

DEPARTMENT OF ZOOLOGY

Guidelines and Syllabus for M.Sc. in Zoology



DEPARTMENT OF ZOOLOGY
KAZI NAZRUL UNIVERSITY
ASANSOL
WEST BENGAL 713340

THE UNIVERSITY

KaziNazrul University was established under the West Bengal Act XIX of 2012. The Assent of the Governor was first published in the Kolkata Gazette Extraordinary 16th August 2012. Named after the rebel poet, KaziNazrulIslam(1899-1976) of India – who is also the national poet of Bangladesh – this university aims at achieving an ideal of creative freedom that marks the life of the mind and the intellectual traffic of ideas. The revolutionary poet, KaziNazrul, has been immortalised in Bengali cultural memory because of his acute thirst for a spirit of independence and his attentiveness to the syncretism that characterises knowledge traditions as well as transactions. This university has been established with the explicit aim of achieving this same syncretism of purpose and its allied commitment to the dream of a transformed future. The founding vision of KaziNazrul University is to function effectively as an institutional space encouraging and providing instruction, teaching, training and research in various branches of learning and courses of study – with a view to promoting advancement and dissemination of knowledge, and extending higher education to meet the immediate needs of society. While teaching activities are the mainstay of any higher educational institution, KNU has been modelled after the Humboldtian fashion of a research university – with specific emphasis on the need for knowledge production alongside processes of dissemination. There have been notable endeavours within the university to set up centres for advanced interdisciplinary exchange and intensive research collaboration, apart from rigorous daily routines of classroom instruction.

For a long time there has been a demand for a university in this area. The setting up of KaziNazrul University was primarily intended at responding to these local-material needs of democratizing higher education, outside of urban-metropolitan centres of cultural dominance. Professor AnuradhaMukhopadhyay, the first Vice Chancellor, assumed office on 3rd December, 2012 at the Asansol Durgapur Development Authority (ADDA) building. On 10th January 2013, the Hon'ble Chief Minister of West Bengal Smt. MamataBandopadhyay laid the foundation stone of KaziNazrul University on its own campus –close to the birthplace of KaziNazrul Islam at Churulia, 31 kilometres away from the city of Asansol. Aligned with its original goal of spreading the reach of higher education along hitherto-neglected vectors of geographical development, the University has been established to promote teaching and advanced research in Asansol and its adjoining areas in the district of PaschimBardhaman.

In July 2013, the University inaugurated its teaching programmes by commencing postgraduation classes in four core disciplines – Bengali, English, History and Mathematics – with about one hundred and twenty students. In the academic session 2014-15 four new Postgraduate courses, including M.A in Education, Hindi, Political Science & M.Com., had been introduced. Professor SadhanChakraborti joined as the Vice-Chancellor of KaziNazrul University in April 2015. Over time, 17 PG departments have started functioning with all necessary infrastructures on the campus of the university, and with an actual intake of 1269 students in the academic year 2018-19. Most of these departments have gone on to introduce full-time M.Phil. and Ph.D. programmes, in complete accordance with UGC guidelines. A total of 20 colleges from adjoining areas are affiliated to the university, with an actual intake of 14,833 students at the undergraduate level in the academic year 2018-19. While a large number of students enrolled at the university departments as well as in its affiliated colleges are first-generation learners, an astounding 66 percent of the total student strength comprises women. It is also noteworthy that KNU's commitment to cultural and demographic diversity reflects in its efforts at extending the benefits of higher education to minority communities and those from socially deprived backgrounds.

Situated in the Damodar River valley, historically enveloped amidst a setting of coal mines and industries in the city of Asansol, KaziNazrul University has been envisioned as more than a source of general education for building careers in the Humanities, General Science, Commerce and Law.

Heeding the policy need for embedding tertiary education within local contexts and conditions for development, the University has recently introduced two engineering departments in Mining and Metallurgy with opportunities of hands-on training in the vicinity. KNU thus represents an effective and significant investment in students' potential development in the context of targets set by the Ministry of Higher Education, Government of West Bengal. The Nazrul Centre for Social and Cultural Studies, an advanced research centre pledged to the principle of conscientious and socially translatable scholarship, has been established in the University and research collaborations have been initiated with renowned institutions of Bangladesh. With generous support from the Hon'ble Chief Minister of West Bengal, this centre is pursuing crucial research on the life and work of Nazrul and will soon publish some very significant scholarship by acclaimed researchers. In this, KNU is proud to be seen as an agent of deep cultural and diplomatic alliances across borders.

DEPARTMENT OF ZOOLOGY

The Department established in the academic year 2015-16, aims to bridge the gap between the theoretical concepts with practically applied domains of Zoology. Zoology was one of the subjects in which Post-graduate teaching was initiated soon after the foundation of the University. Teaching at M. Sc. Level commenced in 2015. The two year M.Sc. (Applied Zoology) programme taught by competent faculty. The department is temporarily located at the Banwarilal Bhalotia College & Triveni Devi Bhalotia College & Head of the department Dr. Asamanja Chatteraj. The Department offers specialization in Entomology & Aquaculture – Fisheries.

PROGRAMMES OFFERED IN THE DEPARTMENT

➤ M.Sc. in Zoology

MISSION

- To pursue student-centred teaching methods and to motivate students to engage themselves in the pursuit of truth joyfully
- To develop criticality of outlook and insight, in order to push at the boundaries of knowledge and expand one's understanding of the world
- To develop a collaborative research climate, so that students and teachers can participate in research activities in partnership with other reputed national/international research institutes or universities, and can contribute significantly to research output
- To facilitate Higher education & research in zoology.
- To provide opportunities for professional and personal development through curricular and cocurricular activities.

VISION

KaziNazrul University (KNU), a fledgling institution of higher learning, aims at generating a special genre of citizens with a perfect blend of knowledge, criticality, skills and values that are indispensable for the future of democratic imagination at home and abroad. To develop as a globally recognized destination for teaching and researching in the context of indigenous cultural and value system resulting in the further strengthening of Zoology as an academic discipline to serve all the stake holders.

GOALS

- The department was started with the aim to train students to make Zoology more practically oriented and to apply the principles of Zoology to cater to the needs of the human welfare.
- To provide quality education offering skill based programs and motivate the students for self-employment in applied branches of Zoology.
- To provide quality education in a branch of Biological sciences i.e. Zoology with different specializations.
- To inculcate the value based education and entrepreneurial skills among the students.
- To inculcate the spirit of resource conservation and love for nature.
- To conduct field studies and different projects of local and global interests.

COURSE DESCRIPTION

The M.Sc. Zoology aims to train the students with theoretical knowledge and practical skills of Zoology. Each year of the course has two semesters numbered in succession from one to four. The first three semesters offers common papers to all the students enrolled from M.Sc. applied Zoology that aims to equip students for the theoretical and practical aspects of general understanding of Zoology in its totality. During fourth semesters the students are opted to choose one of the two specializations namely ENTOMOLOGY and AQUACULTURE – FISHERIES. The specialization courses intend to train students in the different areas from both theoretical and practical application to the respective fields. Therefore, the specializations have internship as well as dissertations that equip both practice of the specialized field as well as researching in the area of specialization. The course is designed in such way that students are trained in the overall spectrum of specialization along with the background preparation.

Core papers in the first three semesters comprising of papers, which can be considered to be fundamental in imparting a larger perspective of Zoology for its theoretical and practical foundation. At the end of the first year and third semester students are allowed to take an internship in their interested field to facilitate them to choose their specializations.

The fourth semester aims at training students in the chosen specialization papers namely, ENTOMOLOGY and AQUACULTURE – FISHERIES with the on field exposure through an project work / term paper. The specialization is prepared in such a manner that students can relish the knowledge of both practice and research by way of internship and dissertation work after the completion of MSc.

COURSE OBJECTIVES

The course is developed as a rigorous two-year programme with extensive theoretical knowledge and widespread practical experience to acquire the necessary skills in the area of Zoology.

The specific learning goals for General Zoology are to provide students with a working knowledge of fundamental principles in zoology that will provide a foundation for their later advanced course work in more specific biological subjects. Understand the animal behavior. Provide inexpensive educational services, inspire to all the section of society to get expertise /skills above P.G. level in biological sciences. To develop research aptitude and a scientific advancement. Provide a broad range of Transform society through the empowerment of youth.

COURSE REGULATIONS (2016-17)

SEMESTER	COURSE	CODE	CREDIT	SEM CREDIT	TOTAL MARKS	SEM MARKS
I	Biosystematics and Taxonomy ; Evolution and Population Genetics	MSCZOOLC101	4	24	40+10 =50	300
	Comparative Anatomy ; Histology and Histochemistry	MSCZOOLC102	4		40+10 =50	
	Fundamentals of Biochemistry ; Metabolism	MSCZOOLC103	4		40+10 =50	
	Cell Biology and Genetics	MSCZOOLC104	4		40+10 =50	
	Practical: Taxonomy, Anatomy, Histology and Histochemistry	MSCZOOLC105	4		40+10 =50	
	Practical: Biochemistry, Cell Biology and Genetics	MSCZOOLC106	4		40+10 =50	
II	Ecology ; Behavioural Biology	MSCZOOLC201	4	24	40+10=50	300
	Physiology ; Endocrinology	MSCZOOLC202	4		40+10=50	
	Molecular Biology ; Immunology	MSCZOOLC203	4		40+10=50	
	Practical: Ecology, Physiology and Endocrinology	MSCZOOLC204	4		40+10=50	
	Practical: Molecular Biology and Immunology	MSCZOOLC205	2		20+5=25	
	Community Outreach	MSCZOOLC206	2		20+5=25	
	Choose from Pool of Minor Electives	MIE	4		40+10=50	
III	General Entomology ; Applied Entomology	MSCZOOLC301	4	24	40+10=50	300
	General Parasitology ; Medical Parasitology	MSCZOOLC302	4		40+10=50	
	Fish Biology ; Aquaculture	MSCZOOLC303	4		40+10=50	
	Toxicology ; Microbiology	MSCZOOLC304	4		40+10=50	
	Practical: Entomology and Parasitology	MSCZOOLC305	4		40+10=50	

	Practical: Fish Biology, Toxicology and Microbiology	MSCZOLC306	4		40+10=50	
IV	Developmental Biology ; Biostatistics and Computational Biology	MSCZOLC401	4	24	40+10=50	300
	Practical: Developmental Biology and Computational Biology	MSCZOLC402	2		20+5=25	
	Entomology -I	MSCZOOLMJE401	4		40+10=50	
	Aquaculture and Fisheries -I	MSCZOOLMJE402	4		40+10=50	
	Entomology - II	MSCZOOLMJE403	4		40+10=50	
	Aquaculture and Fisheries-II	MSCZOOLMJE404	4		40+10=50	
	Entomology - III	MSCZOOLMJE405	4		40+10=50	
	Aquaculture and Fisheries-III	MSCZOOLMJE406	4		40+10=50	
	Term Paper / Project Work	MSCZOOLMJE407	2		25	
	Major Elective Practical	MSCZOOLMJE408	4		40+10=50	

FIRST SEMESTER

Course Code	CODE	Credits
Biosystematics and Taxonomy ; Evolution and Population Genetics	MSCZOOLC101	4
Comparative Anatomy ; Histology and Histochemistry	MSCZOOLC102	4
Fundamentals of Biochemistry ; Metabolism	MSCZOOLC103	4
Cell Biology and Genetics	MSCZOOLC104	4
Practical: Taxonomy, Anatomy, Histology and Histochemistry	MSCZOOLC105	4
Practical: Biochemistry, Cell Biology and Genetics	MSCZOOLC106	4

MSCZOOLC101: Biosystematics and Taxonomy; Evolution and Population Genetics

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand-

The fundamental questions and knowledge of Animal taxonomy & evolutionary biology

Explore the ways in which Zoologists go about studying these questions.

