*
3. Grasshopper
4. *Apis*
5. *Vespa*

(B) Minor Dissection:

1. Tentorium, Tympanum and spiracles of Grasshopper
2. Gizzard, Endocrine system, Heart and blood vessels of Cockroach
3. Cardiac glands of *Gryllotalpa*
4. Aristate antenna and Haltere of *Musca*
5. Sting apparatus of *Apis* and *Polistes*

(C) Study of Museum specimens and prepared slides of important Insects (Selected from the Orders of insects as per theory course for the purpose of identification)

(D) Exercises on growth and development of insects using following biostatistical calculations; Chi- square test, Growth index, Dyar's law, Howe's index values, critical differences, standard deviation, standard error, Transformed and Angular values.

(E) Study of histological preparations of Grasshopper viscera exposed to easily available insecticides/Pesticides

(F) Study of Insecticide Application Equipment's:

1. Fumigators 2. Sprayers 3. Dusters

(G) Collection and identification of Insects:

1. Pests 2. Parasitoids 3. Predator
4. Other beneficial Insects 5. Insect of Taxonomic importance

B050906T Parasitology:

1. Study of methods of collection and preservation of Parasites (Protozoans, Helminths and Arthropods)
2. To collect and preserve parasites from different invertebrate/vertebrate hosts in Lab
3. Study of prepared slides of protozoan parasites, Helminths and Arthropod Parasites
4. ***Permanent stained preparation and identification of Protozoans***

(Rectal ciliates, *Monocystis*, Blood film for *Plasmodium*, *Leishmania*,

Trypanosoma, Herpetomonas)

5. ***Permanent stained preparation and identification of Cestodes***
   (*Raillietina, Cotugnia, Stilesia, Moniezia, Avitellina*)
6. **Permanent stained preparation and identification of Trematodes**
   (*Fasciola, Fasciolopsis, Gastrothylax, Gastrodiscoides, Paramphistomum,* Redia larva, Cercaria larva)
7. **Temporary glycerine preparation and identification of Nematodes**
   (*Ancylostoma, Ascaridia, Trichuris trichura, Bunostomum, Oesophagostomum, Enterobius*)
8. **Permanent preparation and identification of arthropod parasites**
   (*Pediculus, Haematopinus, Cimex,* larval forms, Ticks, Mites)
9. Detection of presence or absence of cholesterol in the solution provided

B050907T Ichthyology:

1. **Major Dissection:**
   Mystus – Cranial nerves
   Dasyatis – Cranial nerves
   Labeo – Cranial nerves
   Torpedo – Cranial nerves
   Exposure of Pituitary from a fresh water fish
2. **Minor Dissection:**
   Accessory respiratory organs of *Heteropneustes, Channa* and *Anabas*
   Eye and eye muscles
   Weberian ossicles of fresh water fish
3. **Permanent Preparations:**
   Ampullae of Lorenzini of *Dasyatis*
   Different types of scales
   T.S. of spine of *Dasyatis*
   Weberian ossicles of *Labeo*
   Blood film
   Nerve Fibers
   Hand section of Olfactory organs
4. Study of various methods of fishing (Nets and Gears) through charts/Photographs
5. Taxonomic identification:
   (a) Collection, preservation and identification (up to species level) of Local Ichthyo fauna
   (b) Study of Important Estuarine and Marine fishes from museum specimen
6. Study of prepared slides of fishes (Histology)
7. Study of endoskeleton of a bony fish (Disarticulated bones)
8. Physiological and Biological experiments:
   (a) Comparative study of Dissolved Oxygen (DO) of the sample of tap water and pond water

(b) Comparative study of alkalinity of the sample of pond water and river water
(c) Estimation of Hardness, Chloride, Planktons in the sample of water provided
(d) To determine the relationship between body length and body weight (g) of the given sample of fish

B050908T Endocrinology

1. Dissection of a suitable vertebrate to show Pituitary, Thyroid, Adrenal, Pancreas and Gonads
2. Surgical procedures of Orchidectomy, Bilateral ovariectomy, Thyroidectomy and adrenalectomy in Rat
3. Study of histological slides of endocrine glands from fish to mammals
4. Preparation of microtomic permanent slides of endocrine glands from fish to mammals (at least 20)
5. Study of Parabiosis in Rat
6. Study of Radio Immuno Assay and Scatchard analysis
7. Study of Immunohistochemistry to visualize the expression pattern of hormone or receptor

