UNIVERSITY OF GOUR BANGA

UG SYLLABUS FOR ZOOLOGY (MAJOR)

(BASED ON NEP – 2020)

(SEMESTER VII & VIII)

(As per Curriculum and Credit Framework for Undergraduate Programs, i.e., FYUGP or Four Years Undergraduate Programs)

UG syllabus for ZOOLOGY (Major) (SEMESTER VII - VIII) (Based on NEP-2020)					
Year	**Semester**	**Course Code**	**Title of the Course**	**Credits**	**Full Marks**
I	**SEM-I**	ZOO-DC-MJ-101	Diversity of Non-Chordates (Theory)	03	30
		ZOO-DC-MJ-101	Diversity of Non-Chordates (Practical)	01	20
	SEM-II	ZOO-DC-MJ-201	Diversity of Chordates & Comparative anatomy of Vertebrates (Theory)	03	30
		ZOO-DC-MJ-201	Diversity of Chordates & Comparative anatomy of Vertebrates (Practical)	01	20
II	**SEM-III**	ZOO-DC-MJ-301	Ecology & Conservation Biology (Theory)	03	30
		ZOO-DC-MJ-301	Ecology & Conservation Biology (Practical)	01	20
		ZOO-DC-MJ-302	Cell Biology (Theory)	03	30
		ZOO-DC-MJ-302	Cell Biology (Practical)	01	20
	SEM-IV	ZOO-DC-MJ-401	Genetics (Theory)	03	30
		ZOO-DC-MJ-401	Genetics (Practical)	01	20
		ZOO-DC-MJ-402	Histology & Endocrinology (Theory)	03	30
		ZOO-DC-MJ-402	Histology & Endocrinology (Practical)	01	20
		ZOO-DC-MJ-403	Animal Physiology (Theory)	03	30
		ZOO-DC-MJ-403	Animal Physiology (Practical)	01	20
III	**SEM-V**	ZOO-DC-MJ-501	Biochemistry (Theory)	03	30
		ZOO-DC-MJ-501	Biochemistry (Practical)	01	20
		ZOO-DC-MJ-502	Developmental Biology & Reproductive Biology (Theory)	03	30
		ZOO-DC-MJ-502	Developmental Biology & Reproductive Biology (Practical)	01	20
		ZOO-DC-MJ-503	Systematics & Evolution (Theory)	03	30
		ZOO-DC-MJ-503	Systematics & Evolution (Practical)	01	20
		ZOO-DC-MJ-504	Economic Zoology (Theory)	03	30
		ZOO-DC-MJ-504	Economic Zoology (Practical)	01	20
	SEM-VI	ZOO-DC-MJ-601	Molecular Biology (Theory)	03	30
		ZOO-DC-MJ-601	Molecular Biology (Practical)	01	20

	SEM-VI	ZOO-DC-MJ-602	Animal behavior & Chronobiology (Theory)	03	30
		ZOO-DC-MJ-602	Animal behavior & Chronobiology (Practical)	01	20
		ZOO-DC-MJ-603	Immunology (Theory)	03	30
		ZOO-DC-MJ-603	Immunology (Practical)	01	20
		ZOO-DC-MJ-604	Toxicology, environmental biology & public health (Theory)	03	30
		ZOO-DC-MJ-604	Toxicology, environmental biology & public health (Practical)	01	20
IV (HONOURS)	**SEM VII**	ZOO-DC-MJ-701	Parasitology & Microbiology (Theory)	03	30
		ZOO-DC-MJ-701	Parasitology & Microbiology (Practical)	01	20
		ZOO-DC-MJ-702	Biostatistics & Bioinformatics (Theory)	03	30
		ZOO-DC-MJ-702	Biostatistics & Bioinformatics (Practical)	01	20
		ZOO-DC-MJ-703	Biotechnology (Theory)	03	30
		ZOO-DC-MJ-703	Biotechnology (Practical)	01	20
		ZOO-DC-MJ-704	Research Methodology (Theory)	03	30
		ZOO-DC-MJ-704	Research Methodology (Practical)	01	20
	SEM VIII	ZOO-DC-MJ-801	Advanced Molecular Biology (Theory)	03	30
		ZOO-DC-MJ-801	Advanced Molecular Biology (Practical)	01	20
		ZOO-DC-MJ-802	Aquaculture (Theory)	03	30
		ZOO-DC-MJ-802	Aquaculture (Practical)	01	20
		ZOO-DC-MJ-803	Biology of Insects (Theory)	03	30
		ZOO-DC-MJ-803	Biology of Insects (Practical)	01	20
		ZOO-DC-MJ-804	**(Term paper / Field report / Literature review / Book review)	04	75
IV (HONOURS WITH RESEARCH)	**SEM VII**	ZOO-DC-MJ-701	Parasitology & Microbiology (Theory)	03	30
		ZOO-DC-MJ-701	Parasitology & Microbiology (Practical)	01	20
		ZOO-DC-MJ-702	Biostatistics & Bioinformatics (Theory)	03	30
		ZOO-DC-MJ-702	Biostatistics & Bioinformatics (Practical)	01	20
		ZOO-DC-MJ-703	Biotechnology (Theory)	03	30
		ZOO-DC-MJ-703	Biotechnology (Practical)	01	20

		ZOO-DC-MJ-704	Research Methodology (Theory)	03	30
		ZOO-DC-MJ-704	Research Methodology (Practical)	01	20
	VIII	ZOO-DC-MJ-801	Advanced Molecular Biology (Theory)	03	30
		ZOO-DC-MJ-801	Advanced Molecular Biology (Practical)	01	20
		DRP-1	***Dissertation / Research / Project	12	225

Scheme for Evaluation

For End Semester (Theory) Examination related to Major Courses: The Question pattern with marks allotment for each End Semester (Theory) Examination of Full Marks: 30 and Time: 2 hours is tabulated below:

Question No.	Mark(s) per Question	No. of Questions to be attempted	No. of Options to be provided	Marks
1	1	6	8	1×6 = 6
2	3	3	5	3×3 = 9
3	5	3	5	5×3 = 15
Total Marks				**30**

**** Term paper/Field report/Literature review/Book review**: Total credit = 04; This may be spilt into two parts: Term paper preparation (03 credits) and presentation/viva-voce (01 credit). Examination guidelines will be prepared by the concerned BOS considering their feasibility. **Marks allocation**: Preparation: 50 and presentation: 15 & viva-voce: 10
Evaluation method: Home centre in presence of internal and external examiners.
Internal credit: No internal marks will be allotted for Term paper (DC-MJ-804).