Explain the relationship between theories of biosystematics and evolution & research application in this field.

Unit – I: BIOSYSTEMATICS AND TAXONOMY

Taxonomy

History and Importance

General concepts

Micro- and Macro-taxonomy

Levels of taxonomic study

Concepts of species

Types –Typological, Biological and Evolutionary

Kinds of species, Taxonomic types

Hierarchy

New trends in taxonomy

Biochemical, Cytological & Molecular

Zoological nomenclature

Nomenclature

Rules of

Unit –II: EVOLUTION AND POPULATION GENETICS

Population Genetics

Molecular Population genetics

Neutral theory

Molecular evolution and Phylogenetics

Variation and Evolution

Genetic variation in population (Morphological, Chromosomal and Biochemical)

Quantification of genetic variation in populations

Quantitative genetics

Hardy–Weinberg equilibrium – Testing population samples

Factors affecting Hardy – Weinberg equilibrium

Evolution

Natural Selection

Darwinian fitness

Genetic burden or load

Polymorphism and balancing Natural Selection

Diversifying natural selection with examples.

Macro and Micro evolution

Evolutionary pattern and rate

Isolating mechanisms and speciation

Suggested readings:

- Barton, N.H., Briggs, D.E.G., Eisen, J.A., Goldstein, D.B. & Patel, N.H. (2007). Evolution. CSHL Press.
- Brooker. (2001). Genetics. McGraw-Hill.
- Dobzhansky, T., Ayala, F. J., Stebbins, G. L. & Valentine, J. W. (1977). Evolution. Surjeet Publications, New Delhi.
- Futuyama, D. (1997). Evolutionary Biology. 3rd ed. Sinauer Associates, INC.
- Futuyama, D. (2005). Evolution. Sinauer Associates, INC.
- Hall, B. K., Hallgrimson, B. (2008). Strickberger's Evolution. 4th ed. Jones and Bartlett.
- Hartl, D. L. (2005) Principles of Population Genetics. 4th ed. Sinauer Associates.
- Minkoff, D. (1983). Evolutionary Biology. 3rd ed. Sinauer Associates, INC.
- Page, R. D. M. & Holmes, E. C. (1998). Molecular Evolution: A Phylogenetic Approach Blackwell Science Ltd (2nd Reprint, 2001).
- Ridley, M. (1996). Evolution. 2nd ed. Blackwell Science Ltd.
- Savage, J. M. (1969). Evolution. 2nd ed. NY, Holt.
- Stansfield, W. D. (2001). Principles of Genetics. (5th ed.). Tata McGraw-Hill. Publ. Co.
- Stearns, S. C. & Hoeskstra, R. F. (2005). Evolution. Blackwell Science Ltd.
- Stebbins, G. L. (1969). Process of Evolution. Tata McGraw-Hill.
- Volpe, E. P. & Rossenbaum, P. A. (1999). Evolution. Mc-Graw Hill Science Engineering.

MSCZOOLC102: Comparative Anatomy ; Histology and Histochemistry

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand-

- Detail anatomical organization of important biological systems of Invertebrates & Vertebrates.
- Theoretical & practical application of histology & histochemistry in the field of Zoology.
- Explore the ways in which Zoologists go about studying the questions from Anatomy, histology & histochemistry.

Unit – I: COMPARATIVE ANATOMY

Comparative study of invertebrates

Digestive system
Nervous system
Reproduction and Larval forms

Comparative study of vertebrates

Stomach
Respiratory system
Brain and sense organs

Thyroid and Adrenal glands

Development, uses and comparative account in vertebrates

The integument and its derivatives (except glands)

Unit –II: HISTOLOGY AND HISTOCHEMISTRY

Fixation and related procedures

Types of fixation, Fixation process; fixation of whole tissue;
Fresh-frozen sections; Decalcification

Embedding

Gum-sucrose/gelatin and paraffin wax embedding

Microtomy

Methods, problems and remedies of microtomy including cryostat and freezing microtome

Structure and function

Tongue, Intestine and Thymus

Biological dyes and stains

Properties, source and use of haematoxylin, eosin and carmine

Theoretical basis and application of following histochemical methods:

PAS/AB test for carbohydrates

Fuelgen reaction for DNA

Metallic and Azo dye methods for alkaline and acid phosphatase, adenosine tri- phosphatase.

Suggested readings:

Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd ed. Oxford University Press.

Barnes, R. D. & Ruppert, E. E., (1996). Invertebrate Zoology. 6th ed. Brooks Cole.

Ruppert, E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. 7th ed. Brooks Cole.

Barrington, E. J. W. (1981). Invertebrate Structure and function. 2nd ed. ELBS & Nelson.

Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th ed. Sinauer Associates.

Hildebrand, M. (1995). Analysis of Vertebrate Structure. John Wiley & Sons.

Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.

Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th ed. McGraw Hill.

Meglitsch, P. A. & Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press.

Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill.

Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th ed. Saunders College Publishing.

Weichert, C. K. & Presch, W. (1984). Elements of Chordate Anatomy. Tata-McGraw Hill Pub. Comp.

MSCZOOLC103: Fundamentals of Biochemistry; Metabolism

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand-

- To demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways, and the regulation of biological/biochemical processes.
- Explain/describe the synthesis of proteins, lipids, nucleic acids, and carbohydrates and their role in metabolic pathways along with their regulation at the epigenetic, transcriptional, translational, and post-translational levels including RNA and protein folding, modification, and degradation.

Unit – I: FUNDAMENTALS OF BIOCHEMISTRY

Bioenergetics

Laws of thermodynamics and its relevance to biological systems.
High-energy phosphate bonds and its role in energy capture and transfer

Proteins

Amino acid structure of protein
Primary and higher orders of protein
Protein folding
Nitrogenase system

Enzymes

Classification and general properties
Kinetics
Mechanisms of enzyme action (chymotrypsin)
Regulation of enzyme activities.

Carbohydrates

Carbohydrates of physiologic significance

Lipids

Lipids of physiologic significance, membrane lipids, cholesterol

General topics

Pumps and membrane channels

Unit –II: METABOLISM

1. Overview of metabolism and metabolic fuels
2. Enzymes: Catalytic & regulatory strategies
3. Glycolysis & Krebs cycle: Pathway & regulation
4. Oxidative metabolism: electron transport chain, oxidative phosphorylation
5. Metabolism of Glycogen
6. Gluconeogenesis, control of blood sugar
7. Hexose monophosphate Shunt
8. Synthesis and Oxidation of fatty acids: Ketogenesis
9. Catabolism of proteins and amino acids
10. Metabolic strategies & integration of metabolic pathways

Suggested readings:

Berg, J. M., Tymoczko, J. K. & Stryer, L. (2007). Biochemistry. 6th ed. W. H. Freeman & Company.
Devlin, T. M. (Ed.). (2002). Textbook of Biochemistry with clinical correlations. 5 ed. Wiley-Liss.
Haynie, D. T. (1998) Biological Thermodynamics. Cambridge University Press (South East Asian Reprint 2007)
Mathews, C. K., Van Holde, K. E. & Ahern K. G. (2001). Biochemistry. 3 ed. Person Education.
Metzler, D. E. (2003). Biochemistry: The Chemical reactions of living cell.. Vol. 1 & 2. Academic Press.
Murray, R. K., Granner, P., Mayes A. & Rodwell, V. W. (2003). Harper's Illustrated Biochemistry. 25 ed. McGraw-Hill.
Nelson, D. L. & Cox. M. M. (2004). Lehninger's Principles of Biochemistry. 2nd ed., Macmillan Worth Publishers.
Switzer, R. L. & Garrity, L. F. (1999). Experimental Biochemistry. W. H. Freeman & Company.
Voet, D., Voet, J. G. & Pratt C. W. (1999). Fundamentals of Biochemistry. Upgrade edition. John Wiley & Sons.

MSCZOOLC104: Cell Biology and Genetics

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand

- The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- How these cellular components are used to generate and utilize energy in cells.
- Apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Unit – I: CELL BIOLOGY

Gene and the genome

Complexity of the genome: eukaryotic genome

C–value enigma. DNA reassociation kinetics, Cot curves, T_m values

Centromeric and telomeric DNA, Telomeric repeats and chromosome-end replication problem, rescue by telomerase

DNA replication in Eukaryotes

Components and mechanics

Cell cycle Kinetics

Labeling index and cell cycle duration measurement

Cell synchronization and cell cycle inhibitors

Cell-cell communication

Cell signaling molecules

Cell surface receptors and ion channels

Signal transduction pathways (DAG and cAMP)

Cell cycle deregulation and cancer

Hallmark features of cancer

Cancer critical genes and their role in tumourigenesis

Carcinogenesis-Two hit- model of Knudson and multi- hit model of Vogelstein

Cancer-Multifactorial disease

Hybridoma technology and its application in monoclonal antibody production

Cell and its environment

5L

Mutagens, clastogens, carcinogens and teratogens

Mutagenicity test protocols, mammalian *in vivo* and *in vitro* test protocols

Unit –II: GENETICS

Techniques in molecular genetics

Restriction endonuclease and cloning of genes;

Cloning vectors; production of recombinant DNA molecules;

Construction and screening of genomic and cDNA library; DNA sequencing;

PCR and RT PCR

Mutation

Molecular basis

Mutations in human

Cystic fibrosis

DNA repair and recombination

NER, PR, SOS, PRR and MMR

Recombination nodule

Cleavage and rejoining of DNA molecules

Gene conversion

Mitochondrial genome

Comparison between mt-genome and human genome;

mt-DNA and limited autonomy of mt-genome

Genomic imprinting

DNA methylation; genetic basis of human disease: Huntington's chorea

Human genome project

Methodologies

Suggested readings:

Alberts, B. et al. (2008). *Molecular Biology of the Cell*. 5th Ed. Garland Publishing House. Becker. (2009). *The World of the Cell*. 7th ed. Benjamin-Cummings. Brown, T. A. (2002). *Genomes 2*. Wiley-Liss. Clark, D. P. (2005). *Molecular Biology*. Elsevier. Cooper, G. M. (2004). *The Cell*. 3rd edn. ASM Press. Griffiths, A. J. F., Wessler, S. R., Lewontin, R. C. & Carroll, S. B. 2008. *Introduction to genetic analysis*. 9th ed. W. H. Freeman and Company, New York. Griffiths, A. J. F. (2002). *Modern Genetic Analysis: Integrating Genes and Genomics*, 2nded. W. H. Freeman and Company, New York. Hartl, D. L. & Jones, E. W. (1998). *Genetics, Principles and analysis*. (4th ed). Blackwell Scientific, Oxford. Hartl, D. L. & Jones, E. W. (2005). *Genetics: analysis of genes and genomes*. 6th ed. Jones and Bartlett Publishers, Sudbury, Mass. Hartl, D. L. & Jones, E. W. (2006). *Essential Genetics: a genomics perspective* (4th ed.). Jones and Bartlett Publishers, Boston. Hartwell et al. (2001) *Genetics: From genes to Genomes*. McGraw Hill Harvey, L. (2004). *Molecular cell Biology*. 5th ed. W.H.Freeman. Karp, G. (2008). *Cell and Molecular Biology: Concepts and experiments*. 5th edn., John Wiley. Kendrew, S. J. (Ed.) (1994). *The Encyclopedia of Molecular Biology*. Blackwell Science. Lewin, B. (2008). *Genes IX*. Jones & Bartlett Publishers.