B050909T Environmental Biology

1. Determination of minimum size of Quadrate (Species area curve)
2. Determination of minimum number of quadrates
3. Study of life tables and plotting of survivorship curves of different types from the hypothetical data
4. Determination of frequency of individual species: Line transect method, point frame method
5. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2
6. Study of biomass of producers in the field
7. Study of physical and chemical characteristics of soil
8. Study of different ecosystems to construct ecological pyramids
9. Exercises on population, toxicology and genetics on the basis of provided data
10. Observations and studies on planning and management of Zoological Garden, Wild life sanctuaries and national parks for the conservation of animals

B050910T Animal Cytogenetics

1. Study of somatic chromosomes preparation from bone marrow of rat
2. Demonstration of preparation of polytene chromosomes from salivary glands of *Drosophila melanogaster* larva OR larva of

Chironomus

3. Staining of nucleolus (RNA) and chromatin (DNA) with methyl green-pyronin Y
4. Stained preparation of the mitochondria in striated muscle cells/cheek epithelial cells using Janus green
5. Use of colchicine in arresting anaphase movement (onion root tips)
6. Preparation of chromosome squashes from grasshopper testes/Rat testis for the observation of stages of meiosis
7. Preparation of permanent slide to show the presence of Sex chromatin in female rat
8. Study of prepared slides and photomicrographs showing ultrastructure of cell and cell organelles of prokaryotes and animal eukaryotic cells
9. Study of lethal hereditary syndromes in man with the help of chart
10. Familiarization with techniques of handling *Drosophila,* identifying males and females; observing wild type and mutant (white eye, wing less) flies, and setting up cultures

Ecology and Toxicology			
Paper Code: B051001T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Ecology: its relevance to human welfare, sub divisions and scope. The environment: physical environment, biotic environment. Biotic and abiotic interaction. Climate, soil and vegetation patterns and organizations: Life zones, major biomes, Vegetation, Soil types, concept of community, Ecological Succession Ecosystems organization structure and functions, primary production, energy dynamics, litter fall and decompositions, Global BGC Cycles, mineral cycles in terrestrial and aquatic ecosystems. Concept of Habitat and Niche	15
II	Biological Interactions: Predation: Predator-Prey interaction, Host parasite interaction, Types and theories of competition, commensalism and mutualism, Plant- Pollinator and animal-animal interactions Environmental pollution: types, Sources effects on plant and animal ecosystems Greenhouse gases, Ozone layer and ozone hole, consequences of climatic changes. Ecological management: concepts, sustainable development, sustainability indicators, degraded ecosystems and their regeneration with special reference to waste lands, forests and aquatic ecosystems	15
III	Definition, history, scope & sub-divisions of toxicology. Dose-effect and dose-response relationship- acute toxicity, chronic toxicity reversible & irreversible effects. Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins. Factors affecting toxicity – species and strain, age, sex, nutritional status, hormones, environmental factors, Toxicity Tests: Acute toxicity tests for terrestrial and aquatic animals, Chronic toxicity tests, Concept of maximum acceptable toxicant concentration (MATC) and safe concentration	15
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. Safety evaluation of xenobiotics Antidotal therapy 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

Suggested books:

1. Manual on Sewage and Sewage treatment by Ministry of works and Housing, New Delhi
1. Introduction to environmental Engineering and Science by Gilbert, M. M.
2. Environmental Engineering by Kiely, G.
3. Handbook of Environmental Management and technology by Gwendolyn Holmes