*****DRP-1**: **Dissertation / Research / Project**: Total credit = 12; This may be split into two parts: Dissertation preparation (08 credits) and presentation (04 credits).
In preparation section, a student will have to focus on a relevant topic (1) Literature review, (2) Research gap, (3) Objective(s), (4) Materials, (5) Methods, (6) Results, (7) Discussion (8) Major findings and conclusion and (9) References (following internationally accepted style)
Marks allocation: Preparation: 150 and presentation: 50 & viva-voce: 25
Evaluation method: Away centre in presence of internal and external examiners.
Internal credit: No internal marks will be allotted for Dissertation (DRP-1).

SEMESTER-VII	
Course Code:	**ZOO-DC-MJ-701**
Title of the Course:	**Parasitology & Microbiology**
Credit = 4	
Theory: 30 marks, Practical: 20 marks, Internal Assessment: 25 marks	

a) Objective of the Course:

The course aims to provide a comprehensive understanding of parasitology and microbiology by introducing students to the diversity, structure, and functioning of microorganisms and parasites. It focuses on developing knowledge of host–parasite relationships, life cycles, and disease-causing mechanisms, along with their diagnosis, prevention, and treatment. The course also seeks to build a strong foundation in microbial classification, growth, culture techniques, and sterilization methods. In addition, it introduces key concepts of microbial genetics and pathogenesis to help students understand how microorganisms evolve and cause diseases. Overall, the objective is to equip learners with essential theoretical knowledge and practical insights necessary for understanding infectious diseases and their control in medical, research, and public health contexts.

b) Learning Outcomes of the Course and Its Future Relevance:

After completing this course, students will be able to:

- Explain key concepts in parasitology, including types of parasites, vectors, and host–parasite relationships.
- Describe morphology, life cycles, and pathogenicity of important parasites such as *Giardia*, *Trypanosoma*, *Leishmania*, helminths, and arthropods.
- Understand microbial diversity and classification, including bacteria, viruses, and fungi. Apply laboratory techniques such as microbial culture, sterilization, and growth analysis. Analyze mechanisms of microbial pathogenesis, including toxin production and host invasion.
- Identify major human diseases, their causative agents, symptoms, transmission, and preventive measures. Understand epidemiological concepts like endemic, epidemic, and pandemic diseases.
- Evaluate issues of antibiotic resistance and its implications for public health.

The study of parasitology and microbiology has significant future relevance in multiple fields, especially in healthcare, research, and public health. It provides a strong foundation for careers in medicine, nursing, and diagnostic laboratories by enabling students to understand disease-causing organisms, their transmission, and methods of prevention and control. The knowledge gained is essential for addressing global health challenges such as infectious diseases, emerging pandemics, and antibiotic resistance. It is also highly valuable in research and biotechnology, where it supports the development of new drugs, vaccines, and diagnostic tools. In addition, the course is relevant to agriculture and veterinary sciences for managing parasitic infections in crops and livestock. Overall, it equips students with the scientific understanding and practical skills necessary to contribute to disease control, healthcare improvement, and advancements in life sciences.

ZOO-DC-MJ-701(Theory = 30 marks)	
Parasitology & Microbiology	
Module 1: Parasitology	
Unit-1	**Introduction to Parasitology**
	Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector), Host- parasite relationship.
Unit-2	**Parasitic Protists**
	Study of Morphology, Life Cycle, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*.
Unit-3	**Parasitic Helminthes**
	Study of Morphology, Life Cycle, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium, Ancylostoma duodenale*, *Trichinella spiralis, Echinococcus granulosus.*
Unit-4	**Parasitic Arthropods**
	Role and control of vectors – Ticks, Mites, Lice, Flea, and Bug.
Module 2: Fundamentals of Microbiology	
Unit-5	**Historical perspective**
	Pasteur and Spontaneous Generation, The Germ Theory of Disease and Koch's Postulates. Diversity of Bacteria based on shape, Classification of Virus (Baltimore, 1971), Classification

	of Kingdom Fungi up to Phylum (Ainsworth & Bisby, 2008).
Unit-6	**Introduction to Bacteriology, Virology and Mycology**
	Culture techniques (continuous, batch); Media (Simple, Complex, Selective and Enriched); Growth requirements and Growth factors, bacterial growth curve, basic idea on sterilization and Pasteurization techniques. Structure of bacteriophage (T4), Lytic and Lysogenic cycle, vegetative structure of fungi, fungal cell wall, ecological and economic importance of fungi.
Module 3: Microbial Genetics and Disease	
Unit-7	**Genetic recombination in bacteria**
	Transformation, Conjugation- F+, F-, Transduction: Generalized and specialized types.
Unit-8	**Microbial Pathogenesis and Diseases**
	Bacterial pathogenesis: Entry to the host, Adherence to host cells, Invasiveness; Bacterial toxins: Exotoxins, Endotoxins. Basic idea on Antigenic switching. Brief idea about disease transmission: Communicable, Non-communicable, Endemic, Epidemic, Pandemic and Sporadic; Name of pathogen, clinical symptoms, pathogenesis & preventive measures of Bacterial (Typhoid, Staphylococcal Food Poisoning) and Viral (SARS CoV-2, Dengue, AIDS) infection to humans. Basic idea on bacterial antibiotic resistance.
Module 4: ZOO-DC-MJ-701 (Practical = 20 Marks)	
Group A: Laboratory experimentation (= 15 marks)	
1. Study of adult/ infective form of *Giardia intestinalis*, *Trypanosoma gambiense, Schistosoma haematobium, Trichinella spiralis* and *Leishmania donovani*, *Echinococcus granolosus* through permanent slides/micro photographs. 2. Study of *Pediculus* sp., *Xenopsylla* sp. and *Cimex* sp. through permanent slides/ photographs. 3. Study of rectal parasites of *Periplaneta* sp. 4. Gram's staining of bacteria. 5. Preparation of liquid media (broth) and solid media for routine culture of bacteria; preparation of slant and stab culture. 6. Inoculation techniques: spread plate, pour plate and streak plate. 7. Isolation of bacteria from environmental sample. 8. Biochemical test for characterization of bacteria: catalase, nitrate-reduction, methyl red and Voges-Poskauer test oxidase, indole and citrate tests.	
Group B: Laboratory note book and Viva voce (2+3 = 5 marks)	
Periodically updated laboratory note-book to be submitted and Viva-voce mostly covering the practical	

syllabus.