Watson, J. D., Baker, T. A. & Bell, S. P. (2007). *Molecular Biology of the Gene*. 6th ed. Benjamin Cummings. Malacinski, G. M. (2003). *Essentials of Molecular Biology*. 4th ed. Jones & Bartlett. McConkey, H. (1993). *Human Genetics: The molecular Revolution*. Jones & Bartlett Publishers. Rob Phillips, Jane Kondev, Julie Theriot (2008). *Physical Biology of the Cell*. Garland Science. Snustad, D. P. & Simmons. M. J. (2004). *Principles of Genetics*. 4th ed. John Wiley and Sons. Stansfield, W. D. (1991). *Schaum's Outline Series: Theory & Problems of Genetics*. 3rd ed. McGraw-Hill. Strachan, T. & Read, A. P. (2004). *Human Molecular Genetics-3*. garland Science. Strickberger M.W. (1985). *Genetics*. 3rd ed, Prentice Hall of India Pvt. Ltd., New Delhi. Tamarin, R. H. (2004). *Principles of Genetics*. Tata McGraw-Hill Publishing Comp. Ltd. Twyman R.M. (2003). *Advanced Molecular Biology*. Viva Books. Vogel, F. & Motulsky, A. G. (1999). *Human Genetics*. Springer.

MSCZOOLC105: Practical: Taxonomy, Anatomy, Histology and Histochemistr

✧ **Full Marks: 50**

✧ **CA+ESE Marks: 30+20**

✧ **Credit: 4**

✧ **L - T - P : 0 - 0 - 8**

Learning Outcomes:

To enable the students to understand

- To bridge the gap between the theoretical concepts with practically applied domains of Taxonomy, Anatomy, Histology and Histochemistry

Unit – I: TAXONOMY

1. Identification of specimens of major animal phyla and/or classes using the key
2. Identification of specimens of major orders of class insecta using the key
3. Construction of key from the provided dataset
4. Retrieval of nucleotide sequences from data bases, sequence alignment
3. Laboratory note Book
4. Viva-voce

Unit –II: ANATOMY and HISTOLOGY & HISTOCHEMISTRY

1. ANATOMY
 - a. Afferent branchial system of Channa sp.
 - b. Ninth (IX) and tenth (X) cranial nervous system of Channa sp.
 - c. Digestive and nervous system of Vespa sp.
 - d. Nervous system of prawn
2. HISTOLOGY
 - a. Fixation, dehydration, embedding, section cutting, staining and mounting of different animal tissues. (Haematoxylin and Eosin, Mallory's Triple)
 - b. Identification of histological preparations of different animal tissues.
 - c. SEM demonstration
2. HISTOCHEMISTRY
Histochemical reactions for: Carbohydrates, Protein, Lipid, DNA/RNA and Alkaline phosphatases
3. Submission of permanent slides prepared for histological and histochemical studies of different tissues
4. Laboratory records
5. Viva-voce.

MSCZOOLC106: Practical: Biochemistry, Cell Biology and Genetics

✧ Full Marks: 50

✧ CA+ESE Marks: 30+20

✧ Credit: 4

✧ L - T - P : 0 - 0 - 8

Learning Outcomes:

To enable the students to understand

- To bridge the gap between the theoretical concepts with practically applied domains of Biochemistry, Cell Biology and Genetics

Unit – I: BIOCHEMISTRY

1. Biochemical estimation of protein (Lowry's method), DNA and RNA
2. Study of the enzyme kinetics
3. Study of the action of catalase, SOD and other enzymes
4. Separation of small molecules by dialysis
5. Desalting column chromatography (Gel Filtration)
6. TLC for separation of steroid and other secondary metabolites
7. Haemoglobin electrophoresis by cellulose acetate
8. Estimation of Lipid profile from blood
9. Biochemical detection of sugars by Osazone formation test
10. Separation of amino acids by paper chromatography
11. Laboratory note book
12. Viva-voce

Unit –II: CELL BIOLOGY & GENETICS

1. CELL BIOLOGY

- a. Preparation of meiotic chromosomes from the Grasshopper testes: Identification of stages
- b. Preparation of somatic chromosome (untreated and treated) from mouse/rat: Identification of chromosomes and determination of mitotic index
- c. Preparation of polytene chromosomes from Chironomid/*Drosophila*/mosquito larvae: Identification of various land marks
- d. Identification of slides on human chromosomal abnormalities and various genetic diseases

2. GENETICS

- a. Identification of mutants of *Drosophila*, setting up of genetic crosses (monohybrid, dihybrid, test crosses; Detection of lethal mutation
- b. Analysis of human pedigree and construction of pedigree chart
- c. Analysis of human karyotypes
- d. Isolation of DNA from *Drosophila*/mosquito/Rat/Goat (liver tissue)

3. Submission of prepared slides and Laboratory record.

4. Viva-voce

SECOND SEMESTER

Course Code	Code	Credits
Ecology ; Behavioral Biology	MSCZOLC201	4
Physiology ; Endocrinology	MSCZOLC202	4
Molecular Biology ; Immunology	MSCZOLC203	4
Practical: Ecology, Physiology and Endocrinology	MSCZOLC204	4
Practical: Molecular Biology and Immunology	MSCZOLC205	2
Community Outreach	MSCZOLC206	2
Choose from Pool of Minor Electives	MIE	4

MSCZOOLC201: Ecology; Behavioral Biology

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand

- The fundamental questions and knowledge of ecology & behavioral biology.
- Explore the ways in which students may acquire the knowledge to solve the inquisitive areas of ecology & behavioural biology.
- Analyze the relationship between theoretical & practical approach in the field of ecology & behavioral biology.

Unit – I: ECOLOGY

The concept of ecosystem, the Gaia Hypothesis, stability in the ecosystem, ecological habitat and niche

Factors of the environment

Concept of limiting factors

Biotic factors: effects of predators, parasites and symbionts

Abiotic factors: effects of temperature, moisture, light and fire

Population dynamics

Population attributes, growth forms, life tables,

Density-dependent and density-independent factors in the population regulation, interspecific competition and coexistence,

Communities and biodiversity

Community organization and structure, relative abundance, species diversity, diversity indices and ecosystem development

Ecoenergetics and biogeochemical cycles

Concepts of primary productivity and secondary production, food-chains and food webs, energy flow through trophic levels;

Global cycling of water, carbon and nitrogen

A brief survey of major Indian biomes

Tropical Rain Forests

Mangrove ecosystem

Environmental pollution

Sources and effects of primary and secondary air pollutants, acid rain, green house effects, water pollution and its control, anti-pollution laws

Conservation ecology

Conservation of natural resources and wildlife

in situ and *ex situ* conservations

Red Data Book

Conservation of wetlands

Unit –II: BEHAVIOURAL BIOLOGY

Ethology

Introduction to Ethology

Proximate and ultimate reasoning

Development of behavior

Social communication and dominance

Approaches and methods in study of behavior

Altruism and evolution-group selection, kin selection, reciprocal altruism

Learning

Neural basis of learning, memory, cognition, sleep and arousal

Biological clocks: Basic components, Functions and Regulations

Territoriality and foraging behaviour

Use of space and territoriality

Mating systems, parental investment and reproductive success

Parental care

Aggressive behavior

Habitat selection and optimality in foraging

Suggested readings

- Alcock, J. (2001). *Animal Behaviour: An Evolutionary Approach*. Sinauer Associates. Inc. USA.
- Begon, M., Harper, J. L. & Townsend, C. R. (2006). *Ecology: Individuals, Populations and communities*. 4th ed. Blackwell science. Chapman, R. L. and Reiss, M. J. (2000). *Ecology – Principles & Application*. Comb.
- Colinvaux, P. (1993). *Ecology 2*. John Wiley & Sons, Inc. New York, pp. 688.
- Cunningham, W. P. & Cunningham, M. A., (2007). *Principles of Environmental Science: Inquiry & Applications*. 4th ed. Tata McGraw-Hill Company.
- Danchin E., Giraldeau L. A., and Cezilly F. (2008). *Behavioural Ecology: An Evolutionary Perspective on Behaviour*. Oxford University Press, USA;
- Dash, M. C., (2001). *Fundamental of Ecology*. 2nd ed. Tata McGraw-Hill Company.
- Enger, E. D. & Smith, B. F. (2008). *Environmental Science: A study of Interrelationships*. 11th ed. McGraw-Hill Higher Education.
- Faurie, C., Ferra, C., Medori, P. & Devaux, J. (2001). *Ecology-Science and Practice*. Oxford & IBH Publishing Company Pvt. Ltd.
- Freedman, B. (1989). *Environmental Ecology*. Academic press, Inc., PP. 424.
- Gupta, I. J. & Mondal, D. K. (2005). *Red data Book (Part – 2): Butterflies of India*. ZSI.
- Kormondy, E. J. (2002). *Concepts of Ecology*. 4th Indian Reprint, Pearson Education.
- Krebs, C. J. (2001). *Ecology*. Benjamin Cummings.
- Leveque, C. (2003). *Ecology: from Ecosystem to Biosphere*. Science Publishers. Inc.
- Manning, A. & Dawkins, M.S. (1999). *Essentials of Animal Behaviour*. Cambridge Univ. Press.
- Mukherjee, B. (1996). *Environmental Biology*. Tata McGraw-Hill Publishing Comp. Ltd.
- Odum, E. P. & Barret, G. W. (2005). *Fundamentals of Ecology*. 5th ed. Thompson Brooks/Cole.
- Odum, E. P. (1971). *Fundamentals of Ecology*. W. O. Saunders company, Philadelphia, pp 574.
- Ricklefs, R. E. & Miller, G. L. (2000). *Ecology*. 4th ed. W. H. Freeman & Company.
- Saharia, V. B. (1998). *Wildlife in India*. Natraj Publishers.
- Santra, S. (2005). *Environmental Science*. New Central Book Agency (P) Ltd.
- Smith, R. L. & Smith, T. M. (2001). *Ecology and Field Biology*. Benjamin Cummings Pearson Education.
- Smith, T. M & Smith, R. L. (2006). *Elements of Ecology*. 6th ed. Pearson Education.
- Stiling, P. (2002). *Ecology- Science and Applications*. 2nd ed. Prentice Hall of India.
- Tikadar, B. K. (1983). *Threatened Animals of India*. ZSI.

MSCZOOLC202: Physiology; Endocrinology

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand-

- The critical areas of physiological & endocrinological system presents in animals.
- Explore the ways students may correlate the subject of animal physiology with endocrinology.
- The necessity physiological & endocrine system in the sound maintenance

Unit – I: PHYSIOLOGY

Basic concepts: Homeostasis, Acclimatization and Adaptation

Circulation

Blood cells: ultrastructure, pigments, and formation

Hemostasis: platelet activation cascades, regulation

Lymph: composition and dynamics

Respiration
General idea: Total and partial air pressure,
Gas solubility and diffusion in air and water.
Aquatic: Gill architecture; ram ventilation, dual pump,
gas exchange (counter current mechanism)
Terrestrial: Lung ventilation (amphibians, reptiles, birds, mammals),
Lung mechanics (human): Respiratory muscles, lung volumes,
elastic properties, compliance, surface tension, pulmonary surfactants.
Regulation (human): Respiratory centers, receptors, integration.