Public health and Hygiene			
Paper Code: B051002T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	**Maintenance of personal hygiene:** Introduction to public health and hygiene- determinants and factors. Pollution and health hazards; water and air borne diseases. Radiation hazards: Mobile Cell tower and electronic gadgets (recommended levels, effects and precaution). Role of health education in environment improvement and prevention of diseases. Personal hygiene, oral hygiene and sex hygiene	15
II	**Nutrient deficiency diseases:** Classification of food into micro and macro nutrients. Balanced diet, dietary plan for an infant, normal adult, pregnant woman and old person. Importance of dietary fibres. Significance of breast feeding. Malnutrition anomalies – Anaemia (Iron and B12deficiency), Kwashiorkar, Marasmus, Rickets, Goiter (cause, symptoms, precaution and cure). Substitution of diet with required nutrients to prevent malnutrition disorders	15
III	**Non-communicable diseases and cure:** Non-communicable diseases such as hypertension, stroke, coronary heart disease, myocardial infarction. Osteoporosis, osteoarthritis and rheumatoid arthritis-cause, symptom, precautions. Diabetes- types and their effect on human health. Gastrointestinal disorders- acidity, peptic ulcer, constipation, piles (cause, symptoms, precaution and remedy) etc. Obesity (Definition and consequences). Mental illness (depression and anxiety). Oral and lung cancer and their preventive measures.	15
IV	**Communicable and contagious diseases:** Infectious agents responsible for diseases in humans. Communicable viral diseases- measles, chicken pox, poliomyelitis, swine flu, dengue, chickunguniya, rabies, leprosy and hepatitis. Communicable bacterial diseases- tuberculosis, typhoid, cholera, tetanus, plague, whooping cough, diphtheria, leprosy. sexually transmitted diseases- AIDS, syphilis and gonorrhoea. Health education and preventive measures for communicable diseases	15

Suggested books:

1. Gibney, M.J. Public Health Nutrition.
2. Wong, K.V. Nutrition, Health and Disease.
3. Mary Jane Schneider. Introduction to Public Health.
4. Muthu, V.K. A Short Book of Public Health.
5. Detels, R. Oxford Textbook of Public Health

Human nutrition and therapeutics			
Paper Code: B051003T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	**Basic concept of Food**: Components and nutrients. Concept of balanced diet, nutrient requirements and dietary pattern for different groups viz., adults, pregnant and nursing mothers, infants, school children, adolescents and elderly people. **Nutritional Biochemistry:** Macronutrients. Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role. Micronutrients. Vitamins- Water-soluble and Fat-soluble vitamins- their sources and importance. Important minerals viz., Iron, Calcium, Phosphorus, Iodine, Selenium and Zinc: their biological function	15
II	**Common nutritional deficiency diseases:** Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives, if any. Life style dependent diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention. Social health problems- smoking, alcoholism, narcotics.	15
III	**Food hygiene:** Potable water- sources and methods of purification at domestic level. Food and Water-borne infections: Bacterial diseases: cholera, dysentery; typhoid fever, viral diseases: Hepatitis, Poliomyelitis etc., Protozoan diseases: amoebiasis, giardiasis; Parasitic diseases: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention. Causes of food spoilage and its prevention.	15
IV	**Therapeutic Nutrition**: Therapeutic adoption of normal diets (normal, soft & fluid diets) factors to be considered in planning therapeutic diets, drugs & diet inter- action, special feeding methods, pre& post operative diets, role of dietician, dietary calculation using food exchange lists, high & low-calorie diet, high protein, high fat, & low carbohydrate diets Therapeutic Diets: Etiology, physiological disturbances, biochemical & clinical manifestations & dietary management of: Fever & infection, Allergy & skin disturbances, Hepatitis, cirrhosis, Diabetes mellitus, cardio vascular disorder. Hyper-lipidemia & Atherosclerosis, Heart disease, hypertension, Coma, Trauma	15

Suggested books:

1. Gopalan, C., Ramasastri, B.S. & Balasubramanian, S.C. Nutritive value of Indian foods.
2. Ghosh, S. The feeding care of infants and young children
3. Swaminathan, M. Handbook of food and nutrition.
4. Swaminathan, M. Essentials of food and nutrition. Vol I & II

Microbiology			
Paper Code: B051004T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	**Microbiology: A brief account of pathogenic bacteria and viruses.** Brief history of microbiology- germ theory of disease, discovery of penicillin. Diversity of microbes- viruses and bacteria. Host pathogen interaction: invasion, antigenic heterogeneity, toxins and enzymes secretions. Kinetics of bacterial growth and staining techniques.	15
II	**Diseases caused by Microbes:** Viral diseases: polio, rabies, hepatitis, influenza, dengue, AIDS, chicken pox, swine flu, chikungunya with emphasis on their causative agents, pathogenesis, diagnosis, prophylaxis and chemotherapy. Bacterial diseases caused by *Bacillus anthracis, Streptococcus pyogenes, Streptococcus pneumoniae, Salmonella typhi, Escherichia coli, Helicobacter pylori, Mycobacterium tuberculosis, Vibrio cholerae.* Fungal diseases: Ringworm infection, aspergillosis, candidiasis	15
III	**Microbes in air and water** Aero microbiology: Intramural and extramural aero-microbiology, Aerosols and Bioaerosols: Sources and launching, Diversity and Survival of microbes in air, control, Aeroallergens, Pollen allergy, Hypersensitivity, effect of climate change on pollen and spore discharge. Aquatic microbiology: aquatic environment; fresh, brackish and marine waters and their microbiology, hydrothermal vents, hot spring, Arctic and Antarctic environment.	15
IV	**Nutrient recycling and manuring:** Biogeochemical cycling: Carbon, Nitrogen, Phosphorus and Sulphur; Importance. Biofertilizers: Definition, types, mass cultivation, inoculums preparation, quality control, significance and applications. Vermicomposting	15