ZOO-DC-MJ-701: Internal Assessment (Full marks = 25*)
(* To be done in the Concerned College)

Suggested Readings

Parasitology

1. Human Parasites: Diagnosis, Treatment, Prevention, Heinz Mehlhorn; 2nd edn., Springer International Publishing.
2. Parasitology: an integrated approach, Alan Gunn and Sarah J. Pitt; 2nd edn., John Wiley & Sons, Inc.
3. Human Parasitology, Burton J. Bogitsh, Clint E. Carter and Thomas N. Oeltmann; 5th edn., Elsevier Science & Technology.
4. Paniker's Textbook of Medical Parasitology, CK Jayaram Paniker; 8th edn., Jaypee Brothers Medical Publishers (P) Ltd.
5. General Parasitology, Thomas C Cheng; 2nd edn., Academic Press, Inc.
6. Markell and Voge's Medical Parasitology, David T. John and William A. Petri; 9th edn., Elsevier Inc.
7. Clinical Parasitology A Practical Approach, Elizabeth A. Gockel-Blessing; 2nd edn., Saunders.

Microbiology

1. Prescott's Microbiology, Joanne M. Willey, Kathleen M. Sandman and Dorothy H. Wood; 12th edn., McGraw Hill LLC.
2. Microbiology: An Introduction, Gerard J. Tortora, Berdell R. Funke, Christine L. Case; 13th edn., Pearson Education, Inc.
3. Talaro's Foundations in Microbiology, Barry Chess; 12th edn., McGraw Hill LLC.
4. Medical Microbiology, Patrick R. Murray, Ken S. Rosenthal and Michael A. Pfaller; 10th edn., Elsevier Inc.
5. Microbiology An Evolving Science, Joan L. Slonczewski, John W. Foster and Erik R. Zinser; 5th edn., W. W. Norton & Company, Inc.
6. Brock Biology of Microorganisms, Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley and David A. Stahl; 16th edn., Pearson Education Limited.
7. Microbiology Principles and Explorations, Jacquelyn Black and Laura Black; 9th edn., John Wiley & Sons, Inc.

SEMESTER-VII	
Course Code:	**ZOO-DC-MJ-702**
Title of the Course:	**Biostatistics & Bioinformatics**
Credit = 4	
Theory: 30 marks, Practical: 20 marks, Internal Assessment: 25 marks	

a) Objective of the Course:

The objective of this study is to provide a comprehensive understanding of statistical methods and bioinformatics principles essential for biological research and data analysis. It aims to develop foundational knowledge of descriptive and inferential statistics, enabling learners to summarize, interpret, and analyze biological data effectively. The study further seeks to introduce key bioinformatics tools, databases, and sequence analysis techniques, fostering the ability to retrieve, process, and interpret biological information. Additionally, it emphasizes molecular phylogenetics and structural bioinformatics to enhance understanding of evolutionary relationships and biomolecular structures. Overall, the course is designed to equip students with analytical, computational, and critical thinking skills necessary for modern biological and interdisciplinary research.

b) Learning Outcomes of the Course and Its Future Relevance:

After completing this course, learners will be able to:

- Understand basic statistical concepts such as sampling, variables, and data organization.
- Calculate and interpret measures of central tendency (mean, median, mode). Analyze variability in data using range, standard deviation, variance, and related measures.
- Apply inferential statistical tests such as chi-square, t-test, and ANOVA in biological studies. Explain the concepts of correlation and regression and their applications in data analysis.
- Understand basic probability concepts and their significance in biological research.
- Describe the scope, applications, and limitations of bioinformatics. Retrieve and analyze biological datafrom major databases. Interpret different biological file formats.

- Perform basic sequence analysis including alignment and similarity assessment. Understand phylogenetic tree construction methods and evolutionary relationships.
- Analyze protein and RNA structures using bioinformatics tools.

The integration of statistics and bioinformatics has become increasingly vital in modern biological sciences, especially in fields such as genomics, proteomics, and systems biology. This study provides essential skills for handling large-scale biological data, which is crucial in the era of big data and computational biology. With advancements in sequencing technologies and data-driven research, knowledge of statistical analysis and bioinformatics tools is indispensable for careers in biotechnology, pharmaceuticals, environmental science, and healthcare. Furthermore, these competencies support innovation in areas like personalized medicine, disease diagnostics, and evolutionary studies, making the course highly relevant for future scientific and technological developments.

ZOO-DC-MJ-702(Theory = 30 marks)	
Biostatistics & Bioinformatics	
Module 1: Descriptive statistics	
Unit-1	**Basic idea**
	Sampling, Data, Variables and Frequency Distribution.
Unit-2	**Measures of central tendency**
	Mean, Median, Mode.
Unit-3	**Measures of variation**
	Range, mean deviation, standard deviation, variance, coefficient of variance and standard error.
Module 2: Inferential Statistics & Probability	
Unit-4	**Test of significance**
	Chi-square test, t-test, ANOVA.
Unit-5	**Correlation and regression**
	Idea about correlation and regression analysis and its importance.
Unit-6	**Probability**
	Basic concept and significance.
Module 3: Principles and Applications of Bioinformatics	

Unit-7	**Introduction**
	Preliminary concept of bioinformatics and its goal, scope, applications and limitations; Biological databases; Information retrieval from biological databases.
Unit-8	**Web-based resources and file formats**
	NCBI, EBI, Swiss Prot, Gene card, BOLD, KEGG pathway; Basic file formats: .fasta, .fastq, .pdb, .pir, .mol, .smiles, .sdf, .aln.
Unit-9	**Basic concept of sequence analysis**
	BLAST, FASTA, Sequence identity and similarity, definitions of homologues, orthologues, paralogues, repeat finding, scoring matrix, Pairwise sequence alignment and multiple sequence alignment.
Unit-10	**Molecular phylogenetics**
	Basics of phylogenetics; Methods of phylogenetic tree construction (Distance: UPGMA & NJ and character: ML & MP), Bootstrapping.
Unit-11	**Structural bioinformatics**
	Visualization of protein structure, Prediction of RNA structure.
Module 4: ZOO-DC-MJ-702 (Practical = 20 Marks)	
Group A: Laboratory experimentation (= 15 marks)	
1. Graphical presentation of data: Bar diagram, Histogram, Pie diagram. 2. Determine the modal value through graphical method. 3. Chi-square test, t-test, ANOVA, Correlation analysis from data provided. 4. Retrieval of particular sequence in a specified format. 5. Identify the similarity of sequence using BLAST search. 6. Construct the phylogenic tree using multiple sequence alignment.	
Group B: Laboratory note book and Viva voce (2+3=5 marks)	
Periodically updated laboratory note-book to be submitted and Viva-voce mostly covering the practical syllabus.	
ZOO-DC-MJ-702: Internal Assessment (Full marks = 25*) (*To be done in the Concerned College)	

Suggested Readings

Biostatistics

1. Fundamental Statistical Concepts and Techniques in the Biological and EnvironmentalSciences: With

jamovi, A. Bradley Duthie; 1st edn., CRC Press.