Excretion & Osmoregulation
Mammalian kidney, Urea cycle and Aquaporins
Ultra structure of nephron
Urine formation – Glomerular filtration and tubular reabsorption,
Importance as osmoregulatory organ.
External osmoregulatory organs: Salt glands, Fish gills
Water and electrolyte balance (Na, K, Mg), Acid-base regulation,
Endocrine regulation

Thermoregulation
Endothermy and Ectothermy
Thermoregulatory organs, responses to high and low temperature
Thermogenesis, Characteristics of fever
Neural Control

Sensory
Neuron: types; synapse (excitatory and inhibitory post synaptic potential)
Genesis of membrane potential
Neurotransmitters (Acetylcholine, GABA), chemical transmission through synapse

Unit –II: ENDOCRINOLOGY

Hormones

General classes of hormones, concept of receptors
Mechanisms of hormone action – second messenger, IP₃ and DAG
Neuroendocrine integration

Hypothalamic and Pituitary hormones

Hypothalamic hormones – structure and functions
Hypophyseal hormones – structure and functions

Thyroid hormones

Biosynthesis and function of T₃/T₄
Role of thyroid hormones in metabolism

Pancreatic hormones

Structure and biosynthesis: insulin and glucagon
Role of hormones in glucose metabolism

Adrenal hormones

Structure and functions of cortical hormones
Structure and functions of medullary hormones

Reproductive hormones

Sex steroids: Structure, source, role and receptors

Suggested readings

- Koppen, B.M. & Stanton, B.A. (2009). *Berne & Levy Physiology*. 6th ed. Mosby.
Bolandar, M. (2001). *Molecular Endocrinology*. Elsevier Science.
Ganong, W. F. (2003). *Review of Medical physiology*. 21st e2d. McGraw Hill.
Chaudhuri, S. K. (2000). *Concise Medical Physiology*. New Central Book Agency (P)
Ltd.
Greenspan, F. S. & Gardener, F. G. (2003). *Basic and Clinical Endocrinology*. 7th ed.
McGraw Hill.
Hadley, M. E. (2000). *Endocrinology*. 5th ed. Pearson Education.
Hill, R.W., Wyse, G.A. & Anderson, M. (2008). *Animal Physiology*. 2nd ed. Sinauer

Associates Inc.

Hoar, W. S. (1984). *General and comparative Physiology*. 3rd ed. Prentice-Hall of India.

Larsen, P. R., Krongberg, H. M., Melmed, S. & Polonsky, K. S. (2002). 10th ed.

Norris, D. O., (2006). *Williams Textbook of Endocrinology: Vertebrate Endocrinology*. 3rd ed. Academic Press.

Randall, D., Burggren, W. & French, K. (2002). *Eckert Animal Physiology – Mechanisms and Adaptation*. 5th ed. W. H. Freeman.

Sherwood, L. (2004). *Human Physiology: From cells to systems*. 5 ed. Thomson Brooks Cole.

Schmidt Nielsen, K. (1994). *Animal Physiology: Adaptation and Environment*.

MSCZOOLC203: Molecular Biology; Immunology

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand-

- Discuss the most significant discoveries and theories through the historical progress of biological scientific discoveries, and their impacts on the development of molecular biology.
- Explain the fundamental principles of phylogeny and systematics of the living world, with the application of the principles of classification.
- Link the structure of tissues, organs, organ systems and organisms with their functions in plants and animals.
- To identify the cellular and molecular basis of immune responsiveness.
- To describe the roles of the immune system in both maintaining health and contributing to disease.
- To describe immunological response and how it is triggered and regulated

Unit – I: MOLECULAR BIOLOGY

Regulation of Gene Expression

Post transcriptional modification and splicing and RNA editing

Protein synthesis and post translational modification and trafficking

Transposons

DNA damage and repair mechanisms

Cloning and Recombinant DNA Technology

Aging and senescence

Methods in Molecular Biology

PAGE, Western Blotting, Chromatography, Spectroscopy

Unit –II: IMMUNOLOGY

Types of Immunity: Innate and Acquired

Cells and Organs of the immune system

Elements of Innate immunity

Antigens and Immunogens

Definition and properties

Antigenic determinants of immunoglobulin (Isotype, allotype & idiotype)

Antibodies

Structure, classes and biological activities

Organization and expression of immunoglobulin genes

T Cell receptors (TCR) and TCR Complex

Structure and roles

Organization and rearrangement of TCR genes

Major histocompatibility complex (MHC)

General organization; Structure and Functions of MHC molecules
 Cytokines
 General properties and functional categories
 Complement
 Activation pathways, Biological functions and Regulation
 Maturation, activation and differentiation of T and B lymphocytes
 Immune effector mechanisms
 Antibody mediated functions
 Cell mediated effector responses
 Antigen-antibody interaction
 Molecular basis
 Secondary interactions – Agglutination, precipitation.
 Hypersensitivity reactions
 Vaccines and immunization

Suggested readings:

Abbas, A. K., Lichtman, A. H. & Pillai, S. (2006). Cellular and molecular Immunology. 6th ed. Saunders.
 Abbas, A. K. & Lichtman, A. H. (2006). Basic Immunology. 2nd ed. Elsevier.
 Chakraborty, A. K. (2003). Immunology II. 2nd ed. N. L. Publishers Siliguri.
 Coico R, Sunshine, G., Benjamini, E. (2003). Immunology: A short Course. 5th ed. Wiley-Liss: New Jersey.
 English, L. S. (1994). Technological Applications of Immunochemicals (BIOTOL). Butterworth-Heinemann, Oxford Freeman & Co.
 Goldsby, R. A., Kindt, T. J., Kuby, J. & Osborne, B. A. (2003). Immunology. 5th ed. W. H. Freeman & Co.
 Khan F. H. (2009) The Elements of Immunology. Pearson.
 Kindt, T., Goldsby, R. Osborne, B. (2007). Kuby Immunology. 6th ed. W.H. Freeman & Co.
 Male, D., Brostoff, J., Roth, D. & Roitt, I. (2006). Immunology. 7th ed. Mosby.
 Rao, C. V. (2002). Immunology. Narosa Publishing House, New Delhi.
 Roitt, I. M. & Delves, P. J. (2001). Roitt's Essential Immunology. 10th ed. Blackwell Science. Ltd.

MSCZOOLC205: Practical: Ecology, Physiology and Endocrinology

✧ Full Marks: 50

✧ CA+ESE Marks: 30+20

✧ Credit: 2

✧ L - T - P : 0 - 0 - 4

Learning Outcomes:

To enable the students to understand

- To bridge the gap between the theoretical concepts with practically applied domains of Ecology, Physiology and Endocrinology

Unit – I: ECOLOGY

1. Quantitative estimation of some Physico-chemical parameters in the aquatic ecosystem: Temperature, pH, dissolved oxygen, carbon dioxide and chloride contents
2. Quantitative estimation of some factors of soil and the sediment: soil moisture, pH, nitrates, phosphates and organic matter
3. The study of aquatic and terrestrial habitats: Identification and characterization of zooplankton and ecotypes inhabiting terrestrial and aquatic environments
4. Laboratory note book and class records
5. Viva –voce

Unit –II: PHYSIOLOGY&ENDOCRINOLOGY

1. PHYSIOLOGY
 - a. Detection of haemoglobin percent, C.T. and B.T.
 - b. Quantitative estimation of Ascorbic acid by titration.
 - c. Biochemical estimation of Cholesterol and Sugar from mammalian blood
 - d. Total count of RBC and WBC
 2. ENDOCRINOLOGY
 - a. Estimation of Steroid and thyroid hormone by ELISA
 - b. Demonstration of ovariectomy, orchidectomy and their effects in laboratory animals
 - c. Quantitative estimation of Ascorbic acid content of ovary as an assay of LH
 - d. Demonstration of Adrenalectomy in rat
 - e. Identification of stages of Oestrous cycle by vaginal smear preparation in rat
 3. Submission of laboratory record.
 4. Viva-voce
-

MSCZOOLC206:Practical: Molecular Biology and Immunology

✧ Full Marks: 50

✧ CA+ESE Marks: 30+20

✧ Credit: 2

✧ L - T - P : 0 - 0 - 4

Learning Outcomes:

To enable the students to understand

- To bridge the gap between the theoretical concepts with practically applied domains of Molecular Biology and Immunology

Unit – I: MOLECULAR BIOLOGY

1. Identification of different common mutant variants of *Drosophila*, Preparation of *Drosophila* food
 2. Extraction of RNA from animal tissue
 3. Western blotting for the study of gene expression
 4. Karyotype and idiogram preparation (G, C banding), human lymphocyte culture
 5. Sex chromatin study
 6. Cell fractionation and isolation of mitochondria
 7. Zymography for the expression of Proteases
 8. Laboratory records
 9. Viva-voce
-

Unit –II: IMMUNOLOGY

1. Separation of protein by Ion Exchange Chromatography
2. Single and double immunodiffusion (Ouchterlony)
3. Preparation of Cell suspension from the lymphoid tissue (primary/secondary) of mouse for the estimation of live and dead cells
4. Separation of macrophages from the peritoneal exudates
5. Immunization procedure and collection of antiserum from rabbit
6. Ammonium sulphate precipitation of immunoglobulin
7. ELISA, Coombs test, Widal test

8. Agglutination reactions
9. Laboratory records
10. Viva-voce

MSCZOOLC206: COMMUNITY OUTREACH

✧ Full Marks: 50

✧ CA+ESE Marks: 30+20

✧ Credit: 2

✧ L - T - P : 0 - 0 - 4

Learning Outcomes:

- Students are taking classes in Schools about the general concept about ZOOLOGY & ENVIRONMENT.
- To participate in social awareness program, like blood donation camp, Tree plantation, Education for all program.

THIRD SEMESTER

Course	CODE	Credits
General Entomology ; Applied Entomology	MSCZOOLC301	4
General Parasitology ; Medical Parasitology	MSCZOOLC302	4

Fish Biology ; Aquaculture	MSCZOOLC303	4
Toxicology ; Microbiology	MSCZOOLC304	4
Practical: Entomology and Parasitology	MSCZOOLC305	4
Practical: Fish Biology, Toxicology and Microbiology	MSCZOOLC306	4

MSCZOOLC301: General Entomology; Applied Entomology

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand

- Ranging from basic aspects of arthropod ecology, morphology, parasitology, physiology, systematics and toxicology.
- Basic insect biology, as well as natural history and evolutionary relationships of insect orders.
- To have a deeper understanding of several aspects of the biology of insects.