Suggested books:

1. Pepper, I.; Gerba, C. and Gentry, T. Environmental Microbiology
2. Jawetz, M. and Adelberg. Medical Microbiology
3. Brock Biology of Microorganisms by Michael T. Madigan
4. Microbiology: An Introduction by Tortora et al.
5. Microbiology: Laboratory Theory & Application by M. Leboffe

Biotechnology			
Paper Code: B051005T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	**Animal and Medical Biotechnology:** Introduction and scope of Animal Biotechnology, Transgenic and knockout animals and their importance. Genome editing- CRISPR/Cas9, TALEN and ZFN. Nano-medicine, artificial blood, Vaccines and therapeutics, Monoclonal antibodies, Gene therapy	15
II	**Stem cells and Regenerative Medicines:** Embryonic stem adult and Cancer stem cells. Stem cells and renewal in epithelial tissues, fibroblast and their reformation. Genesis and regeneration of skeletal muscle, blood vessels, lymphatics and endothelial cells. Regeneration and repair, cell reprogramming and pluripotent stem cells	15
III	**Recombinant DNA, Genomics, DNA Fingerprinting and Forensic Analysis:** rDNA technology and its applications, Brief account of restriction endonucleases: types and classification. Cloning vectors, Difference in cDNA and genomic library, C-value paradox. Some examples of the useful recombinant proteins: Insulin, Streptokinase, enzymes, antibodies, vaccines, Labelling of nucleic acids, DNA fingerprinting.	15
IV	**Aquatic Biotechnology, Biotechnological regulations and Bioethics:** Introduction. Transgenic fish-from Glofish to Giant Trout, Transgenic Salmon, Zebra fish, GFPs, Antifreeze proteins, Drugs and medicines from marine sources FDA guidelines-phase testing. Introduction to patents. CPCSEA Regulations, Bioethical issues.	15

Suggested books:

1. Primrose, S.B. and Twyman, R. Principles of Gene manipulation and Genomics
2. Nicholl, D.S.T. An introduction to Genetic Engineering
3. Watson, J.D. Recombinant DNA
4. Brown, T.A. Gene Cloning and DNA Analysis: An Introduction
5. Introduction to Biotechnology by Theinman & Palladino
6. Biotechnology for Beginners by Reinhard Renneberg
7. Biotechnology by Elleyn Daugherty

Applied Entomology

Paper Code: B051006T	Year - First	Semester : Second	Total marks : 100
Credits : 04			Total no of lectures: 60

Unit	Topic	Total No. of Lectures
I	Effects of physical factors: population dynamics, Intraspecific and interspecific relations: host plant insect – interactions, Biochemical adaptation to environmental stress. Pheromonal control of fertility in insects. Embryology: Embryonic and post embryonic development: diapause, types of larvae, pupae and metamorphosis. Role of endocrine glands in growth and development, viviparity and parthenogenesis	15
II	General idea of damage caused by pests. Principle methods of pest control. Insecticides: Types, mode of action and methods of application. General idea of appliances used in the insecticide treatment and their safe handling A general account of chemosterilants, attractants, repellents, pheromones, growth regulators and such other compounds. Development of resistance to pesticides Insecticide synergists and antagonists	15
III	Life history, damage caused and control of three major pests of each of the following crops: Wheat, paddy, maize, jowar, millet, sugarcane, cotton, mustard and soyabean. Stored grain and milled product pests: *Sitophilus*, *Rhyzopertha*, *Tribolium* , *Trogoderma* , *Oryzaephilus* . An elementary idea of storage Pests of veterinary and medical importance. preliminary idea of insect borne diseases. Life cycle of aphid and locust and their control..	15
IV	A general idea of plant protection organizations in India; forensic entomology with special reference to human and wild life. Beneficial insects: Silk worm, honey bee, lac insect; their economic importance and industries related to them. Role of genetics in insect vector control. An elementary idea of IPM	15