2. Fundamentals of Biostatistics, Bernard Rosner; 7th edn., Brooks/Cole, Cengage Learning.
3. Principles of Biostatistics, Marcello Pagano, Kimberlee Gauvreau and Heather Mattie; 3rd edn., CRC Press.
4. Statistical Methods, N. G. Das; McGraw Hill LLC.
5. Principles and Practice of Biostatistics, B Antonisamy, Prasanna S. Premkumar and Solomon Christopher, 1st Edition, Elsevier.
6. Introduction to Biostatistics (A textbook of Biometry), Pranab Kumar Banerjee, 1st Edition, S. Chand & Company publication.
7. Biostatistics, Veer Bala Rastogi, 3rd Edition, Medtech Publisher.

Bioinformatics

1. Bioinformatics for beginners: genes, genomes, molecular evolution, databases, and analytical tools, Supratim Choudhuri and Michael Kotewicz; 1st edn., Academic Press.
2. Bioinformatics for Biologists, Pavel Pevzner and Ron Shamir; 1st edn., Cambridge University Press.
3. Practical Bioinformatics, Michael Agostino; 2nd edn., CRC Press.
4. Bioinformatics: Methods and Applications (Genomics, Proteomics and Drug Discovery), S.C. Rastogi, Parag Rastogi, Namita Mendiratta, 5th edn., PHI Learning Pvt. Ltd.
5. Bioinformatics: Principles and Applications, Zhumar Ghosh, Bibekanand Mallick, 1st edn., Oxford University Press.
6. Bioinformatics, Orpita Bosu, 1st edn., Oxford University Press.

SEMESTER-VII	
Course Code:	**ZOO-DC-MJ-703**
Title of the Course:	**Biotechnology**
Credit = 4	
Theory: 30 marks, Practical: 20 marks, Internal Assessment: 25 marks	

a) Objective of the Course:

The objective of this study is to develop a comprehensive understanding of modern molecular biology and biotechnology techniques used in gene manipulation, genetic engineering, and applied biological sciences. It aims to familiarize learners with various molecular tools such as cloning vectors, DNA sequencing methods, PCR, and genome editing techniques like CRISPR-Cas9. The course also focuses on the production and applications of genetically modified organisms, including transgenic animals and plants. Furthermore, it seeks to provide practical knowledge of cell culture techniques, molecular diagnostics, and immunebiotechnology, including vaccine development. Overall, the study is designed to equip students with theoretical knowledge and practical insights necessary for research, innovation, and applications in biotechnology and related fields.

b) Learning Outcomes of the Course and Its Future Relevance:

After completing this course, learners will be able to:

- Understand different molecular tools and techniques used in gene manipulation.
- Explain the structure and function of various cloning and expression vectors. Describe methods for constructing and screening genomic and cDNA libraries.
- Compare DNA sequencing methods including Maxam-Gilbert and Sanger techniques.
- Apply knowledge of PCR, DNA fingerprinting, and DNA microarray in biological analysis. Interpret techniques such as Southern, Northern, and Western blotting.
- Understand the mechanism and applications of CRISPR-Cas9 gene editing. Explain site-directed mutagenesis and its role in gene modification.
- Describe methods for producing transgenic organisms and knockout models.
- Explain molecular diagnostic approaches for genetic diseases like thalassemia and sickle cell anemia.

- Understand hybridoma technology and its applications in antibody production. Differentiate between types of vaccines and explain immunization strategies.

Biotechnology plays a transformative role in advancing healthcare, agriculture, and environmental sustainability. The knowledge gained from this study is highly relevant in the era of genetic engineering, personalized medicine, and biopharmaceutical development. Techniques such as CRISPR-Cas9 and DNA sequencing are revolutionizing disease treatment, enabling precise gene editing and early diagnosis of genetic disorders. The development of transgenic organisms contributes to improved crop yield, disease resistance, and food security. Additionally, advancements in immunobiotechnology and vaccine development are critical for combating emerging diseases and global health challenges. With increasing demand for skilled professionals in biotechnology, pharmaceuticals, and research industries, this course provides a strong foundation for future careers and innovations in life sciences.

<table>
<tr><th colspan="2">ZOO-DC-MJ-703 (Theory = 30 marks)</th></tr>
<tr><th colspan="2">Biotechnology</th></tr>
<tr><th colspan="2">Module 1: The Molecular Toolbox</th></tr>
<tr><td rowspan="2">Unit-1</td><td>Molecular Techniques in Gene Manipulation</td></tr>
<tr><td>(i) Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, BAC, YAC and cloning of genes by using these vectors. Expression vectors. Restriction endonucleases, (ii) Construction of genomic and cDNA libraries and screening by colony and plaque hybridization, (iii) Southern, Northern and Western blotting, (iv) DNA sequencing: Maxam Gilbert and Sanger method, (v) Polymerase Chain Reaction, DNA Finger Printing and DNA microarray, (vi) CRISPR-Cas9 technique (vii) Alteration of cloned gene (site–directed mutagenesis).</td></tr>
<tr><th colspan="2">Module 2: Genetic Engineering</th></tr>
<tr><td rowspan="2">Unit-2</td><td>Genetically Modified Organisms</td></tr>
<tr><td>(i) Production of cloned and transgenic organisms: Nuclear Transplantation, Retroviral mediated and Ti plasmid mediated gene delivery methods, DNA microinjection (ii) Development of knockout mice, Applications of transgenic organisms.</td></tr>
<tr><th colspan="2">Module 3: Applied Biotechnology</th></tr>
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Unit-3	**Cell Culture Techniques and Applications**
	Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Thalassemia, Sickle cell anemia)
Unit-4	**Immunobiotechnology**
	(i) Hybridoma technology and its applications (ii) Various types of vaccines; active and passive immunization.