Unit – I: GENERAL ENTOMOLOGY

General characters of Class Insecta, diversity and adaptive features of insect

Outline classification up to orders with examples

Structure of insect

Structure of head - sutures - types of head in various insects

Components of mouthparts and types

Structure of leg - articulation - modification with reference to mobility

Structure and modifications of eyes and antenna

Origin and development of wings - venation – types and modifications – mechanism of flight - wing coupling

Formation and modification of cuticle

Internal organs

- Digestive structure and their modifications and functions
- Circulatory system
 - Organs of circulation
 - Haemolymph
 - Haemocytes with functions
 - Mechanism of circulation
 - Fat-Body
- Excretory system
 - Principal organs
 - Physiology of excretion
 - Excretory products
- Metamorphosis
 - Introduction – Types with examples
 - Larva and pupa – structure and types
- Insect behaviour
 - Feeding behaviour: types of feeding and damage, host range, specialization and host selection
 - Reproductive behaviour: mate location, mating frequency and oviposition
- Social Insects
 - Life cycle and Social organization of termites, honeybees and ants

Unit –II: APPLIED ENTOMOLOGY

- Sound production
 - Structure of the organs
 - Mechanism of sound production
 - Significance
- Bioluminescence
 - Structure of organs
 - Brief mechanism of light production
 - Significance
- Chemical Communication
 - Pheromones, kairomones, allomones, synomones
- Insect-plants interactions
 - Plant structure and chemistry,
 - Insects and host-plant interactions
- Insect control
 - Classification of insecticides,
 - evaluation of toxicity,
 - insecticide resistance
- Integrated Pest Management
 - General Concept
 - Economic Injury Level, Economic Threshold; dynamics
 - Degree Day concept
- Biotechnological control of pests
 - Transgenic plants and agents
- Forensic entomology
 - Basic idea, legal cases
 - Insect succession,
 - Post mortem interval
- Medical and Veterinary Entomology
 - Lice, myiasis
 - Applications of molecular tools in control and management
- Insect molecular Biology
 - Transgenic insects
 - Insect genome projects and its applications

Suggested readings:

- Chapman, R. F. (1998). The Insects: Structure and Function. 4th Ed. Cambridge University Press.
- Gillott, C. (2005) Entomology. 3rd ed. Springer Online Book - ISBN-13 978-1-4020-3183-0 (e-book).
- Gullan, P. J. & Cranston, P. S. (2005). The Insects – an outline of Entomology. 3 ed. Blackwell Publishing.
- Johnson, N. F. & Triplehorn C. A. (2004). Borror and DeLong's Introduction to the Study of Insects. 7th ed. Brooks Cole.
- Richards, O. W. & Davies, R. G. (1977). Imms: A General Text Book of Entomology. 10th ed. Vol. 1 & 2. Chapman and Hall.
- Romoser, S. W., & J.G. Stoffolano. (1998). The Science of Entomology. 4th ed. McGraw Hill.
- Srivastava, K. P. (1988). A textbook of Applied Entomology Vol. I. 2nd ed. Kalyani Publishers, New Delhi.
- Tembhare, D. B. (1997). Modern Entomology. Himalaya Publishing House.

MSCZOOLC302: General Parasitology; Medical Parasitology

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand

- The habit and habitat & life cycle strategy of parasites
- To correlate the Host –Parasite interaction, analyze the pathogenicity with nature of parasite species.
- Knowledge of parasites & vector control for human welfare.

Unit – I: GENERAL PARASITOLOGY

General idea

Symbionts, parasites, vectors and hosts

Host-Parasite interaction

Host–parasite interactions, adherence/colonization, virulence factor secretion systems, exotoxins, quorum sensing, pathogenicity islands

Intestinal Sarcodina and Flagellates

General account, structure, life cycle, pathogenicity and

control of *Entamoeba histolytica* and *Giardia lamblia*
Haemoflagellates
Ultrastructure and morphological stages; morphology, life cycle,
clinical features and control of *Trypanosoma cruzi* and *Leishmania donovani*
Haemosporina
Zoonosis
Evolution of malarial parasites
Morphology, life cycle, clinical features and control of *Plasmodium falciparum*

Unit –II: MEDICAL PARASITOLOGY

Classification of parasitic helminthes
General morphology (including ultrastructure) of parasitic Platyhelminthes.
Morphology, life history, pathogenicity and control
 Paragonimus westermani, *Schistosoma haematobium*, *Taenia saginata*,
 Trichinella spiralis, *Dracunculus medinensis*, *Ancylostoma duodenale*
Biology, importance and control
 Sand fly, Black fly, Tabanid flies, Anopheles, Ticks and Mites
Vector- microbe interaction
 Symbiotic association of microbes with vectors
 Role of microbes as controlling agents of vectors

Suggested readings

Chandler, A. C. & Read. C. P. (1961). Introduction to Parasitology, 10th ed. John Wiley & Sons Inc.
Chandra, G. (2000). Mosquito. SreeBhumi Publication Co. Kolkata.
Cheng, T. C. & Bogitsch. Human Parasitology.
Cheng, T. C. (1986). 2nd ed. General Parasitology Academic Press, Inc. Orlando. U.S.A.
Cox, F. E. G. (1993). Modern Parasitology. 2nd ed. Blackwell Scientific Publications. ed. Lea and Febiger, Philadelphia.
Hati, A. K. (2001). Medical Entomology. Allied Book Agency, Kolkata.
Hati, A. K. (2001). Medical Parasitology. Allied Book Agency, Kolkata.
Noble, E. R. & Noble G. A. (1982). Parasitology. The Biology of animal Parasites. 5th ed.
Schmidt, G. D. & Roberts, L. S. (2001). Foundation of Parasitology, McGraw Hill Publishers, 3rd ed.
Schmidt, G. D. (1989). Essentials of Parasitology. Wm. C. Brown Publishers (Indian print; 1990, Universal Book Stall).
Smyth, J. D. (1994). Animal Parasitology. 3rd ed. Cambridge University Press.
Soulsby, E. J. L. (1982). Helminths, Arthropods and Protozoa of domesticated animals. ELBS and Bailliere Tindall. London.

MSCZOOLC303: Fish Biology; Aquaculture

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand

- The necessity of studying Fisheries.
- To gather detail knowledge of Fish cultivation & its beneficial role.
- To explore the fisheries as economically valuable.

Unit – I: FISH BIOLOGY

Classification of fishes

Principles of classification, extinct fish groups,
Detailed study of major fish orders: Cypriniformes, Clupeiformes,
Ophiocephaliformes, Perciformes, Mastacembeliformes.

Structure, development, comparative account and functions

Bioluminescent organ
Poison gland
Acoustico-lateralis system

Structure and functions

Digestive systems, olfactory organ and chemoreception,
Osmoregulatory and Circulatory systems, Electric organs, Endocrine
glands (Pituitary and Thyroid), Caudal neurosecretory organ

Reproduction and Development

Structure and functions of reproductive organs, Types of reproduction,
Breeding and Parental care

Fish migration – types and regulation

Unit –II: AQUACULTURE

Concepts of fisheries and aquaculture

Present status, scope and possibilities of further development
Different culture systems (extensive, intensive, semi-intensive, fresh water, brackish
water, coastal, hill stream, cage, pen, race way)

Inland fisheries

Pond management for carp culture, induced breeding of prawn
and air breathing fishes, Composite culture of air breathing fishes

Shell fisheries

Edible oysters, chank fishery, pearl fishery

Ornamental fish culture and aquarium management

Fish biotechnology: Production of transgenic fish

Marine fisheries

Resources, Hilsa fishery, pomfrets and flat fishes
Elasmobranch fishery (major groups, fishery methods, importance)

Suggested readings

- Bardach, J. E. & Ryther, J. H. (1972). Aquaculture. John Wiley and Sons.
Beaumont, A. R. & Hoare, K. (2003). Biotechnology & Genetics in Fisheries and Aquaculture. Blackwell Publishing.
Bond, C.E. Biology of Fishes. 2nd ed. Saunders Pub.
Evans, D. H. (1998). The Physiology of Fishes. CRC Press.
Jayaram, K. C. (1999). The Freshwater Fishes of the Indian Region. Narendra Publishing House, New Delhi.
Jhingran, V. G. (1991). Fish and Fisheries of India. 3rd ed., Hindusthan Pub. Corp. John Wiley & Sons.
Lagler, K. F., Bardach, J. E., Miller, R. R. & Passino, D. R. (2003). Ichthyology.
Lowe, H. (2005). Beginner's Guide to Aquarium Fish and Fish Care. Abhishek Press, New Delhi.
Pillay, T. V. R. (1993). Aquaculture. Fishing News Books.
Srivastava, C. B. L. (1999). Fish Biology. Narendra Pub. House.

✧ Full Marks: 50

✧CA+ESE Marks: 30+20

✧ Credit: 4

✧L - T -P : 0 - 0 - 8

Learning Outcomes:

To enable the students to understand

- The critical areas of microbiology & toxicology
- To analyze the detail of microbes in the animal world
- Importance of studying toxicology
- Application of theoretical knowledge of microbiology & toxicology in research areas.

Unit – I: TOXICOLOGY

Concept, history and scope of toxicology

Fundamentals of toxicology

Types of toxic substances (including natural toxins, concept of xenobiotics)

Disposition and biotransformation (phase I and phase II reactions)

Drugs as toxic substance (Paracetamol, Aspirin, Thalidomide)

Effects of toxic substances

Biochemical and physiological effects

Interactive effects: additive effects, potentiation and synergism

Toxicity tests

Dose, dosage, dose response

Acute toxicity tests: Bioassay, LC₅₀ and LD₅₀, Probit analysis and Significance

Chronic toxicity tests: Methods, Significance

Pesticides

Concept and classification

Insecticides and herbicides: Types (including bioinsecticides), sources, effects and kinetics in the environment

Mechanism of action: Organochlorine, Organophosphate, Carbamates,

Paraquat, Phenoxy herbicides

Metaltoxicity

Source, exposure, disposition and effects of heavy metals (Cd, Hg, Pb) and lighter elements (As, Se)Metal chelation

Applied toxicology

Clinical toxicology

Forensic toxicology

Unit –II: MICROBIOLOGY

History and development of Microbiology

Contributions of Leeuwenhoek, Koch, Pasteur, Jenner and Flemming

Bacteria

Structure and function of capsule, pili, flagella, cell wall, cell membrane, outer membrane, reserve materials, cytoplasmic inclusions, plasmid and bacterial chromosome

Bacterial endospore

Structure, properties, spore –formation and germination

Virus

Structural organization of viruses

Prions and Viroids

Lytic cycle of bacteriophages with reference to E. coli and T4
Lysogeny, lysogenic conversion, induction and significance
Control of microorganisms
Physical and chemical agents, chemotherapeutic agents: sulfa drugs
and antibiotics
Medical Microbiology

Microbial virulence
Mode of transmission, pathogenicity and prevention of microbial diseases:
Air-borne (Tuberculosis and Influenza), Food and waterborne (Typhoid
and Cholera) and Arthropod borne (Dengue, JE and Yellow fever)

Suggested readings:

- Alexander, M. (1977). Introduction to Soil Microbiology .New York: John Wiley & Sons.
Atlas, R. M. (1984). Microbiology, Fundamentals and Applications. Macmillan.
Atlas, R. M. &Bartha, R. (1997). Microbial Ecology: Fundamentals and Applications, 4th ed. Benjamin/ Cummings.
Black, J. G. (2001). Microbiology: Principles and Explorations, 5th ed. John Wiley & Sons, New York.
Campbell, R. (1983). Microbial Ecology. 2nd ed. Oxford, Blackwell.
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Davis, B. D., Dulbecco, R., Eisen, H.N. & Ginsberg, H.S. (1990). Microbiology, 4th ed. Harper and Row.
Dimmock, N. J. & Primrose, S. B. (1994). Introduction to Modern Virology. 4th ed. Blackwell Scientific Publications. London.
Holt, J.G., Krieg, N.R., Sneath, P.H.A. Staley, J.T. & Williams, S.T. Bergey's Manual of Determinative Bacteriology. Lippincott Williams & Wilkins.
Maloy, S. R., Cronan, E. J. &Freifelder, D. (1994). Microbial Genetics, 2nd ed. Jones and Bartlett.
Pelczar, M. J., Reid, R. D. & Chan, E. C. (1993). Microbiology, 5th ed. Macmillan. London.
Pinehuk, G. (2003). Schaum's outline Series: Theory and Problems of Immunology. McGrawHill.
Presscott, L. M., Harley, J. P. & Klein, D. A. (1999). Microbiology, 4th ed. McGrawHill, New York.
Schlegel, H. G. (1993). General Microbiology .7th ed. Cambridge University Press.
Slonczewski, J.L. & Foster, J.W. (2009). Microbiology- An Evolving Science. Norton.
Stanier, R. Y., Adelberg, E. A. & Ingraham, J. L. (1986). General Microbiology. 5th ed. Macmillan.
Talaro, K. &Talaro, A. (1999). Foundations in Microbiology 3rd ed. Dubuque, McGraw Hill.
Tortora, G. J., Funke, B. R., & Case. C. L. (1999). Microbiology. An Introduction. 6th ed. Benjamin/Cummings Publishing. Menlo Park Calif.
Voyleys, B. A. (2002). The biology of viruses, 2nd ed. McGraw-Hill.
- De, A. K. (2000). Environmental chemisrtry. 4th ed. New Age International (P) Ltd. Publishers.
Duffus, J.H. & Worth H.G.J. (Ed.) (2006). Fundamental Toxicology. RSC publishing.
Klaassen, C. D. (Ed.) (1996). Casarett&Daul's Toxicology: The Basic Science of Poisons. 5th ed. McGraw-Hill, New York.
Lu, F. C. (1996). Basic Toxicology: Fundamentals, Target organs and Risk Assessment. 3rd ed. Taylor & Francis.
Pandey, K., Shukla, J. P. & Trivedi, S. P. (2005). Fundamentals of Toxicology, New Central Book Agency (P) Ltd. Kolkata.
Plant, N. (2003). Molecular Toxicology, 1st Ed. Bios Scientific Publishers.
Stine, K. E. & Brown, T. M. (2006). Principles of Toxicology. 2nd Ed. CRC, Taylor & Francis Group, New York.
Timbrell, J. (2002). Introduction to Toxicology, 3rd Ed., Taylor & Francis, London.
Walker, C. H., Hopkin, S. P., Sibly, R. M. &Peakall, D. B. (2000). Principles of Ecotoxicology, 2nd Ed. Taylor & Francis, London.

MSCZOOLC305: Practical: Entomology and Parasitology

✧ Full Marks: 50

✧ CA+ESE Marks: 30+20

✧ Credit: 4

✧ L - T - P : 0 - 0 - 8

Learning Outcomes:

To enable the students to understand

- To bridge the gap between the theoretical concepts with practically applied domains of Entomology and Parasitology
- How to & which basis considered them as Pest & Vector

Unit – I: ENTOMOLOGY

1. Digestive system of Grasshopper / Honey bee
2. Nervous system of Grasshopper / Honey bee
3. Mounting: Mouthparts of grasshopper, mosquito; wings of Ephemeroptera, Odonata, Dictyoptera, Hemiptera, Hymenoptera, Diptera, Lepidoptera, Coleoptera; legs of gressorial, cursorial, saltatorial, fossorial, natatorial, clasporial and raptorial; antennae: filiform, setaceous, plumose, pilose, pectinate, clavate, geniculate, aristate, serrate, moniliform
4. Identification of common pests: Paddy (*Nilaparvatalugens*, *Nephotettix nigropictus/virescens*, *Leptocorisaacuta/varicornis*, *Scirpophagaincertulas/innotata*); Jute (*Apioncorchori*, *Dasychiramendosa*); vegetables (*Epilachnadodecastigma*, *Bemisia tabaci*, *Leucinodesorbonalis*); stored grains (*Sitophilusoryzae*, *Callosobruchus chinensis/maculatus*, *Triboliumcastaneum*)
5. Social Insects: Morphological studies of social insects (Honey bee and termite)
6. Laboratory records
7. Submission of prepared slides
8. Viva-voce

Unit –II: PARASITOLOGY

1. Smear preparation and staining of parasitic Protozoa
2. Drawing and staining of blood films for parasitic Protozoa and microfilaria
3. Whole mount preparation of trematode and arthropod parasites
4. Staining of scolex and proglottids of cestodes
5. Whole mount preparation of mosquito vectors (*Anopheles*, *Culex* and *Stegomyia*)
6. Identification of parasites and vectors
7. Laboratory records
8. Submission of prepared slides
9. Viva-voce

MSCZOOLC306: Practical: Fish Biology, Toxicology and Microbiology

Learning outcomes

To enable the students to understand

- To bridge the gap between the theoretical concepts with practically applied domains of Fish Biology, Toxicology and Microbiology
- How to & which basis identify the different fishes.
- How to prepare media for cultivating bacteria.

Unit – I: FISH BIOLOGY

1. Study of bucco-pharynx, gill rakers and gut content analysis in relation to food habits of teleosts
 2. Urinogenital, olfactory and digestive systems in teleosts
 3. Histological preparation of testis, ovary, kidney, pituitary, hepatopancreas, and intestine of fish
 4. Identification of different fish
 5. Laboratory records
 6. Submission of prepared slides
 7. Viva-voce
-

Unit –II: TOXICOLOGY AND MICROBIOLOGY

1. TOXICOLOGY:
 - a. Determination of LC₅₀ and LD₅₀
 - b. Morphological deformities (study of symmetry) in biological organisms due to toxicant exposure
2. MICROBIOLOGY:
 - a. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria
 - b. Preparation of slant and stab
 - c. Pure culture techniques: Spread plate, pour plate and streak plate
 - d. Isolation and enumeration of bacteria from natural sources: soil, air and water
 - e. Simple staining of bacteria and study of cell types; differential staining: Gram staining, endospore staining and acid-fast staining
 - f. Biochemical tests for characterization: Catalase, Nitrate reduction, Indole production, Methyl red and Voges–Proskauer test
 - g. Sugar fermentation test
3. Laboratory note book
4. Viva-voce

FOURTH SEMESTER

Course	Code	Credits
Developmental Biology ; Biostatistics and Computational Biology	MSCZOOLC401	4
Practical: Developmental Biology and Computational Biology	MSCZOOLC402	2

MSCZOOLC401: Developmental Biology; Biostatistics and Computational Biology

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Learning Outcomes:

To enable the students to understand

- The subject of embryology & developmental biology.
- To understand the necessity of studying this subject.
- Bridge the gap between developmental biology & medical biology

Unit – I: DEVELOPMENTAL BIOLOGY

Overview

Scope of Developmental Biology & Future impact

Totipotency

Cell surface proteins, extra cellular matrix

Signaling

Techniques & experimental biology

Cell labeling &genetical methods

Model systems (Dictyostelium, C. elegans, Drosophila& Chick)

Gametogenesis

Spermatogenesis: phases, cellular changes

Oogenesis: types, stages, ooteleosis&luteinization

Fertilization in mammals

Recognition of gametes and acrosomal reaction

Gamete fusion

Activation of egg

Cleavage

Mechanism: molecular aspects

Gastrulation

Cell lineages

Gastrulation in vertebrate embryos

Formation of germ layers in amphibia and birds

Induction, Determination and Differentiation

Pattern formation

Anterior-Posterior & Dorsal- Ventral polarity in Drosophila;

Molecular control of segmentation and homeotic genes

Gap genes, HOX genes in vertebrate, Niuekwoopcentre& ventral organizer

Neurogenesis and Neural tube in vertebrates

General Topics

Mesoderm induction & patterning

Regeneration

In vitro fertilization in human

Embryonic stem cell & their application

Unit –II: BIOSTATISTICS & COMPUTATIONAL BIOLOGY

1. BIOSTATISTICS

Populations and samples

Populations, Samples from populations, Random sampling, Parameters and Statistics, Standard deviation and error, Coefficient of variation

Hypothesis testing

Parametric and Non-parametric tests, One sample hypothesis

Two sample hypothesis

Multisample hypothesis: The Analysis of Variance

Single factor analysis of variance, confidence limits for population mean

Power and sample size in ANOVA, Homogeneity of variances

Homogeneity of coefficients of variation

Multiple comparisons

Tukey test

Linear regression

Regression vs. Correlation, Correlation coefficient, Simple linear regression equation Testing the significance of relation (r^2)

Testing for goodness of fit

Chi-Square goodness of fit, Heterogeneity chi-Square, Log-Likelihood ratio

Chi-Square analysis of contingency table

2. COMPUTATIONAL BIOLOGY

Basic components of computers

Hardware

CPU, input, output, storage devices, Microprocessor

Communication port

Operating system

Concept and function of OS, open source OS

Command type and GUI application, LINUX

Programming Concept

Logical operators, Flow chart and Algorithm, Concept of C – programming

Data Structure, Common RDMBS platform: SQL, Oracle

Computer Networking and Internet

Biological databases

Nucleic acid and Protein database

Sequence Alignment, Protein prediction and pattern search tools

Molecular modeling and docking

Suggested readings

Arias, A. M. & Stewart, A. (2002). *Molecular Principles of Animal Development*.

Balinsky (1981). *Embryology*. Thompson Brooks Cole (India) Pte, Ltd.

Browder, L. W. (1984). *Developmental Biology*. 2nd ed., CBS College Publishing.

Carlson, B. M. (1999). *Patten's Foundations in Embryology*. 6th ed. McGraw Hill.

Gilbert S. F. (1999). *Embryology*. Sinauer Associates, Sunderland, Massachusetts.

Gillbert, S.F. (2006). *Developmental Biology*. 8th ed. Sinauer Associates.

Kalthoff, K., (2001). *Analysis of Biological Development*. 2 ed. McGraw Hill.

Larsen, P. R., Krongberg, H. M., Melmed, S. & Polonsky, K. S. (2002). 10th ed. Williams Oxford University Press.

Moody, S.A. (Ed.) (2007). *Principles of Developmental Genetics*. Academic Press.

Shostak, S. (1991). *Embryology – An Introduction to Developmental Biology*. Harper Collins.

Slack, J. M. W. (2006). *Essential Developmental Biology*. 2nd ed. Blackwell Publishing.

Bailey, N. T. J. (1995). *Statistical Methods in Biology*. 1st ELBS ed.

Boyer, R. (2000). *Modern Experimental Biology*. Pearson Education. English Universities Cambridge Low-price Ed.

Cantor, C.R. & Schimmel, P.R. (2003). *Biophysical chemistry* (3 vol. set). W. H. Freeman & Co.

Forthofer, N. & Lee, E. S. (2006). *Introduction to Biostatistics: A Guide to Design, Analysis and Discovery*. Academic Press.

Friefelder, D. (1982). *Physical Biochemistry*. W. H. Freeman & Co. (Reprint 1999).

Selvin, S. (2004). *Biostatistics: How it works?* Pearson Education .

Sharma, V. K. (1991). *Techniques in Microscopy and Cell Biology*. Tata-McGraw Hill.

Sokal, R. R., Rohlf, F. J., (1995). *Biometry: the principles and practice of statistics in biological research*. 3rd ed. W. H. Freeman and Company, New York.