Suggested books:

7. Chapman RF. The Insects: Structure and Function
8. David BV & Ananthkrishnan TN. General and Applied Entomology
9. Duntson PA. The Insects: Structure, Function and Biodiversity.
10. Evans JW. Outlines of Agricultural Entomology
11. Richards OW & Davies RG. Imm's General Text Book of Entomology
12. Snodgross RE. Principles of Insect Morphology

Clinical Parasitology			
Paper Code: B051007T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Causes, Symptoms, Diagnosis, Treatment and control of following diseases: (i) Amoebiasis, Trpanosomiasis, Leishmaniasis, Malaria, Trichomoniasis, Giardiasis Schistosomiasis, Faciolopsiasis, Dicrocoeliasis, Paragonimiasis	15
II	Causes, Symptoms, Diagnosis, Treatment and control of following diseases: (i) Taeniasis, Diphyllobothriasis, Hymenolepsiasis, Human hydatidosis, Human cysticercosis Hook worm disease, Filariasis, Dracunculiasis, Trichinosis, Onchocerciasis	15
III	**Immuno-parasitology:** Immunology in relation to Parasitism, Immunity and parasitic populations, immunomodulation by parasites, Immunodiagnosis, Intradermal test and their significance, Immunopathology in parasitic infection Parasitism and Vaccination Vaccines against protozoan and helminth parasites	15
IV	**Physiology and biochemistry of Parasites:** Physiological basis of Parasitism Absorptive, secretory and excretory features of tegument Physiology of digestion, excretion and respiration Metabolism of protein, lipid and carbohydrate In Vitro cultivation of Parasites (Trematodes, Cestodes and Nematodes) Physiology of egg–shell formation	15

Suggested books:

1. Clinical Parasitology by Craig, C. F., and Faust, E. C.
2. Parasitic Diseases by Katz, M., Despommier, D.D., and Gwadz, R.
3. The Physiology of Nematodes by Lee, D. L.
4. The Physiology of Cestodes by Smyth, J. D. & Macmanus
5. H u n t e r ' s Tropical Medicine by Strickland, G. T.
6. Biochemistry of Parasites by von Brand, T.
7. A text book of clinical parasitology by Belding
8. Physiology of Trematodes by Smyth & Halton
9. Immunology of Parasitic Infections by Cohen & Warren
10. Immunity to parasite By Derek Wakelin
11. Clinical parasitology by Beaver PC, Jung, RC, Cupp, EW
12. Medical Parasitology by Markell EK, Voge M, John, DT
13. Molecular Parasitology by JE Hyde

Applied Ichthyology			
Paper Code: B051008T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Fisheries of India; study of marine, freshwater, estuarine and cold-water fisheries. Riverine fisheries with special reference of north India and their fisheries. **Prawn Fisheries** – fishing method, culture methods, pollution in prawn fisheries in India. **Pond culture:** types of fish farming, planning and construction of fish farm, physiological and biological characteristics of fish farms; and their maintenance and improvement.	15
II	**Fishing Method**: Seawater fishing method (Crafts of east and west coast, tackles, electric fishing, light fishing and by eco-sounders), inland waters fishing (Crafts and tackles) **Principal cultivable fishes:** Indigenous and exotic species, procurement of seed, collection, identification and transport of seed. Tagging of fishes Fish marketing and their transport	15
III	**Induced Breeding:** stripping, hypophysation technique, bund fisheries, indoor hatcheries and hapa technique. Fish products like oil, fish sauce, fish glue, etc. Relationship between age, growth, length and weight	15
IV	Development – Gastrulation, neurulation, organ formation, larval development and metamorphosis. Seasonality, prolific breeders; oviparity and viviparity, fecundity. Endocrinal regulation, embryogenesis of any carp fish, parental care in fishes	15

Suggested books:

1. Freshwater Fishery Biology by Lagler KF, Bardach, JE, Miller, RR, Passino DRM
2. Fish Physiology by Hoar WS, Randall DJ and Donaldson EM
3. Fundamentals of Fish Taxonomy by Jayaram KC
4. An introduction to Ichthyology by Moyle PB.
5. Handbook of Fish Biology and Fisheries by Paul J.B. Hart and John D. Reynolds
6. Fish and Fisheries of India by Jhingran VG.
7. Ecology and Inland waters and Estuaries by Reid GR