Module 4: ZOO-DC-MJ-703 (Practical = 20 Marks)

Group A: Laboratory experimentation (= 15 marks)

1. Genomic DNA isolation from *E. coli*.
2. Plasmid DNA isolation (pUC 18/19) from *E. coli*.
3. Construction of circular and linear restriction map from the data provided.
4. Calculation of transformation efficiency from the data provided.
5. To study the following techniques by photographs and documentation- (a) Southern Blotting, (b) Northern Blotting, (c) Western Blotting, (d) DNA Sequencing (Sanger's Method), (e) PCR, (f) DNA fingerprinting.
6. Seminar on tools and techniques of biotechnology.

Group B: Laboratory note book and Viva voce (2+3=5 marks)

Periodically updated laboratory note-book to be submitted and Viva-voce mostly covering the practical syllabus.

ZOO-DC-MJ-703: Internal Assessment (Full marks = 25*)
(*To be done in the Concerned College)

Suggested Readings

1. Molecular Biology and Biotechnology, Ralph Rapley; 7th edn., The Royal Society of Chemistry.
2. An Introduction to Genetic Engineering, Desmond S. T. Nicholl; 4th edn., Cambridge University Press.
3. Handbook of Molecular Biotechnology, Dongyou Liu; 1st edn., CRC Press.
4. Molecular Biology and Biotechnology, John M Walker and Ralph Raply; 5th edn., Royal Society of Chemistry.
5. Gene Cloning And DNA Analysis An Introduction, T. A. Brown; 8th edn., John Wiley & Sons Ltd.
6. Laboratory Manual for Biotechnology and Laboratory Science: The Basics, Lisa A. Seidman, Mary Ellen Kraus, Diana Lietzke Brandner and Jeanette Mowery; 1st edn., aylor& Francis Group, LLC.
7. Biotechnology, David P. Clark and Nanette J. Pazdernik; 1st edn., Elsevier Inc.

SEMESTER-VII	
Course Code:	**ZOO-DC-MJ-704**
Title of the Course:	**Research Methodology**
Credit = 4	
Theory: 30 marks, Practical: 20 marks, Internal Assessment: 25 marks	

a) Objective of the Course:

The objective of this study is to provide a strong foundation in scientific research methodology, enabling learners to understand the principles, design, and execution of research in biological and interdisciplinary sciences. It aims to develop skills in identifying research problems, formulating hypotheses, and selecting appropriate research designs and data collection methods. The course also emphasizes academic writing, ethical considerations, and intellectual property rights to ensure responsible and credible research practices. Additionally, it introduces essential biophysical tools and techniques used in scientific investigation, enhancing the learner's ability to analyze and interpret experimental data. Overall, the study is designed to build critical thinking, analytical abilities, and ethical awareness necessary for conducting high-quality research.

b) Learning Outcomes of the Course and Its Future Relevance:

After completing this course, learners will be able to:

- Understand the meaning, objectives, and types of scientific research. Differentiate between analytical and descriptive, qualitative and quantitative, and basic and applied research.
- Identify research problems and formulate hypotheses effectively. Design a research plan with appropriate structure and methodology.
- Select suitable experimental and sampling designs for research studies. Apply various methods of primary data collection such as observation, interviews, and questionnaires. Evaluate and utilize secondary data sources appropriately.
- Develop skills in academic writing and preparation of research reports. Understand and avoid plagiarism while maintaining academic integrity. Apply proper citation, referencing, and bibliography techniques.

- Gain basic knowledge of intellectual property rights, patents, and copyright laws.
- Explain principles and applications of biophysical tools like microscopes (light, SEM, TEM, fluorescence). Understand concepts such as resolving power, magnification, buffers, molarity, and normality.

Research methodology is a cornerstone of scientific advancement and innovation. The knowledge gained from this course is essential for pursuing higher education, research careers, and professional work in science and technology sectors. Understanding intellectual property rights and ethical guidelines is crucial in protecting innovations and ensuring responsible research conduct. Moreover, familiarity with modern research tools and techniques enhances employability and prepares students to contribute effectively to scientific discovery, policy development, and technological progress in the future.

ZOO-DC-MJ-704 (Theory = 30 marks)	
Research Methodology	
Module 1: Fundamentals of Scientific Research	
Unit-1	**Foundations of Research**
	Meaning, Objectives, Motivation. Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied.
Unit-2	**Research Design**
	Need for research design – Features of good design, Important concepts related to good design.
Unit-3	**Developing a research plan**
	Problem identification, Experimentation, Determining experimental and sample designs.
Unit-4	**Methods of Data collection**
	Collection of primary data: Observation method, Interview method, Questionnaire method; Collection of secondary data; Selection of appropriate method for data collection.
Module 2: Research Ethics and Intellectual Property Rights	
Unit-5	**Information Retrieval and Academic Writing**
	Searching research articles from different databases. Different steps in writing report. Plagiarism. Basic idea on Citation, Reference, and Bibliography.

Unit-6	**Intellectual property and Bio-ethics**
	Intellectual Property Rights, Patent law, Commercialization, Copyright, Royalty. Animal ethics committee.
Module 3: Tools and techniques	
Unit-7	**Biophysical Methods**
	i) Microscope: Resolving Power, Limit of Resolution and Magnification, Numerical Aperture. ii) Working principle and applications: Light microscopes, phase contrast microscope, SEM, TEM, Fluorescence microscope. iii) Concept of Buffer, Normality and Molarity.
Module 4: ZOO-DC-MJ-704 (Practical = 20 Marks)	
Group A: Laboratory experimentation (= 15 marks)	
1. Preparation of buffer (PBS, Acetate buffer, Ammonium buffer). 2. Presentation of data by table/charts. 3. Determination of Normality and Molarity. 4. Handling of different types of microscope. 5. Identify the sign and scales of hazardous chemicals and their relevance. 6. Submission of report on Research Laboratory visit/ Research proposal/ collection and presentation of data using questionnaire method (Minimum sample size 30).	
Group B: Laboratory note book and Viva voce (2+3=5 marks)	
Periodically updated laboratory note-book to be submitted and Viva-voce mostly covering the practical syllabus.	
ZOO-DC-MJ-704: Internal Assessment (Full marks = 25*) (*To be done in the Concerned College)	

Suggested Readings

1. Scientific Research and Methodology An Introduction to Quantitative Research and Statistics, Peter K. Dunn; 1st edn., CRC Press.
2. Research Methodology Methods & Techniques, C. R. Kothari; 2nd edn., New Age International (P) Ltd.
3. Handbook of Research Methodology A Compendium for Scholars & Researchers, Shanti Bhushan Mishra and Shashi Alok; 1st edn., Educreation Publishing.
7. Scientific Research Methodology: Principles, Tools, and Techniques, Sanjeev Singh Yadav & Shivani Gupta & Atul Kumar Choudhary; 1st edn., CRC Press.
4. Research Methodology for Beginner, Tripti Sahu; 1st edn., Himalaya Publishing House Pvt. Ltd.