MSCZOOLC402: Practical Developmental Biology & Computational Biology

✧ Full Marks: 50

✧ CA+ESE Marks: 30+20

✧ Credit: 2

✧ L - T - P : 0 - 0 - 4

Learning Outcomes:

To enable the students to understand

- To bridge the gap between the theoretical concepts with practically applied domains of Developmental Biology & Computational Biology

1. DEVELOPMENTAL BIOLOGY

a. Culture and Regeneration of Hydra

b. Morphological studies on the developmental stages of snail, fish, frog, chick and mouse

c. Histological slides of various organs and systems during development using stained serial sections

d. Identification of whole mounts and histological sections of embryos larvae, pupae and nymphs

e. Submissions of preparations of different stages of development

2. COMPUTATONAL BIOLOGY

a. Unix operation: File management, net work commands, shell programming

b. C- Programming: Data structure, string function, array and variations

c. Sequence retrieval – nucleotide and protein

d. BLAST search

e. Protein pattern search, Motif search

3. Laboratory note book

4. Viva-voce

Course	Code	Options	credit
Entomology -I	MSCZOOMLMJE401	(Any One)	4
Aquaculture and Fisheries -I	MSCZOOMLMJE402		4
Entomology - II	MSCZOOMLMJE403	(Any One)	4
Aquaculture and Fisheries-II	MSCZOOMLMJE404		4
Entomology - III	MSCZOOMLMJE405		4

SPECIAL PAPER

Aquaculture and Fisheries-III	MSCZOOLMJE406	(Any One)	4
Term Paper / Project Work	MSCZOOLMJE407	Compulsory	2
Major Elective Practical	MSCZOOLMJE408		4

MSCZOOLMJE401: ENTOMOLOGY I

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

LEARNING OUTCOMES:

TO ENABLE THE STUDENTS TO UNDERSTAND

- TO HAVE A DEEPER UNDERSTANDING OF SEVERAL ASPECTS OF THE BIOLOGY OF INSECTS
- TO BE ABLE TO EXAMINE INSECTS DEEPLY WITHIN A BIOLOGICAL LEVEL OF ANALYSIS AND COMPARE STRATEGIES USED BY DIFFERENT GROUPS
- TO HAVE A GOOD UNDERSTANDING OF THE PRIMARY LITERATURE IN ENTOMOLOGY AND TO BE ABLE TO CRITICALLY EVALUATE INFORMATION IN PRIMARY RESEARCH ARTICLES

Insect Anatomy

Morphology and Biology of the orders

Collembola, Orthoptera, Thysanoptera, Hemiptera, Siphonaptera, Lepidoptera, Coleoptera, Diptera, Strepsiptera & Hymenoptera

Integument

Structure and functions of cuticle

Cuticular modifications

Moulting

Head

Head segmentation and evolution

Generalized Pterygote Head
 Modified Mouthparts (Orthopteroid, Hemipteroid and Neuropteroid)

Thorax
 Generalized thoracic structure
 Structure and morphological variation of wing
 Appendages of thorax

Abdomen
 Segmentation
 Skeletal composition

Vision
 The dorsal ocelli
 The stemmata
 Structure of compound eye
 Formation of image

Perception
 Chemoreception: structure of cuticular and contact receptors, distribution & functions
 Mechanoreception: Structure and functions of cuticular, cellular, proprioceptors. chordotonal and tympanal organs.

Exocrine glands

Important exocrine glands: origin, structure and functions

Suggested readings:

Chapman, R. F. (1998). *The Insects: Structure and Function*. 4th ed. Cambridge University Press.

Gillott, C. (2005) *Entomology*. 3rd ed. Springer Online Book - ISBN-13 978-1-4020-3183-0 (e-book).

Gullan, P. J. & Cranston, P. S. (2005). *The Insects – an outline of Entomology*. 3rd Ed.

Johnson, N. F. & Triplehorn C. A. (2004). *Borror and DeLong's Introduction to the Study of Insects*. 7th ed. Brooks Cole.

Klowden, M. (2002). *Physiological Systems in Insects*, Academic Press.

Nation, J. L. (2008). *Insect Physiology and Biochemistry*. 2nd ed. CRC Press. Taylor & Francis Group.

Richards O. W. & Davies, R. G. (1977). *Imms: A General Text Book of Entomology*. 10th ed. Vol.1 & 2. Chapman and Hall.

Rockstein, M. (1978). *Biochemistry of Insects*. Academic Press.

Rockstein, M. (Ed.) (1986-1996) *Advances in Insects Physiology* Vols. 19-26 Academic Press,

Snodgrass, R. F. (1935). *Principles of Insect Morphology*. McGraw-Hill Publishing Company Ltd.

Srivastava, K. P. (1988). *A textbook of Applied Entomology*. Vol.I 2nd ed. Kalyani Publishers, New Delhi.

Wigglesworth, V. B. (1972). *Principles of Insect Physiology*. ELBS (Methuen & co.)

MSCZOOLMJE402: AQUACULTURE AND FISHERIES I

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

LEARNING OUTCOMES:

TO ENABLE THE STUDENTS TO UNDERSTAND

- THE NECESSITY OF STUDYING FISHERIES.
- TO GATHER DETAIL KNOWLEDGE OF FISH CULTIVATION & ITS BENEFICIAL ROLE. • TO EXPLORE THE FISHERIES AS ECONOMICALLY VALUABLE.
- TO EXPLORE THE FUTURE PROSPECTS OF FISHERIES.

Fresh Water Aquaculture

Inland fisheries resources in India and their principal species.

Food fishes and their economic importance

Indian Major carps: Catlacatla, Labeorohita, Cirrhinusmrigal

Exotic carps: Hypophthalmichthysmolitrix, Ctenopharyngodonidella,

Cyprinus carpio

Cat fishes : Clarias batrachus, Heteropneustes fossil

Other groups: Anabas testudineus, Channastrriatus, Etroplussuratensis

Fish culture practices

Collection of spawn, fries and fingerlings and their subsequent transport

Culture of air-breathing fishes

Integrated aquaculture: crop-livestock-fish farming

Paddy-cum-fish culture

Sewage-fed fish culture

Impact of invasive fish species

Cold water fisheries: resources, management and development.

Fish breeding

endocrine control of fish reproduction

Induced breeding in carps and catfishes

Ecological requirements for induced breeding

Hybridization and genetic manipulation

Selective breeding (Intergeneric, interspecific)

Ploidy manipulation, Androgenesis, Gynogenesis

Transgenesis: Transgene delivery, integration, expression

Neuro-

Suggested readings:

Bardach, J. E. & Ryther, J. H. (1972). Aquaculture. John Willey and Sons.

DE Silva, S. S. & Anderson, T. A. (1995). Fish Nutrition in Aquaculture. Chapman & Hall, London.

Guillaume, J., Kaushik, S., Bergot, P. & Metailler, R. (2001). Nutrition and Feeding of Fish and Crustaceans. Springer and Praxis, U. K.

Halver, J. E. (1972). Fish Nutrition. Academic Press, New York & London.

Jhingran, V. G. (1991). Fish and Fisheries of India. 3rd ed., Hindusthan Pub. Corp.

Pillay, T.V.R. (1993). Aquaculture. Fishing News Books.

Srivastava, C. B. L. (1999). Fish Biology. Narendra Pub. House.

Srivastava, C. B. L. (2006). A Text Book of Fishery Science & Indian Fisheries. Kitab Mahal. Allahabad.

MSCZOOLMJE403: ENTOMOLOGY II

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

LEARNING OUTCOMES:

TO ENABLE THE STUDENTS TO UNDERSTAND

- DEMONSTRATE PHYLOGENETIC "TREE THINKING" AND BE ABLE TO CATEGORIZE INSECTS BASED ON BASIC ECOLOGICAL, BEHAVIORAL, MORPHOLOGICAL, PHYSIOLOGICAL, OR DEVELOPMENTAL ATTRIBUTES.
- THE PHYSIOLOGICAL SYSTEMS OF INSECTS.
- IMPORTANCE OF INSECTS AS VARIOUS SOURCE FOR HUMAN WELFARE

Insect Physiology

Digestive system

- The alimentary canal

- The salivary glands

- Mechanism of digestion

 - Micro-organisms and their role in digestion

 - Nutritional requirements

Respiratory system

- Structure of respiratory organs

- Mechanism of gaseous exchange

- Aquatic respiratory organs

- Physiology of gill and plastron respiration

Excretory system

- Types of excretory systems

 - Organs of excretion

 - Accessory organs of excretion

 - Physiology of excretion

 - Composition of insect urine

 - Vitamins in Malpighian tubules

Nervous system

- The neurons

- The central nervous system

- The brain

- The Sympathetic nervous system

Reproduction

- Male and Female reproductive system

 - Special types of reproduction

 - Factors controlling fecundity and fertility

 - Swarming and oviposition

 - Egg maturation

Development

- The insect egg

- Embryonic development and dynamics

 - Post-embryonic development and metamorphosis

Endocrine system

- Anatomical organization

 - Structure and hormones

 - Endocrine control of metamorphosis, diapause

Gall formation

- Insects involved in formation of galls

- Mechanism of galls formation

- Importance of galls

Suggested readings:

Chapman, R. F. (1998). *The Insects: Structure and Function*. 4th Ed. Cambridge University Press.

David, B. V. & Ananthakrishnan, T. N. (2006). *General and Applied Entomology*. Tata McGraw-Hill Publishing.

Gillott, C. (2005). *Entomology*. 3 ed. Springer Online Book - ISBN-13 978-1-4020-3183-0 (e-book).

Gullan, P. J. & Cranston, P. S. (2005). *The Insects – an outline of Entomology*. 3rd Ed.

Klowden. (2002). *Physiological Systems in Insects*, Academic Press.

Richards O.W. & Davies, R.G. (1977). *Imms: A General Text Book of Entomology*. 10th ed. Vol.1 & 2. Chapman and Hall.

Rockstein, M. (1978). *Biochemistry of Insects*. Academic Press.

Rockstein, M. (Ed.) (1973). *The Physiology of Insecta*. Vol.I. 2nd ed. Academic Press.

Snodgrass, R.F. (1935). *Principles of Insect Morphology*. Tata McGraw-Hill Publishing Company Ltd.

Srivastava, K. P. (1988). *A textbook of Applied Entomology*. Vol. I. 2nd ed. Kalyani Publishers, New Delhi.

MSCZOOMJE404:AQUACULTURE AND FISHERIES II

✧ Full Marks: 50

✧CA+ESE Marks: 30+20

✧ Credit: 4

✧L - T - P : 0 - 0 - 8

Learning Outcomes:

To enable the students to understand

- THE NECESSITY OF STUDYING FISHERIES.
- TO GATHER DETAIL KNOWLEDGE OF FISH CULTIVATION & ITS BENEFICIAL ROLE.
- TO EXPLORE THE FISHERIES AS ECONOMICALLY VALUABLE.
- TO EXPLORE THE FUTURE PROSPECTS OF FISHERIES.

Fresh Water & Brackish Water Aquaculture

Nutrition and supplementary feeding

Nutritional requirements

Intermediary metabolism and bioenergetics

Feed types, composition, ingredients, formulation

Feeding schedules, feed dispensing methods

Storage and quality control of feed

Maintenance of Fish Farm

Productivity of freshwater bodies

Limnological methods and their application (oxygen and carbon-di-oxide)

Pond fertilization

Control of aquatic weeds, insects, predatory and weed fishes

Aquaculture hazards

Common diseases of fish: Causative organisms, effects and control

Shrimp diseases and treatment

Pollution: sources, effects and control

Present status of brackish water fish farming in India

Mixed culture of brackish water fish species

Estuarine fisheries

Spoilage of fresh water and brackish water fishes

Aminoacid changes

Breakdown products indicative of spoilage

Other substances

Development strategies

Fish conservation

Fish marketing: imports and exports

Suggested readings:

Bardach, J. E. & Ryther, J. H. (1972). Aquaculture. John Wiley and Sons.

DE Silva, S. S. & Anderson, T. A. (1995). Fish Nutrition in Aquaculture. Chapman & Hall, London.

Guillaume, J., Kaushik, S., Bergot, P. & Metailler, R. (2001). Nutrition and Feeding of Fish and Crustaceans. Springer and Praxis, U. K.

Halver, J. E. (1972). Fish Nutrition. Academic Press, New York & London.

Jhingran, V. G. (1991). Fish and Fisheries of India. 3rd ed., Hindusthan Pub. Corp.

Pillay, T.V.R. (1993). Aquaculture. Fishing News Books.

Srivastava, C. B. L. (1999). Fish Biology. Narendra Pub. House.

Srivastava, C. B. L. (2006). A Text Book of Fishery Science & Indian Fisheries. Kitab

Mahal. Allahabad.

MSCZOOMJE405: ENTOMOLOGY III

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

LEARNING OUTCOMES:

TO ENABLE THE STUDENTS TO UNDERSTAND

- ENTOMOLOGY, THE STUDY OF INSECTS HAS DEVELOPED INTO A VERY LARGE DIVISION OF THE ANIMAL SCIENCES OWING TO THEIR HUGE PROPORTION IN THE ANIMAL KINGDOM AND THEIR IMPORTANCE IN THE APPLIED FIELDS.
- TO APPRECIATE THE IMPACT THAT INSECTS HAVE (BOTH POSITIVE AND NEGATIVE) ON HUMAN SOCIETY, INCLUDING HUMAN HEALTH, AGRICULTURE, AND THE ENVIRONMENT
- BE ABLE TO IDENTIFY THE POTENTIAL IMPACT OF DIFFERENT INSECT SPECIES ON AGRICULTURE, HUMAN HEALTH, AND SOCIETY IN GENERAL; TO BE KNOWLEDGEABLE ABOUT POTENTIAL CONTROL STRATEGIES

Applied Entomology

Crop Husbandry

Morphology, Bionomics and Management of pests of paddy, wheat, jute, sugarcane, mango, oil-seed crops, pulses, vegetables and stored grains
Distribution, bionomics and control of polyphagous pest: locusts and termites

Control/Management of insect pests

Integrated pest Management:

Concept of injury level, Economic level of injury,

Economic threshold level, IPM.

Chemical control: Organochlorines, Organophosphates,

Carbamates, Pyrethroids and Botanicals

Biological Control. Predators, Parasitoids and Nematodes

Hormonal control: Concept, use of juvenoids, ecdysoids

and Insect growth regulators (IGRs)

Genetic control: Methods of genetic manipulation and field trials.

Biotechnological control- use of transgenic plants, transgenic agents and impact of environment on the method.

Non-insecticidal method

Insect attractants, fumigants, repellents and antifeedants

Forest Entomology

Insects common to forests and their damage

Defoliators, borers and sapsuckers.

Forensic Entomology

Insects associated with the corpses and carrions

Forensic entomological techniques

Industrial Entomology

Non-Mulberry sericulture-Tasar, muga and eri.

Lac culture: Lac insects, Life history, Industrial importance.

Honey bees and Apiculture

Medical Entomology

Insects of medical importance - naming with its status in Entomology

Morphology of mosquitoes, house flies, human lice and rat fleas with role in disease transmission and control

Insect molecular genetics

Insect genome organization

Transgenic pest and application

Suggested readings:

Atwal, A. S. & Dhaliwal, G.S. (2002). *Agricultural pests of South Asia and their*

- management*. Kalyani Publishers, New Delhi.
- Dent, D. (2000). *Insect Pest Management*. 2nd ed. CABI. 44
- Dhaliwal, G.S. & Singh, R. (2004). *Host plant Resistance to Insects: Concepts and Applications*. Panima Publishing Corporation.
- Dorothy, E. G. (2006). *Forensic Entomology*. Wiley.
- Gullan, P. J. & Cranston, P. S. (2005). *The Insects – an outline of Entomology*. 3rd Ed. Blackwell Publishing.
- Hill, D.S. (1994). *Agricultural Entomology*. Timber Press.
- Hoy, M. A. (2003). *Insect Molecular Genetics– An introduction to principles and Applications*. 2nd ed. Academic Press.
- Ignacimuthu, S. & Jayraj, S. (Eds.) (2007). *Biotechnology and Insect Pest Management*. Elite Publishing House Pvt. Ltd.
- Jha, L. K. & SenSarma, P. K. (1993). *Agroforestry – Indian Perspective*. Ashish Publishing House.
- Kettle, D. S. (1995). *Medical and veterinary Entomology*. 2nd Ed. CAB International.
- Koul, O, Cuperus, G.W. & Elliot, N. (Ed.) (2008) *Area wide pest management Theory and Implementation*. CAB International.
- Metcalf, R. L. & Luckmann, W. H. (1994). *Introduction to Insect Pest Management*. 3rd Ed. John Wiley & Sons, Inc.
- Mullen, G.R. & Durden, L.A. (2009). *Medical and Veterinary Entomology*. 2nd Ed. Academic Press.
- Nation, J. L. (2008). *Insect Physiology and Biochemistry*. 2nd ed. CRC Press. Taylor & Francis Group.
- Pedigo, L. P. & Rice E. M. (2009). *Entomology and Pest Management*. Pearson/Prentice Hall.
- Pimentel D. (Ed.) (2007). *Encyclopedia of Pest Management*. Vol.II. CRC Press, Taylor & Francis.
- Radcliffe, E.B., Hutchinson, W.D. & Cancelado, R.E. (2009) *Integrated Pest Management – Concepts, Tactics, Strategies & Case studies*. Cambridge University Press.
- Rechcigl J. E. & Rechcigl, N. A. (1998). *Biological and Biotechnological control of Insect pests*. Lewis Publishers.
- Shukla, G. S. & Upadhyay, V. B. (2005-2006). *Economic Zoology*. 4th ed. Rastogi Publication.
- Speight, M. R., Hunter, M.D. & Watt A. D. (2008). *Ecology of Insects: Concepts and Applications*. 2nd ed. Wiley-Blacwell.
- Srivastava, K. P. (1988). *A textbook of Applied Entomology*. Vol. II 2nd ed. Kalyani Publishers, New Delhi.
- Stewart A.J.A., New, T.R. & Lewis, O.T. (Ed.) (2007). *Insect Conservation Biology*. CABI.

MSCZOOLMJE406: AQUACULTURE AND FISHERIES III

✧ **Full Marks: 50**

✧ **CA+ESE Marks: 10+40**

✧ **Credit: 4**

✧ **L - T - P : 4 - 0 - 0**

LEARNING OUTCOMES:

TO ENABLE THE STUDENTS TO UNDERSTAND

- THE NECESSITY OF STUDYING FISHERIES.
- TO GATHER DETAIL KNOWLEDGE OF FISH CULTIVATION & ITS BENEFICIAL ROLE.
- TO EXPLORE THE FISHERIES AS ECONOMICALLY VALUABLE.
- TO EXPLORE THE FUTURE PROSPECTS OF FISHERIES

Marine Fisheries

General survey of marine fisheries in India

Marine biology and oceanography in relation to fisheries

Principal marine fisheries and exploited species
Oil sardine and lesser sardines, Indian Mackerel, Bombay duck,
Pomfrets, Prawns, Molluscs
Fishing crafts and Gears
Types of Indigenous crafts and gears, designing
Modernization of craft, Preservation
Life in sea
Phytoplankton, Zooplankton Nekton and fisheries
Fluctuation in marine fisheries
Causes of fluctuation, overfishing problem
Rational exploitation of fisheries
Preservation and processing
Chemical composition of fish
Drying and salting, Chilling and freezing, Smoking and canning
Mariculture
Cultivable fin-fishes, Cultivable crustaceans, Cultivable mollusca
Fish in human nutrition
Nutritive value of fish protein,
Fish oils, fatty acids and nutrition
Fish as a source of mineral, Fish as a source of vitamins
Fish by-products, marketing of fish and aquaculture products
Conservation of marine environment through establishing National marine reserves

Suggested readings:

Bardach, J. E. & Ryther, J. H. (1972). Aquaculture. John Willey and Sons.
DE Silva, S. S. & Anderson, T. A. (1995). Fish Nutrition in Aquaculture. Chapman & Hall, London.
Guillaume, J., Kaushik, S., Bergot, P. & Metailler, R. (2001). Nutrition and Feeding of Fish and Crustaceans. Springer and Praxis, U. K.
Halver, J. E. (1972). Fish Nutrition. Academic Press, New York & London.
Jhingran, V. G. (1991). Fish and Fisheries of India. 3rd ed., Hindusthan Pub. Corp.
Pillay, T.V.R. (1993). Aquaculture. Fishing News Books.
Srivastava, C. B. L. (1999). Fish Biology. Narendra Pub. House.
Srivastava, C. B. L. (2006). A Text Book of Fishery Science & Indian Fisheries. Kitab Mahal. Allahabad.

Term Paper / Project Work MSCZOOLMJE407

✧ Full Marks: 50

✧ CA+ESE Marks: 10+40

✧ Credit: 4

✧ L - T - P : 4 - 0 - 0

Term Paper / Project Work (based on special paper)

[Submission (within 10,000 words) & Seminar presentation & Discussion]

Major Elective Practical MSCZOOMLMJE408

✧ Full Marks: 50

✧ CA+ESE Marks: 30+20

✧ Credit: 4

✧ L - T - P : 0 - 0 - 8

Learning Outcomes:

To enable the students to understand

MAJOR ELECTIVE: ENTOMOLOGY

1. Anatomy

- a. Cockroach: Sympathetic Nervous and male reproductive system
- b. Blue bottle fly: Digestive and Nervous systems
- c. Butterfly: Digestive and Reproductive system
- d. Any coleopteran: Nervous system
- e. Mounting: antenna, scales, spiracles, tympanum, wings (small insects-at least 5 types), legs (at least 5 types) and mouthparts at least two types

2. Taxonomy

- a. Study of insect collecting devices
- b. Methods of insect collection and preservation
- c. Identification (up to family) with reasons of Apterygote and Exopterygote (Hemimetabolans) and Endopterygote (Holometabolans) insects
- d. Study of insects of economic importance (5 species)

3. Physiology

- a. Preparation insect blood smear and identification of blood cells under microscope after proper staining
- b. Detection of amino acids by chromatography
- c. Chitosan test of cuticle

4. Toxicology

- a. Preparation of insecticidal formulation (emulsion, dust and suspension)
- b. Study of insect infestations (at least 5) in grains and forest trees
- c. Study of LC_{50} of two common insecticides against any two pests (graphical representation)

5. Study (life cycle, damage etc.) of at least 2 types of pests

6. Field Entomology-Laboratory Note Book and submission of collected Apterygote and Exopterygote (Hemimetabolans) and endopterygote (Holometabolans) insects

7. Viva-voce

MAJOR ELECTIVE: AQUACULTURE AND FISHERIES

1. Dissection of different organ systems

2. Studies of life histories of cultivated freshwater fishes, preparation and mounting of the various stages and their identification

3. Techniques of induced breeding

4. Detection of food and feeding habit by analyzing gill rakers, buccopharynx and gut content

5. Systematic identification of fishes

6. Separation of amino acids by paper and thin layer chromatography

7. Histological studies of different tissues and their identification

8. Limnological studies

9. Biochemical estimation of protein, lipid and carbohydrate from fish tissues

10. Qualitative and quantitative detection of digestive enzymes

11. Identification and mounting of some common freshwater Zooplankton, benthos, aquatic weeds and insects)
12. Electrophoretic separation of proteins and nucleic acids
13. Field study Laboratory Note and class records, submission of prepared slides
14. Viva voce