Molecular Endocrinology			
Paper Code: B051009T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Chemical nature and properties of hormones Purification and characterization of hormones- RIA, ELISA, HPLC, Immunoassay, Immunocytochemistry, assay methodologies, Analysis of gene expression in endocrine system, animal model of endocrine research Modern endocrine technologies: RNA extraction, RT-PCR, Hormone Localization-Northern blot, ISH	15
II	General class of hormones: Peptide, steroid, amines, neurohormones, Pheromones, Chalones etc. Biosynthesis of peptide hormones: production of Insulin and GH hormones by r-DNA technology. Biosynthesis of catecholamines, Chemistry and synthesis of Steroid hormones, steroid hormone metabolism, biosynthesis of thyroid hormones	15
III	General mechanism of hormone action: Receptor and types, cytosolic receptor, surface receptor, nuclear receptor Signal transduction, second messenger, G protein, phosphorylated proteins as physiological effectors Multiple membrane messengers- PIP3, DAG, protein kinase C. Mode of action of Steroid and Thyroid hormone, Receptor regulation, Termination of hormone action	15
IV	Hormone and behaviour- Hormone disruptors chemicals, cellular and molecular action of semiochemicals, pharmacokinetics of Hormones. Eicosinoid: Structure, synthesis and actions. Hormones as therapeutics agents, recombinant protein hormones: production and their application design and production of hormonal contraceptives, Current development in hormone research	15

Suggested books:

1. Vertebrate Endocrinology by Norris
2. Comparative Vertebrate Endocrinology by Bentley
3. Basic & Clinical Endocrinology by Greenspan and Strewler
4. Williams Textbook of Endocrinology: H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen
5. Neuroendocrinology: Charles B. Nemeroff
6. Essential Endocrinology: Darville Brook, C.G. & Marshall
7. Endocrinology: Mac E. Hadley, Jon E. Levine
8. General and Comparative Endocrinology: John B. Allard
9. Endocrinology Vol 1and 2 by LESLIE J. De GROOT J. LARRY JAMESON
10. Harrison's endocrinology by J. Larry Jameson

Applied Environmental Biology			
Paper Code: B051010T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Environmental aspects of Human population demography, growth factors regulating human population. The impacts on environmental imbalance. Environment and development in India, Challenges and Efforts, Land degradation, Water management, urbanization and Industrialization. Global Warming and Climate change, Urban Water management: Sources, Water quality, Solid particles, Content and their types criteria standards, Sewage and Waste water treatment and disposal. Degradation of Natural Resources and the environmental problems.	15
II	Natural Resources and Degradation of Natural Resources, Deforestation and its impact on various forestry's Fauna and flora of India. Soil Resource, Land use in India, Types of Soil in India and soil degradation. Integrated Land use, planning and integrated land. Land degradation. Limitation of Water resource. National waste land Development Board, Role of voluntary Agencies and Non-Government Organization (NGO's) for conservation. Forest Resources. Forest Survey of Indian, Conservation and agroforestry in India. National conversation strategy (NCS) world conservation strategy (WCS).	15
III	Climatic and Topographic Factors, Edaphic (Soil) and Biotic factor, Basic concepts of populations, Populations Characteristics and population dynamics. Ecological succession. Structure and function of Ecosystem. Wild life of India and it's conservation (Brief) Environmental pollutants. Various Source of pollutants, Carbon and Sulphur Compounds, Nitrogen Oxide, Acid Rain, Ozone layer and it's protection. Hydrocarbons, metals and photo chemical product. The black cloud of pollutant. Prevention and control of Air pollution	15
IV	Noise pollution, water pollution and their source. Ground and marine pollution. Mercury, Fluoride and lead pollution. Ganga Action Plan (GAP), Measurement of water quality & management in India. Prevention and control of water pollution. Control of water and Air	15

	pollution through Laws, Wetland Conservation, Solid waste pollution and their management. Radiation and Chemical Toxicology, Chemical Toxicants and their effects on Industrial and agricultural wastes. Eco toxicology: Ecological change and disease, Role of water in human health urbanization, stress and health. Bioindicators and environmental monitoring. Environmental Organization in India. Environmental Organization and agencies, Man and Biosphere programme (MAB), Indian Environmental laws. National Environmental Policy	

Suggested books:

3. Stiling, P. D. Ecology Companion Site: Global Insights and Investigations
4. Kendeigh, F C. Ecology with Special Reference to Animal and Man
5. Southwood, T.R.E. and Henderson, P.A. Ecologial Methods
6. Ricklefs, R.E. Ecology
7. Odum, E.P., Fundamentals of Ecology
8. Colinvaux, P. A. Ecology

Clinical Cytogenetics			
Paper Code: B051011T	**Year - First**	**Semester : Second**	**Total marks : 100**
Credits : 04			**Total no of lectures: 60**

Unit	Topic	Total No. of Lectures
I	Concept of gene: Fine structure of gene, split genes, pseudogenes, noncoding genes, overlapping genes and multigene families. Genome organization in viruses, prokaryotes and eukaryotes: Organization of nuclear and organellar genomes. C value paradox, Repetitive DNA satellite DNAs and interspersed repeated DNAs, Transposable elements, LINES, SINES, Alu family and their application in genome mapping.	15
II	Linkage, and crossing over - types of linkage, linkage maps and groups, detection of linkage; cytologic basis of crossing over, crossing over between, three linked genes, gene conversion. Chromosomal compliments in human nomenclature, morphology, karyotype and chemical composition; types of chromatins of different regions of the chromosomes. Dupraw model of human chromosome structure	15
III	Lethal hereditary diseases in man - Sickle cell anaemia, Phenyl - ketonuria, Huntington's chorea, albinism and Galactosemia. Sex chromosomes and abnormalities, Klinefelter's syndrome, Turner's and Down's syndrome, testicular feminization and aged eggs. Genetic and chemical aspect of Rh disease, A, B, O, incompatibility and control, effect of IQ score and phenocopy.	15
IV	Effect of environment on development of characters -external, internal environment. Population genetics - Factors affecting genes, gene frequencies, migration, mutations, selection, fitness, random drift, gone pool, Hardy Weinberg law. Malignancy and its effects.	15

Suggested books:

1. Cell Biology by Gerald Carp
2. The Cell by Cooper and Hausman
3. Molecular Biology of Cell by Alberts et al
4. Cell and Molecular Biology by De Robertes
5. Molecular Cell Biology by Lodish et al
6. Culture of Animal Cells by Freshney
7. Gene XI by Lewin B.
8. Genetics by Benjamin A. Pierce

B051012P	Practical	Max. Marks

The duration of the practical examination will be 04 hours. The distribution of marks will be as follows-

Section A:

1. Exercises based on Ecology and Toxicology B051001T 10
2. Exercises based on public health and Hygiene B051002T/ Human nutrition and therapeutics B051003T 10
3. Exercises based on Microbiology B051004T/ Biotechnology B051005T 10

Section B (Specialization):

1. Exercises based on B051006T/ B051007T/ B051008T/ B051009T/ B051010T/ B051011T 45

Grant Total= 75

Distribution of marks of Continuous Internal Assessment (CIA):

1. Examination..... 15
2. Seminar/Presentation/Assignment/Quizzes... 10

Grand Total = 25

M.Sc. Semester- II

Zoology Practical Examination (ESE)- 20....

Date: Batch: Duration: 4 hrs Max. Marks: 75

Question Paper

Section -A

Q.No.1. Any one exercise based on Ecology and Toxicology **10**

Q. No. 2. Any one exercise based on public health and Hygiene / Human nutrition and therapeutics **10**

Q. No. 3. Any one exercise based on Microbiology / Biotechnology **10**

Section-B (Applied Entomology)

Q. No. 4. Identify the given species of mosquitos **05**

Q. No, 5. Identify and comment upon the social insect A & B **10**

Q. No.6. Identify and comment upon spots. (1-10) **15**

Q. No. 7. Viva-voce **10**

Q. No.8. Practical record/ Collection/ Chart **05**

Section-B (Clinical Parasitology)

Q. No. 4. Detect the presence or absence of cholesterol in a solution **10**

Q. No. 5. Make a blood film using Leishman stain **05**

Q. No. 6. Identify and comment upon spots. (1-10) **10**

Q. No. 7. Viva-voce **10**

Q. No.8. Practical record/ Collection/ Chart **10**

Section-B (Applied Ichthyology)