SEMESTER-VIII	
Course Code:	**ZOO-DC-MJ-801**
Title of the Course:	**Advanced Molecular Biology**
Credit = 4	
Theory: 30 marks, Practical: 20 marks, Internal Assessment: 25 marks	

a) Objective of the Course:

The objective of this study is to develop a comprehensive understanding of genome organization, DNA replication, and the molecular mechanisms of gene expression and regulation in eukaryotes. It aims to familiarize learners with the structure and function of RNA, transcriptional and translational processes, and post-transcriptional modifications. The course also focuses on regulatory mechanisms, epigenetics, and developmental genetics, along with the molecular basis of aging and related diseases, to build a strong foundation in advanced molecular biology.

b) Learning Outcomes of the Course and Its Future Relevance:

After completing this course, learners will be able to:

- Describe the organization and packaging of the eukaryotic genome. Explain gene structure, gene families, pseudogenes, and repetitive DNA elements. Interpret concepts like C-value paradox, Cot curve, and DNA stability.
- Understand the structure and role of transposable elements in genome evolution.
- Explain the mechanism and regulation of eukaryotic DNA replication, transcription, and translation.
- Explain post-transcriptional modifications such as splicing, RNA editing, and RNA interference. Also describe the process of post-translational modifications.
- Understand genetic control of development, especially in *Drosophila*.
- Explain the molecular and cellular basis of aging and senescence. Relate gene expression regulation to development, disease, and evolution.

Understanding genome organization and gene regulation is fundamental to modern biology, biotechnology, and medicine. This knowledge is crucial in fields such as genomics, genetic

engineering, and personalized medicine, where insights into gene expression and regulation help in disease diagnosis, treatment, and prevention. Epigenetics and RNA-based regulation are rapidly advancing areas with applications in cancer therapy and developmental biology. Additionally, studying aging and related diseases provides opportunities for developing anti-aging strategies and improving healthcare. With the increasing importance of molecular biology in research and industry, this course prepares students for careers in biomedical research, pharmaceuticals, and biotechnology innovation.

ZOO-DC-MJ-801 (Theory = 30 marks)	
Advanced Molecular Biology	
Module 1: The Genome	
Unit-1	**Organization of eukaryotic genome**
	Packaging of the eukaryotic DNA into chromosome; Gene organization (number, distribution and spacing), Gene families; Pseudogenes; C-value, C-value paradox, unique and repetitive DNA, satellite DNA, mini- and micro-satellite DNA, coding and non-coding DNA, significance of non-coding DNA, DNA renaturation kinetics: C_0t curve, C_0t value, DNA melting temperature and factors affecting DNA stability. Mobile Elements: Basic idea of transposable elements, transposable element in maize and retrotransposons, jumping gene concept, role of transposable elements in genome evolution.
Unit-2	**Eukaryotic DNA Replication**
	Initiation (ARS, ORC, pre-RC, Licensing); Elongation (role of Pol δ and Pol ε); DNA end-replication problem and its resolution; Role of telomerase in aging and cancer.
Module 2: Transcription and Translation	
Unit-3	**The structure and versatility of RNA**
	RNA folding; Tertiary structures; Nucleotide substitution; Short noncoding RNAs; Long noncoding RNAs; Ribozymes.
Unit-4	**Eukaryotic transcription**
	Multiple forms of Eukaryotic RNA Polymerase, roles of three RNA Polymerases (Class I, II and III), Promoters (Class I, II and III), Enhancers and Silencers, General Transcription Factors in Eukaryotes (Class I, II and III), Regulation of Transcription Factors, Mechanism of Transcription by RNA - pol I, -pol II, -pol III.

Unit-5	**Post-transcriptional modifications**
	Ribosomal RNA processing; Transfer RNA processing; Trans-splicing; Alternative splicing, Self-splicing (Ribozymes); RNA editing; Post-Transcriptional Control of Gene Expression (RNAi, siRNA, microRNA).
Unit-6	**Eukaryotic Translation**
	Mechanism of eukaryotic translation; translational inhibitors, Post-translational modifications (Folding Nascent Proteins, Protein splicing)
Module 3: Regulation of gene expression	
Unit-7	**Regulation of transcription**
	Cis-acting regulatory elements and *trans*-acting regulatory protein, Histone modification, DNA methylation and Epigenetic regulation of gene expression.
Unit-8	**Regulation of gene expression and development in eukaryotes**
	Genetic control of development in *Drosophila*: Imaginal discs and development, Homeotic mutation and Morphogenesis of *Drosophila*. Aging and Senescence: Introduction, Theories, Cellular and Molecular basis of aging, Physiological changes, Aging related diseases, Anti-aging strategies.
Module 4: ZOO-DC-MJ-801 (Practical = 20 Marks)	
Group A: Laboratory experimentation (= 15 marks)	
1. Presentation and submission of writeup. 2. Isolation and quantification of genomic DNA/RNA using spectrophotometer (A_{260}) or diphenyl method. 3. Determination of protein contamination in DNA/RNA preparation (A_{260}/A_{280} ratio). 4. Extraction and electrophoresis of RNA using agarose gel. 5. Extraction and electrophoresis of protein using SDS-PAGE. 6. Relationship between C_0t value and genome complexity. 7. Plot of percentage reassociation verses log(C_0t). 8. Pictorial study of different mutations in *Drosophila*. 9. DNA footprinting.	
Group B: Laboratory note book and Viva voce (2+3=5 marks)	
Periodically updated laboratory note-book to be submitted and Viva-voce mostly covering the practical syllabus.	
ZOO-DC-MJ-801: Internal Assessment (Full marks = 25*) (*To be done in the Concerned College)	

Suggested Readings

1. Molecular Biology by David P. Clark, Nanette J. Pazdernik, Michelle R. McGehee.
2. Molecular Biology by Robert Franklin Weaver.
3. Molecular Biology of the Gene by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine.
4. Molecular Biology: Genes to Proteins by Burton E. Tropp.
5. Molecular Biology: Principles of Genome Function by Nancy Craig, Rachel Green, Carol Greider, Gisela Storz, Cynthia Wolberger, Orna Cohen-Fix.
6. Molecular Biology: Principles and Practice by Michael M. Cox, Michael O'Donnell, Jennifer Doudna.
7. Molecular Biology Structure and Dynamics of Genomes and Proteomes by Jordanka Zlatanova, Kensal E. Van Holde.
8. Fundamental Molecular Biology by Lizabeth A. Allison.
9. Advanced Molecular Biology by Richard Twyman.
10. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology by Andreas Hofmann and Samuel Clokie.

SEMESTER-VIII	
Course Code:	**ZOO-DC-MJ-802**
Title of the Course:	**Aquaculture**
Credit = 4	
Theory: 30 marks, Practical: 20 marks, Internal Assessment: 25 marks	

a) Objective of the Course:

The objective of this study is to provide fundamental and applied knowledge of aquaculture, including fish biology, culture systems, nutrition, and health management. It aims to develop an understanding of sustainable aquaculture practices, water quality management, and modern culture techniques such as biofloc and aquaponics. The course also focuses on aquarium fish keeping, capture fisheries, fish pathology, and breeding techniques in prawns and shrimps, preparing learners for scientific and practical applications in fisheries and aquaculture.

b) Learning Outcomes of the Course and Its Future Relevance:

After completing this course, learners will be able to:

- Understand the basics of inland and marine fisheries. Identify qualities of cultivable fish and differentiate between indigenous and exotic species. Explain different aquaculture systems such as extensive, semi-intensive, and intensive culture.
- Learn prawn culture practices. Explain modern aquaculture techniques like cage culture, pen culture, raceways, aquaponics, and biofloc systems.
- Identify common aquarium fish species and their characteristics. Develop basic skills in aquarium fish keeping and management.
- Gain knowledge on fish nutritional requirements and feed formulation. Describe capture fisheries, fishing gears, fish transport, and marketing.
- Identify common diseases in finfish and prawns along with their control measures. Understand breeding techniques such as eyestalk ablation and salinity shock.

Aquaculture is one of the fastest-growing food production sectors, playing a crucial role in food security, nutrition, and livelihood generation. The knowledge gained from this study is

highly relevant for sustainable fish farming, especially in countries like India where fisheries contribute significantly to the economy. Modern techniques such as biofloc and aquaponics promote environmentally friendly and resource-efficient production systems. Understanding fish health management and breeding techniques helps reduce losses and improve productivity. Additionally, skills in aquarium fish keeping, fish marketing, and value-added products open opportunities for entrepreneurship. With increasing demand for aquatic products and sustainable practices, this field offers vast career prospects in research, industry, and aquaculture development.

ZOO-DC-MJ-802 (Theory = 30 marks)	
Aquaculture	
Module 1: Fundamentals of Aquaculture	
Unit-1	**Introduction to Fish Biology**
	(i) Basic idea on Inland and Marine fisheries (ii) Qualities of Cultivable fish (iii) Indigenous and Exotic fish.
Unit-2	**Sustainable Aquaculture System**
	(i) Culture Systems: Extensive, Semi-intensive, Intensive (ii) Monoculture and Polyculture (iii) Water quality in culture ponds and factors controlling water quality (iv) Prawn Culture (Basic idea on Freshwater prawn, Culture of *Penaeus monodon*) (v) Cage Culture, Pen Culture, Raceways (vi) Aquaponics, Biofloc.
Module 2: Advances in Aquaculture and Fishery Practices	
Unit-3	**Aquarium Fish Keeping, Nutrition, and Capture Fisheries**
	Introduction to Aquarium Fish Keeping: (i) exotic and endemic species of aquarium fishes, preparation and management of fish aquarium (ii) Common character and sexual dimorphism of fresh water and marine aquarium fishes such as Guppy, Molly, Swordtail, Goldfish, Butterfly fish and Clownfish. Fish Nutritional Requirements: Feed formulations and preparation of compound diets, aquarium fish as larval predator, Use of live fish feed organisms. Capture Fishery: Fishing crafts and gears, fish transport and marketing, fish by-products.
Module 3: Fish Pathology and Applied Aquaculture	
Unit-4	**Fin Fish and Prawn pathology**

	Fin Fish: Causative agents, symptoms, and control measures of (i) Bacterial diseases: Dropsy, Fin and Tail rot (ii) Protozoan disease: White Spot Disease, Boil disease (iii) Fungal diseases: Gill rot, Saprolegniasis (iv) Ectoparasitic infection: Gyrodactylosis, fish lice (v) Viral disease: Rhabdovirus. **Prawn**: Causative agents, symptoms, and control measures of (i) Bacterial: Black spot disease (ii) Fungal disease: Black gill disease (iii) Viral disease: White Spot Syndrome.
Unit-5	**Breeding Techniques in Shrimps and Prawns**
	Eyestalk ablation in shrimp and Salinity shock in prawns.

Module 4: ZOO-DC-MJ-802 (Practical = 20 Marks)

Group A: Laboratory experimentation (= 15 marks)

1. Identification of fish and prawn: *Labeo rohita, Labeo calbasu, Labeo bata, Cirrhinus mrigala, Catla catla, Mugil parsia, Tenualosa ilisha, Pampus argenteus, Oreochromis niloticus, Cyprinus carpio, Mystus vittatus, Ompok pabo, Cirrhinus reba, Clarias batrachus*, *Heteropneustes fossilis, Penaeus monodon, Macrobrachium rosenbergii.*
2. Identification of aquarium fish: Guppy, Molly, Swordtail, Goldfish, Butterfly fish and Clownfish.
3. Identification of fish disease & prawn disease: Dropsy, Fin and Tail rot, Gill rot, Saprolegniasis, fish lice; Black spot disease, Black gill disease, White Spot Syndrome in prawn.
4. Visit to **any** aquaculture farm/ survey of any local fish market/ study of any natural waterbody and prepare a report on it. [Report should contain: Introduction, Materials and methods, Data analysis (when applicable), Conclusion, geotag pictures]

Group B: Laboratory note book and Viva voce (2+3=5 marks)

Periodically updated laboratory note-book to be submitted and Viva-voce mostly covering the practical syllabus.

ZOO-DC-MJ-802: Internal Assessment (Full marks = 25*)
(*To be done in the Concerned College)

Suggested Readings

1. Chaudhuri,S. (2017) Economic Zoology, NCBS.
2. Sarkar, S.,Kundu,G. Chaki,K.C. (2017) Introduction to Economic Zoology. NCBA
3. Khanna, S.S. and Singh, H.R. (2017) A Text Book of Fish Biology and Fisheries. Narendra Publishing House.
4. Menon, A.G.K. (1999) the Freshwater Fishes of India, A Handbook. Z.S.I

5. Das, M.K. and Das, R.K. (1997) Fish and Prawn Diseases in India- Diagnosis and Control. Inland Fisheries Society in India, Barrackpore, West Bengal.

6. Jhingran, V.G. (2007) Hindustan Publishing Corporation. 3rd Edition.

7. Pillai, T.V.R. and Kutty. (2007) Fishing News Book. 2nd Edition.

8. Lutz. C.G. Practical Genetics for Aquaculture. Fishing News Book. Oxford.

9. Govindan,T.K.(2008) Fish Processing Technology.Oxford and IBH Publishing Co. Pvt. Ltd. Kolkata.

10. Dunham, R.A. (1985) Aquaculture and Fisheries Biotechnology. Genetic Approaches. CABI.

11. Pierre Boundry, Andy Beaumont, Kathryn Hoare. (2010) Biotechnology and Genetics in Fisheries and Aquaculture. Wiley Blackwell.

12. Das,S. (2022) Aquarium Fishery.

13. Srivastava, C. B. L. (1999). Fish Biology. Narendra Publishing House. New Delhi.

SEMESTER-VIII	
Course Code:	**ZOO-DC-MJ-803**
Title of the Course:	**Biology of Insects**
Credit = 4	
Theory: 30 marks, Practical: 20 marks, Internal Assessment: 25 marks	

a) Objective of the Course:

The objective of this study is to provide a fundamental understanding of insect biology, classification, morphology, and physiology. It aims to familiarize learners with the structural and functional aspects of insects, including their adaptation, development, and ecological success. The course also focuses on the economic importance of insects, particularly their role as vectors of diseases and as pollinators, thereby building a strong foundation in both basic and applied entomology.

b) Learning Outcomes of the Course and Its Future Relevance:

After completing this course, learners will be able to:

- Describe the general characteristics, diversity, distribution and evolutionary success of insects.
- Describe external morphology including head structures, antennae, mouthparts, wings, and legs. Explain the structure and function of insect cuticle.
- Understand the anatomy and physiology of major insect systems such as respiratory, digestive, and excretory systems.
- Describe insect sensory systems including photoreceptors and vision. Explain different types of metamorphosis and their hormonal control.
- Understand the role of semiochemicals in insect communication. Analyze the economic importance of insects as vectors of diseases. Describe the role of insects in pollination and ecosystem functioning.

Entomology plays a crucial role in agriculture, public health, and environmental management. Understanding insect biology and behavior is essential for controlling pest

populations, preventing vector-borne diseases, and improving crop productivity through pollination. With increasing concerns about food security and climate change, knowledge of insect ecology and integrated pest management is becoming increasingly important. Additionally, insects are gaining attention in fields such as biotechnology, forensic science, and sustainable food production. This course provides a strong foundation for careers in agriculture, pest control, environmental science, and research, contributing to sustainable development and human well-being.

ZOO-DC-MJ-803 (Theory = 30 marks)	
Biology of Insects	
Module 1: Fundamentals of Entomology	
Unit-1	**Introduction**
	(i) General features of insects, (ii) Distribution and success of insects on the earth.
Unit-2	**Insect Taxonomy**
	Basis of insect classification; classification of insects up to orders (Imms, 1957)
Module 2: Morphology and Physiology of Insects	
Unit-3	**General Morphology**
	External Features (i) Head: eyes, types of antennae, mouth parts and feeding habits, (ii) Cuticle: structure and function (iii) Thorax: wings and wing articulation, types of legs adapted to diverse habitat.
Unit-4	**General Anatomy and Physiology**
	(i) Structure and physiology of Insect body systems: respiratory (trachea, siphons), digestive, and excretory (ii) Photoreceptors: Types, structure and function, image formation in insect vision (iii) Metamorphosis: Types and neuroendocrine control (iv) Types of Semiochemicals in insects.
Module 3: Applied Entomology	
Unit-5	**Economic importance of Insects**
	(i) Insects as mechanical and biological vectors, (ii) brief discussion on houseflies and mosquitoes as important vectors (iii) role of insects in pollination.
ZOO-DC-MJ-803 (Practical = 20 marks)	
Group A: Laboratory experimentation (= 15 marks)	

1. Identification of different type of adult mosquitoes (*Anopheles* sp., *Culex* sp., *Aedes* sp.)
2. Study and documentation of life cycle of any one mosquito.
3. Study and identification of different kinds of antennae, legs and mouth parts of insects.
4. Mounting of mouth parts of *Periplaneta*.
5. Mounting of wings, spiracles and genitalia of insects.
6. Dissection of digestive system and nervous system of *Periplaneta*.
7. Study of life cycle of any three major insect pest and its damages.
8. Morphological studies of various castes of *Apis*, *Camponotus, Odontotermes.*
9. Collection, preservation, identification and submission of any three insect pests.

Group B: Laboratory note book and Viva voce (2+3=5 marks)

Periodically updated laboratory note-book to be submitted and Viva-voce mostly covering the practical syllabus.

ZOO-DC-MJ-803: Internal Assessment (Full marks = 25*)
(*To be done in the Concerned College)

Suggested Readings

1. Bernays, E.A. and Chapman, R.F. Host Selection by Phytophagous insects. Chapmanand Hall, New York, USA.
2. Bigness, Roisin and Lo. Biology of Termites: A Modern Synthesis. Springer.
3. Borror, D.J. Triplehorn, C.A. and Johmson N.F. Introduction to the Study of insects.Saunders College Publication, USA.
4. Chapman, R.F. The Insects: Structure and function. Cambridge University Press, UK.
5. Gullan, P.J. and Cranston, P.S. The Insects: An Outline of Entomology. Wiley Blackwell.
6. Hati, A.K. Medical Entomology. Allied Book Agency, Kolkata.
7. Imms, A.D. A General TextBook of Entomology. Chapman & Hall, UK.
8. Klowden, M.J. Physiological system in Insects. Academic Press, USA.
9. Lehane, M.J. The Biology of Blood Sucking Insects. 2nd Edn. Cambridge Univ. Press.
10. Nation, J.L. Insect Physiology and Biochemistry. CRC Press, USA.
11. Snodgrass, R.E. Principles of Insect Morphology. Cornell Univ. Press, USA.
12. Wilson, E.O. The Insect Societies. Harvard Univ. Press, UK.