Q. No. 4. Identify the net and gears given **05**

Q. No. 5. Estimate the number of planktons in a given sample **05**

Q. No. 6. Identify and comment upon spots. (1-10) **15**

Q. No. 7. Viva-voce **10**

Q. No.8. Practical record/ Collection/ Chart **10**

Section-B (Molecular Endocrinology)

Q. No. 4. Any one exercise based on Scatchard analysis/RIA	**05**
Q. No. 5. Any exercise based on Hormone assay	**05**
Q. No. 6. Identify and comment upon spots. (1-10)	**15**
Q. No.7. Viva-voce	**10**
Q. No.8. Practical record/ Collection/ Chart	**10**

Section-B (Applied Environmental Biology)

Q. No. 4. Comment upon Ecosystem model

Q. No. 5. Estimate the DO/Chlorides/dissolved organic matter in a sample

Q. No. 6. Identify and comment upon spots. (1-10)

Q. No.7. Viva-voce

Q. No.8. Practical record/ Collection/ Chart

Section-B (Clinical Cytogenetics)

Q. No. 4. Any one exercise based on Pedigree analysis	**05**
Q. No.5. Any one exercise based on Hardy Weinberg Law	**05**
Q. No. 6. Identify and comment upon spots. (1-10)	**15**
Q. No.7. Viva-voce	**10**
Q. No.8. Practical record/ Collection/ Chart	**10**

Detailed Syllabus of Semester IV

B051001T Ecology and Toxicology

1. Study of decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro- and macro-fauna in decomposition
2. Study of ecological succession by studying various stages of vegetation/community assemblages' development
3. Identification of aquatic organisms of different trophic levels and construction of food chain and food web
4. Estimation of LC^{50} and LD^{50}
5. Dose response relationship curve
6. Study of effects of toxicant on opercular movement of fish

B051002T Public health and Hygiene / B051003T Human nutrition and therapeutics

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
2. Estimation of Lactose in milk
3. Ascorbic acid estimation in food
4. Estimation of Calcium in foods

B051004T Microbiology / B051005T Biotechnology

1. Preparation of culture media, sterilization
2. Study of Bacterial growth curve
3. Culturing methods (bacterial plating, making stab, slant and growing liquid culture)
4. Staining and identification of Gram positive and Gram negative bacteria
5. Construction of restriction digestion maps from data provided
6. Genomic DNA isolation from *E. coli*
7. Plasmid DNA isolation (pUC 18/19) from *E. coli*

B051006T Applied Entomology:

1. Study of various types of social insects and their nests
2. Collection and identification of economically important insects and various stages of their life history
3. Ecology: Measuring insect microclimate
4. Life tables/population dynamics modelling in insects
5. Identification and anatomical studies of major vector species of Anopheles, Culex and Aedes

B051007T Clinical Parasitology

1. Study of prepared slides and museum specimens of selected parasites of representative groups of protozoans, helminths and arthropods
2. Identification of various types of immune cells in peripheral blood smear

3. Histological study of spleen, thymus and lymph nodes through slides/photographs
4. Detection of IgG by precipitation ring test
5. Test for Cholestral

B051008T Applied Ichthyology

1. Collection and identification of aquatic weeds and aquatic insects
2. Determination of age and growth; Gonadosomatic index
3. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India
4. Study of fishing gears and nets with the help of models
5. Quantitative and qualitative analysis of phytoplankton and zooplankton from natural resources
6. Display of visceral organs; preparation of fish skeleton; alizarine preparation

B051009T Molecular Endocrinology

1. Steroid and thyroid hormone assay by ELISA
2. Identification of different neuropeptides and area of its localization in brain following immunohistochemical (IHC) methods
3. Isolation of testicular cells and ovarian follicular cells in Rat
4. In vivo bio- assay for estrogen or testosterone
5. In vitro biochemical assay for a hormone (LH or PRL)
6. Calcium estimation in VitD3 treated Rat

B051010T Applied Environmental biology

1. To measure microclimatic variables *viz*., temperature, humidity and light conditions in a microhabitat
2. Making an ecosystem in a wide-mouthed bottle
3. Constructing distribution map of species of a genus through GPS by estimating the coordinates
4. Estimation of the ratio of the producers and consumers

B051011T Clinical Cytogenetics

1. Demonstration of multiple allelism by showing mutants of white eye series in *Drosophila*
2. Pedigree analysis of some human inherited traits
3. To calculate allelic frequencies by Hardy-Weinberg Law
4. Linkage maps based on data from *Drosophila* crosses
5. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs