VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM&SYLLABUS (DRAFT) OF

B. Sc. (HONOURS/ HONOURS WITH RESEARCH)

MAJOR IN ZOOLOGY

4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes

(CCFUP), 2023& NEP, 2020

VIDYASAGAR UNIVERSITY
BACHELOR OF SCIENCE (HONOURS/ HONOURS WITH RESEARCH) MAJOR IN ZOOLOGY
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title		Credit	L-T-P	Marks		
									CA	ESE	TOTAL
B.Sc. (Hons./ Hons. with Research)	4th	VII	SEMESTER-VII								
			Major-14	ZOOHMJ14	T: Functional anatomy & physiological process; P: Practical		4	3-0-1	15	60	75
			Major-15	ZOOHMJ15	T: Cytogenetics and Evolutionary Process; P: Practical		4	3-0-1	15	60	75
			CRM	ZOOHCRM	T: Research Methodology and Ethics; P: Practical		4	3-0-1	15	60	75
			Major Elective-03	ZOOHDSE03	Bioinformatics & Biostatistics/ Applied Zoology / Biotechnology & Public Health		4	3-0-1	15	60	75
			Minor-07 (Disc.-I)	ZOOMIN07	T: Comparative Anatomy & Embryology of Vertebrates; P: Practical *(To be taken by the other Discipline)*		4	3-0-1	15	60	75
						Semester-VII Total	20				375
		VIII	SEMESTER-VIII								
			Major-16	ZOOHMJ16	T: Advanced Parasitology & Immunology; P: Practical		4	3-0-1	15	60	75
			Major Elective-04	ZOOHDSE04	Cell and Molecular Biochemistry OR Biophysics and Microscopy		4	3-0-1	15	60	75
			Major Elective-05	ZOOHDSE05	Environmental Issues & Management OR Biosystematics & Applied Entomology	FOR HONOURS STUDENTS	4	3-0-1	15	60	75
			Major Elective-06	ZOOHDSE06	Embryology OR Human Genetics		4	3-0-1	15	60	75
			Research	ZOOHRD	DISSERTATION:	*FOR HONOURS WITH RESEARCH STUDENTS*	*8*	*0-0-8*	*-*	*150*	*150*
			Minor-8 (Disc.-II)	ZOOMIN08	T: Molecular Biology & Biotechnology; P: Practical *(To be taken by the other Discipline)*		4	3-0-1	15	60	75
						Semester-VIII Total	20				375
						YEAR-4	40				750
			To be awarded *Bachelor of Science (Honours / Honours with Research) Major in Zoology*				166	**Marks (Year: I+II+III+IV)**			3075

MJ = Major, MI = Minor Course, DSE = Discipline Specific Elective Course, CRM= Compulsory Research Methodology, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

SEMESTER-VII

MAJOR (MJ)

MJ-14: Functional anatomy and physiological process **Credits 04 (Full Marks:75)**

MJ-14T: Functional anatomy and physiological process (Theory) *Credits 03 (45 hrs.)*

About the Course

This course examines evolutionary milestones from Precambrian life to the Cambrian explosion and subsequent terrestrial colonization. It highlights patterns of early biodiversification and the distribution of modern animal species across zoogeographical realms. Functional adaptations such as fish swimming and bird flight are analyzed through anatomical and biomechanical perspectives. The course introduces systems biology, integrating computational tools, high-throughput techniques, and biological networks. Physiological processes, stress responses, and thermoregulation are studied to understand animal survival and adaptation in varied environments.

Course Outcomes

The students at the completion of the course will be able to-

CO1. Explain key evolutionary events, including the Cambrian explosion, animal colonization on land, and patterns of biodiversification.
CO2. Functional adaptations like fish swimming and bird flight using anatomy and vector-based approaches.
CO3. Apply systems biology tools such as high-throughput methods, computation, and network analysis to biological problems.
CO4. Evaluate physiological and stress responses, including circulation, respiration, thermoregulation, and acclimatization to extreme environments.

Course Content:

Unit	Course Contents	Lectures (Hrs.)
Unit 1:	**Cambrian explosion and terrestrial animal species:** Key Cambrian explosion events: Precambrian life Small shelly fauna Uniqueness of the early Cambrian biodiversification Terrestrial Life Post-Cambrian Explosion (Later Colonization, Arthropod invasions, Environmental factors)	**5**

Unit 2:	**Animals of the 21st century and their distribution in zoogeographical realms:** Bumpy Snailfish; *Labeo chekida*; Sumatran Cascade Frog; Miniature Frogs; Caribbean lizards; *Theloderma khoii* (Khoi's mossy frog); Peleng leaf warbler; Pygmy three-toed sloth; Vangunu giant rat	**5**
Unit 3:	**Morpho-functional coordination and Bioengineering:** Swimming Mechanism in Fish (Anatomical structure &vector analysis) Flight mechanism of Birds (Anatomical structure &vector analysis)	**4**
Unit 4:	**System Biology and its components:** Biological Problems High-Throughput Technologies Computation and Mathematics Data Integration Biological Networks	**4**
Unit 5:	**Punctuated equilibrium and Darwin's thoughts:** Stasis and Spurts Speciation Fossil record evidence Criticisms of Darwinian thoughts	**5**
Unit 6:	**Stress-Response mechanisms:** Homeostasis, feedback control systems Oxidative stress; Cellular response; Free radicals and antioxidants Acclimatization to extreme conditions like hypoxia & diving	**5**
Unit 7:	**Blood, Circulatory, and Respiratory processes:** Haemopoiesis & haemostasis Regulation of blood volume and blood pressure Body oxygen stores: Haemoglobin, Oxyhaemoglobin, and Myoglobin; Oxygen dissociation curve	**6**
Unit 8:	**Cardiovascular System:** Regulation of heart pumping; gap junction Cardiac cycle & Cardiac output Neural and chemical regulation of excitation & conduction in the heart ECG – principles and interpretations	**6**
Unit 9:	**Thermoregulatory processes:** Body temperature and determinants of body heat production and loss Physical, chemical, and neural regulation of body temperature; Counter current heating & cooling mechanisms	**5**

Course Outline:

Functional Anatomy

i) Identification of Invertebrate species collected from the local area.

ii) Model demonstration of selected vertebrate species (Culturable animals).

Physiological process

i) Demonstration of haemoglobin from blood in an animal model or visualization in a structural database

ii) Bioassay of any aquatic organism using chemicals or physical factors (pH).

iii) Observation of gut movement in an animal under hypoxia using Dale's apparatus and preparing a kymograph.

iv) Comparing Blood Pressure and Heart Rate during rest and exercise

v) Determination of Breath-Holding Time (BHT)

Recommended Readings

1. "The Cambrian Explosion: Evolution's Big Bang? Or Darwin's Dilemma", by Walter L. Starkey, Last edition [2011].
2. "The geographical distribution of animals" By Alfred Russel Wallace, Macmillan and Co., Harvard University Press, London [1876].
3. "Vertebrates Comparative Anatomy, Function, Evolution" Eighth edition, Kenneth V. Kardong, Ph.D. Washington State University, McGraw-Hill Education, [2018].
4. "Systems Biology Principle, Methods and concept" Edited by A. K. Konopka, CRC Press, Taylor and Francis Group [2007].
5. "One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Thought" by Ernst Mayr, Harvard University Press, Cambridge, Massachusetts [1991].
6. Ganong's Review of Medical Physiology; McGraw-Hill.
7. Gunstream SE. 2010. Anatomy and Physiology with an integrated study guide. McGraw-Hill.
8. Guyton AC, Hall JE. 2006. Textbook of Medical Physiology. Hercourt Asia P Ltd.
9. Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sineuer Asso.
10. Kesar, S. and Vashisht, N.; 2007. Experimental Physiology, Heritage Publishers.
11. Prosser C. L. and F. A. Brown – Comparative Animal Physiology; Saunders.
12. Randall D, Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W. H. Freeman. Refinetti R. 2000. Circadian Physiology. CRC Press, Boca Raton.
13. Schmidt-Neilson K – Animal Physiology – Adaptation & Environment, Cambridge University Press.
14. Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn., Brooks & Cole Tortora, G.J. and Derrickson, B.H.; 2009. Principles of Anatomy and Physiology, XII Ed, Wiley and Sons, Inc.

MJ-15: Cytogenetics and Evolutionary Process — Credits 04 (Full Marks: 75)

About the Course

This course provides an in-depth understanding of the cytogenetic basis of heredity and its role in evolutionary processes. It covers the **genetics of prokaryotes**, mechanisms of population genetics, and the principles of genetic equilibrium and genetic variation that drive evolutionary changes. Emphasis is placed on how genetic alterations at the cellular and molecular levels contribute to the process of adaptation, natural selection, and speciation. Students will gain both theoretical knowledge and practical skills relevant to the fields of genetics, cytogenetics, and evolutionary biology.

Course Outcomes:

Upon successful completion of this course, students will be able to:

CO1. **Perform transcriptional analysis using in situ hybridization techniques** to visualize gene expression at the chromosomal level, thereby understanding the regulation of genetic activity.
CO2. **Carry out gene mapping studies in** *Escherichia coli* and other model organisms to determine gene location, linkage, and recombination frequencies, thereby gaining insights into microbial genetics.
CO3. **Analyse evolutionary changes through population genetics approaches**, including the study of genetic drift, mutation, migration, and selection, and explain their role in the emergence of new species (speciation).
CO4. **Interpret the relationship between chromosomal variations and evolutionary processes**, with special reference to polyploidy, chromosomal aberrations, and molecular cytogenetics.
CO5. **Develop problem-solving skills** by applying the principles of cytogenetics and evolutionary biology to experimental data and case studies relevant to biodiversity, conservation, and human genetics.

MJ-15T: Cytogenetics and Evolutionary Process (Theory) — *Credits 03 (45 hrs.)*

Course Content:

Unit	Course Contents	Lectures (Hrs.)
Unit- 1	**The structure and function of the eukaryotic chromosome:** Polytene chromosome structure and sequence organization.	**4**
Unit- 2	**Regulation of gene expression in *E. coli*:** Constitutive, Inducible, and repressible gene expression, Positive and negative control of gene expression, Lactose and Tryptophan Operon in bacteria.	**8**
Unit- 3	**Genetic fine structure:** The rII fine structure, complementation, and deletion mapping	**4**

Unit- 4	**Genetic transfer and mapping in Bacteria and bacteriophages:** Conjugation mapping, Transduction mapping.	**5**
Unit- 5	**Medical genetics and cancer:** Genetic analysis of human diseases, the genetic basis of cancer.	**6**
Unit- 6	**Genetic analysis of population:** Theory of allele frequencies, Genetic equilibrium, estimation of equilibrium frequencies in natural populations. Changes in gene frequencies through natural selection, mutation, migration, and genetic drift	**10**
Unit- 7	**Molecular Evolution:** Molecules as documents of evolutionary history, molecular phylogenetics, and rates of molecular evolution	**8**

MJ-15P: Cytogenetics and Evolutionary Process (Practical) *Credits 01 (30 hrs)*

Course Outline:

1. Studies on the life history of *Drosophila melanogaster*, identification of larval stages and adults.
2. Dissection of salivary gland, preparation of polytene chromosome from 3rd instar larva, studies on band, inter-band, and puffs.
3. Analytical studies on the Genetic cross of different mutants of *Drosophila*.
4. Making a molecular phylogenetic tree by gene sequences and amino acid sequences

Recommended Readings:

1. Griffiths, A. J. F., Doebley, J., Peichel, C., & Wassarman, D. A. (2025). *Introduction to Genetic Analysis* (12th ed., Digital Update). W. H. Freeman & Company. ISBN: 978-1319337797.
2. Lewin, B. (2019/2020). *Lewin's GENES XII* (12th ed.). Jones & Bartlett Learning. ISBN: 978-1284104493.
3. Brooker, R. J. (2023). *Genetics: Analysis and Principles* (8th ed., International Student Edition). McGraw-Hill Education. ISBN: 978-1265350796.
4. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (1999). *An Introduction to Genetic Analysis* (7th ed.). W. H. Freeman.
5. Pierce, B. A. (2020). *Genetics: A Conceptual Approach* (7th ed.). W. H. Freeman & Company. ISBN: 978-1319216801.
6. Russell, P. J. (2010). *iGenetics: A Molecular Approach* (3rd ed.). Benjamin Cummings (Pearson). ISBN: 978-0321569769.
7. Snustad, D. P., & Simmons, M. J. (2015). *Principles of Genetics* (7th ed.). Wiley. ISBN: 978-1119142287.
8. Hartl, Daniel L., & Ruvolo, Maryellen. *Genetics: Analysis of Genes and Genomes* (8th Edition). Jones & Bartlett Publishers, 2012. ISBN 978-1449626105.

COMPULSORY RESEARCH METHODOLOGY (CRM)

[for both Hons. and Hons. with Research students]

CRM: Research Methodology and Ethics

About the Course

The course is designed to provide postgraduate students with a comprehensive understanding of the fundamental principles and practical aspects of research processes while emphasizing the importance of ethical conduct in scholarly inquiry. Covering key topics such as research design, literature review, data collection and analysis, and scientific writing, the curriculum also addresses essential ethical issues, including intellectual honesty, plagiarism, research integrity, authorship, and responsible publication practices. Through a blend of conceptual frameworks, case studies, and applied exercises, the course equips students to engage critically with methodological challenges and ethical dilemmas, fostering both academic rigor and social responsibility in research.

Course Outcomes

On successful completion of the course, students will be able to:

CO1. Develop an understanding of different types of research problems and the different steps of formulation of research problems according to their roles in real life.
CO2. Generate research questions associated with research problems.
CO3. List various sources of information for literature review and data collection
CO4. Apply different research techniques and methodologies for implementation so that the research problem can be solved.

CRM (T): Research Methodology and Ethics (Theory) ***Credits 04 (60 Hrs.)***

Course Content:

Unit	Course Contents	Lectures (Hrs.)
Unit 1:	**Facets of Research Design:** Importance and features of research; Research prototype; phenomenological and positivistic research; inductive and deductive reasoning	6
Unit 2:	**Research problems and processes:** Identification and formulation of research problem; research questions and objectives; Hypothesis – meaning, role, and types - *a priori* and *a posteriori* hypotheses testing	8

	Research design – meaning, significance, and types (exploratory, descriptive, analytical, and experimental). Experimental design- informal and formal; concept of replicates and its application in biology	
Unit 3:	**Data Collection** Types of data – primary and secondary; sources of data; methods of data collection – observation, interview, questionnaire, case study, experiment, content analysis**; distinction between method and methodology**	6
Unit 4:	**Sampling Methods** Concept of sampling; probability sampling – simple, random, stratified, cluster, systematic; non-probability sampling – purposive, convenience, quota, snowball.	4
Unit 5:	**Basics of drafting scientific papers** Writing scientific research papers, concept of IMRAD, types of research articles, literature review, style and formats for references, and graphical presentations. Empirical, case study, methodology, and theoretical papers	5
Unit 6:	**Research Ethics and Integrity** Nature and scope of ethical practice in research and academia; Responsibilities of researchers - honesty, transparency, and accountability; Academic integrity and scientific misconduct: plagiarism, data fabrication, falsification, selective reporting, redundancy and overlapping publications; Concepts of privacy, autonomy, confidentiality, and anonymity in research; ethical handling of sensitive data.	10
Unit 7:	**Publication Ethics and Professional Conduct** Definition and importance of publication ethics; publication misconduct; conflict of interest; authorship issues; responsibilities of editors, reviewers, and publishers; Peer review ethics and transparency	6
Unit 8:	**Research Metrics** Impact Factor, h-index, g-index, i10-index; altmetrics and their role in evaluating research impact.	5
Unit 9:	**Exercise:** **Submission of Review of Literature or Project Proposal**	10

Recommended Readings:

1. Baran E., Warry F. 2008 Simple data analysis for biologists. World Fish Center and the Fisheries Administration. Phnom Penh, Cambodia. 67 pages.
2. Grafen A, Hailes R. 2002. Modern Statistics for Life Sciences. Oxford University Press, New York, USA.351.
3. Holmes D, Moody P, Dine D, Trueman L 2010. Research Methods for the Biosciences. 2nd ed. Oxford University Press, New York, USA. 460p
4. Mangel M. 2006. The theoretical Biologist's toolbox. Quantitative Methods for Ecology and Evolutionary Biology. Cambridge University Press, New York, USA. 390p.
5. Hurlbert SH. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs, 54(2); 187 – 211.
6. Kothari, C. R., and Garg, G., Research Methodology: Methods and Techniques, New Age International Publishers; 4th edition, 2019.
7. Quinn GP, Keough MJ.2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press, Cambridge UK 537p.
8. Zar JH. 1999. Biostatistical Analysis. IV ed. Pearson Education Pte Ltd. Singapore (Indian Branch) New Delhi, India. 663 pages
9. Davis, M.: Scientific Papers and Presentations. Academic Press, San Diego (1997)
10. Day, R.A.: How to Write and Publish a Scientific Paper. Second edn. ISI Press, Philadelphia (1983)
11. Council of Biology Editors: Proposed definition of a primary publication. Newsletter,
12. Council of Biology Editors (1968)
13. Booth, W.C., Colomb, G.G., Williams, J.M.: The Craft of Research. Univ. of Chicago Press, Chicago (1995)
14. Stock, W.G.: Was ist eine Publikation? Zum Problem der Einheitenbildung in der Wissenschaftsforschung. In Fuchs-Kittowski, K., Laitko, H., Parthey, H.,Umstätter, W., eds.: Wissenschaftsforschung Jahrbuch 1998. Verlag für Wissenschaftsforschung, Berlin (2000) 239- 282
15. O'Connor, M.: Writing Successfully in Science. Chapman & Hall, London (1995)
16. Peat, J., Elliott, E., Baur, L., Keena, V.: Scientic Writing - Easy when you knowhow. BMJ Books, London (2002)
17. Swales, J.M.: Genre analysis: English in academic and research settings. Cambridge Univ. Press, Cambridge (1993)
18. Berry, R.: How to Write a Research Paper. Second edn. Pergamon Press, Oxford (1986)
19. Dees, R.: Writing the Modern Research Paper. Second edn. Allyn & Bacon, Boston (1997)

MAJOR ELECTIVE (DSE)

Major Elective – 03:

(Bioinformatics & Biostatistics/ Applied Zoology / Biotechnology & Public Health)

MJDSE-03: Bioinformatics & Biostatistics **Credits 04 (Full Marks: 75)**

About the Course

This course provides a comprehensive introduction to the principles and applications of biostatistics and bioinformatics in modern biological research. The biostatistics component focuses on methods for data collection, summarization, visualization, and statistical inference, enabling evidence-based decision-making in the presence of uncertainty. The bioinformatics component introduces computational approaches for analysing biological data, with emphasis on sequence alignment, database searching, molecular phylogenetics, and the use of online tools and software for genomic and proteomic studies. Together, these components equip students with quantitative and computational skills essential for contemporary life sciences.

Course Outcome:

On successful completion of this course, students will be able to:

CO1. Explain the theoretical foundations of **parametric and nonparametric statistics** and apply them to biological datasets.

CO2. Perform and interpret standard statistical analyses, including **t-tests, Chi-square tests, correlation, regression, and ANOVA.**

CO3. Utilize **biostatistical and bioinformatics software tools** for data visualization, hypothesis testing, and biological interpretation.

CO4. Apply **bioinformatics approaches** such as sequence alignment, database mining, molecular phylogeny construction, and gene/protein annotation.

CO5. Integrate biostatistical reasoning and bioinformatics tools to solve complex problems in **genomics, proteomics, molecular biology, and biomedical sciences**.

CO6. Develop analytical, computational, and critical thinking skills necessary for research, data-driven decision making, and preparation for competitive examinations.

MJDSE-03T: Bioinformatics & Biostatistics (Theory) *Credits 03 (45 hrs)*

Course Content:

Unit	Course Contents	Lectures (Hrs.)
Unit- 1	**Basics of Bioinformatics** Introduction and scope of bioinformatics: concept of digital laboratory; Basics of information technology, computer, operating systems, network; Introduction to data archiving systems (FASTA format and Accession Number); Applications of bioinformatics.	**6**
Unit- 2	**Database Management: Software, Packages, and Tools** Basic features and management systems of Nucleic acid sequence databases, genome databases, protein sequence, structures, and interacting proteins databases, literature databases; Introduction to data retrieval systems, Search engines, Entrez, sequence retrieval system (SRS), and protein identification resource (PIR); Sequence alignments (BLAST and Clustal W) and phylogenetic trees (PHYLIP).	**12**
Unit- 3	**Data Collection, Distribution, Presentation, Authentication, and Analysis** Collection and classification of data; Graphical representation of data: Pie chart, Bar diagram, Histogram, Frequency polygon. Cumulative frequency curve (Ogive), Box plot; Probability theory: Binomial distribution, Poisson distributions; Measures of central tendency: Mean, Median, Mode; Measures of dispersion: Variance, Standard deviation, and Standard error; Concept of Coefficient of variation.	**15**
Unit- 4	**Unit 4: Statistical Tests** Correlation: Types of correlation, calculation of correlation, Partial and multiple correlation; Regression: Linear regression, regression coefficient; Hypothesis testing: Parametric tests (Paired and unpaired t-test, z-test, & F-test) Analysis of variance (ANOVA): One-way, post-hoc tests; Non-parametric tests (Rank Correlation, Chi-square test, Mann-Whitney U-test).	**12**

MJDSE-03P: Bioinformatics & Biostatistics (Practical) *Credits 01 (30 hrs)*

1. Perform Chi-square test, t-test, z-test, F test, ANOVA, and Mann-Whitney U-test analysis from the provided data.
2. Solve the problems related to correlation and regression from the supplied data.

3. Graphically represent the supplied data (Pie chart, Bar diagram, Histogram, Frequency polygon, Cumulative frequency curve).
4. Introduction to Biological Databases: NCBI, EMBL, DDBJ, UniProt, PDB. Retrieval and management of nucleotide and protein sequence data.
5. Sequence Alignment: Pairwise alignment using BLAST and FASTA; Multiple sequence alignment (MSA) using CLUSTAL Omega; Interpretation of alignment scores and significance.
6. Phylogenetic Analysis: Construction of phylogenetic trees from aligned sequences; Interpretation of evolutionary relationships.
7. Genomics and Proteomics Tools: Gene prediction tools and annotation methods; Analysis of protein domains and motifs (Pfam, PROSITE, InterPro); Secondary and tertiary structure prediction (SWISS-MODEL, Phyre2).
8. Molecular Visualization: Structural visualization using tools such as PyMOL or RasMol.

Recommended Readings:

1. Daniel, W.W. (2012). Biostatistics: A Foundation for Analysis in Health Sciences (10th edition). John Wiley.
2. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition), McGraw-Hill.
3. Zar, J.H. (2013). Biostatistical Analysis (5th edition). Pearson.
4. Barnes, M.R. and Gray, I.C. (2003) Bioinformatics for geneticists, Wiley.
5. Mount, D.W. (2006) Bioinformatics (2nd edition) CBS.

OR

MJDSE-03: Applied Zoology **Credits 04 (Full Marks: 75)**

About the Course

The study of the Applied Zoology program focuses on developing theoretical and practical knowledge in sericulture, lac culture, apiculture, fishery, dairy and poultry farming, vermiculture, and pearl culture, among others. Based on the acquired experience, students will be encouraged to take up a small-scale business as a career.

Course Outcomes

Applied Zoology deals with the application of Zoological knowledge for the welfare of mankind. At the end of the course, the student will be able to:

CO1. To understand the different breeds in poultry and dairy farming, along with their management
CO2. Gain knowledge about silkworm rearing and their products.
CO3. Acquire knowledge about the culture techniques of oyster and prawn.
CO4. Acquire knowledge about the basic procedure and methodology of vermiculture.
CO5. Learn various aspects of beekeeping & lac culture.
CO6. Know the concepts of induced breeding techniques and post-harvesting techniques of fish.

MJDSE-03T: Applied Zoology (Theory) *Credits 03 (45 hrs)*

Course Content:

Unit	Course Contents	Lectures (Hrs.)
Unit- 1	**Poultry & Dairy Farming** Types of poultry breeds, poultry housing, farm, and farm Management. Egg grading, handling, and marketing management of poultry diseases. Composition of Milk, Dairy products, National Dairy Development Board, and Operation Flood Program.	**10**
Unit- 2	**Economic Zoology** **2.1 Sericulture:** Definition, Types of silkworms and their host plants; Life cycle of Bombyx mori; Structure of silk gland; Silk: composition, characteristics, and uses; Diseases and pests of silkworms and their control measures; Genetic improvement of silk breed in India; Prospects of sericulture in India. **2.2: Apiculture:** Definition, Status and Scope, Products of Apiculture and their uses, Life Cycle of the Honey Bee **2.3: Prawn culture:** Types of cultivable prawn species; Different categories of modern prawn culture; Culture of prawn in brackish water and fresh water and	**28**

	their advantages; Hazards of brackish water and fresh water prawn culture and their control; Prawn breeding; Preservation and processing of prawn; Prospects of prawn culture in India. **2.4: Pearl Culture:** Definition: Chemical composition and uses of pearl; Pearl-producing oysters; Process of pearl formation; Biology of pearl oyster; Pearl oyster farming. Recent development leading to the quality of pearl and prospects of pearl culture in India.	
Unit- 3	**Vermitechnology:** Definition of vermiculture, vermicomposting, and vermi-bed; Suitable and non-suitable breeds for vermiculture; Vermiculture process; Advantages and disadvantages of vermicomposting; Prospects of vermiculture.	**07**

MJDSE-03P: Applied Zoology (Practical) *Credits 01 (30 hrs)*

Course Outline:

1. Finding out the significance and identification of economically significant animals such as *Antheraea* sp., *Bombyx mori*, *Penaeus* sp., *Macrobrachium* sp., *Pinctada* sp., *Eisenia* sp, and *Apis dorsata*
2. Identification and application of different rearing tools and equipment used in sericulture and lac culture.
3. Study of the morphology of different stages of the silk moth and the lac insect (through photographs).
4. Identification and uses of the products of sericulture and lac culture.
5. Identification of penaeid and non-penaeid groups from the supplied prawn specimens.
6. Identification of different species of earthworm used for vermicomposting, Estimation of pH of vermicompost.
7. Visit to Sericulture farm /Lac culture farm/Prawn processing farm/ Pearl culture center and submission of the report.

Suggested Readings:

1. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
2. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan.
3. Dunham, R.A. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.
4. Sharma P.L. and Singh, S.H. Book of Bee Keeping

5. Khanna and H.R. Singh, A textbook of Fish Biology and Fisheries, Narendra Publishing House.
6. Ghorai, N. Lac culture in India. International Books and Periodicals, New Delhi.
7. Pillay, T.V.R. Aquaculture Principles and Practices, Fishing New Books, Blackwell Science Ltd.
8. Banerjee, G.C. A Text Book of Animal Husbandry. Oxford and IBH Pub. Co. Pvt. Ltd, New Delhi.
9. Singh, H. and Moore, E.N. Livestock and Poultry Production. Prentice-Hall of India Pvt. Ltd, New Delhi.

OR

MJDSE-03: Biotechnology & Public Health **Credits 04 (Full Marks: 75)**

About the Course:

The course is designed to enlighten the students on both the basic principles and practical applications of Biotechnology in the progress of industrial, medical, agricultural, and aquacultural sectors of modern civilization. The course also highlights the role of Biotechnology in managing environmental pollution.

Moreover, the course focuses on the fundamental aspects of public health issues, as well as the causes and control of various vector-borne and food- or water-borne diseases. Further, the course highlights the role of vaccination in promoting public health.

Course Outcomes:

Upon completing the course, the students will be able to understand:
CO1. The basic principles of gene cloning and cDNA technology,
CO2. The application of Biotechnology in the production of biofuels, clinically useful substances, improved varieties of crops, and pest-resistant plants.
CO3. The use of Biotechnology in the management of environmental pollution.
CO4. The cause and control of different vector-borne and food-borne diseases.
CO5. The role of vaccination in promoting public health.

MJDSE-03T: Biotechnology & Public Health (Theory) *Credits 03 (45 hrs)*

Course Content:

Unit	Course Contents	Lectures (Hrs.)
Unit 1:	**Unit 1: Key Aspects of Biotechnology** Meaning and advantages of Biotechnology; Purview of Biotechnology: white, red, green, blue, and environmental biotechnology; Restriction and modifying enzyme, Recombinant DNA: Production of recombinant DNA molecule, Cloning vectors ; Gene cloning vs. cDNA technology; Biotechnology sector (Sunrise sector) of India and National Biotechnology Development Strategy (NBDS).	**6**
Unit 2:	**Unit 2: White (Industrial) Biotechnology** Need and advantage of biofuel production; Principles of bio-ethanol and bio-diesel production.	**3**

Unit 3:	**Unit 3: Red (Medical) Biotechnology** Production of human insulin by genetic engineering	**3**
Unit 4:	**Unit 4: Green (Agricultural) Biotechnology** Production and utility of golden rice; Controversies over genetically modified crops (GMC).	**3**
Unit 5:	**Unit 5: Blue (Aquacultural) Biotechnology** Production of transgenic fish and its application	**3**
Unit 6:	**Unit 6: Environmental Biotechnology** Bioremediation; Production of 'superbug'; Vermicomposting and its utility	**3**
Unit 7:	**Unit 7: Biotechnology-related laboratory techniques** Agarose gel electrophoresis; Southern blotting hybridization, Western blotting hybridization, Polymerase chain reaction (PCR), Cell fractionation	**5**
Unit 8:	**Unit 8: Introduction to Public Health Issues** Zoonotic and vector-borne diseases; Endemic, epidemic and pandemic diseases; Mechanical and biological vectors of diseases; Propagative, cyclo-propagative, and cyclo-developmental transmission of diseases, virus-associated human cancer	**5**
Unit 9:	**Unit 9: Vector-borne diseases** Life cycle of *Plasmodium vivax* and *Leishmania donovani*; Mode of transmission, pathogenicity and symptoms, diagnosis and treatment/control, and prophylaxis of Cerebral malaria, Kala-azar, and Dengue. Mosquito control measures: chemical, environmental, and biological measures	**7**
Unit 10	**Food and water-borne diseases** Mode of transmission, pathogenicity and symptoms, diagnosis and treatment/control, and prophylaxis of Amoebiasis and Shigellosis.	**3**
Unit 11	**Vaccination to promote public health** Utility of vaccination; Formulation and efficacy of BCG vaccine, oral polio vaccine; National Immunization Schedule in India.	**4**

1. Agarose gel electrophoresis
2. Tissue homogenization
3. Demonstration of PCR
4. Microscopic identification with reasons: Signet ring of malaria parasite, Microfilaria larva, Entamoeba histolytica (trophozoite), some important vectors, Head of female Anopheles and Culex mosquitoes.
5. Observation of people's awareness on any health issue in any locality (E.g., Source of drinking water used by villagers; Measures taken by villagers to avoid mosquito-borne diseases; Use of sanitary napkin by village women; Practice of Yoga and physical exercise by school children; Awareness of villagers on any other health issue), University USIC visit

Recommended Readings:

1. Chatterjee, K. D. (2009). Parasitology (Protozoology and Helminthology), 13th edition, CBS Publishers & Distributors, Kolkata.
2. Dubey, R. C. (2022). A Textbook of Biotechnology, S. Chand and Co. Ltd., New Delhi
3. Mullen, G. R. and Durden, L. A. (2018). Medical and Veterinary Entomology, 3rd edition, Academic Press, London.
4. Singh, B. D. (2025). Biotechnology (Expanding Horizons), 6th edition, Kalyani Publishers, New Delhi.
5. Thieman, W. J. and Palladino, M. A. (2014). Introduction to Biotechnology, 3rd edition, Pearson, London.
6. Hati A.K. (2001) Medical Parsitology, Allied Book Agency, Kolkata
7. Eiteman, D. K., Moffett, M. H., Stonehill, A. I., Thieman, W. J., & Palladino, M. A. (2020). Introduction to Biotechnology (4th Ed.). Pearson.
8. Clark, D. P., & Pazdernik, N. J. (2015). Biotechnology (2nd Ed.). Academic Cell (Elsevier).
9. Park, K. (2021). Park's Textbook of Preventive and Social Medicine (26th Ed.). Banarsidas Bhanot.
10. Tuttle, T. D. (2020). Principles of Public Health: A Simple Textbook on Hygiene Presenting the Principles Fundamental to the Conservation of Individual and Community Health. Lector House.
10. Lal, S., & Vikas. (2025). Public Health Management: Principles and Practice (4th Ed.). CBS Publishers & Distributors Pvt. Ltd.
11. Roberts, L. S., Janovy, J. and Nadler S. (2013) *Gerald D. Schmidt &Lary S. Roberts' Foundation of Parasitology*. 9th ed. McGraw-Hill International.
12. Lynne Shore Garcia (2007) Diagnostic Medical Parsitology (5thEdn) ASM press Washington D.C.

13. T.A. Brown (2010) Gene cloning an DNA analysis- An introduction (6thEdn) Willey Blackwell
14. iGenetics: A Molecular Approach by Peter J. Russell 3rd Edn. (2010)
15. Mosquito (2001) G. Chandra, Sribhumi Publ.

MINOR (MI)

Minor (MI)-07: Comparative Anatomy & Developmental Biology of Vertebrates

Credits 04 (Full Marks:75)

MI-07T: Comparative Anatomy & Developmental Biology of Vertebrates (Theory) *Credits 03 (45 hrs)*

About the Course

This course is designed at graduation level to know comparative account of the different vertebrate systems as well as basic embryology. The primary objective is to analyse and critically evaluate the structure and functions of vertebrate systems as well as early and late embryonic developmental process in vertebrates.

Course Outcomes

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

1. Learn the comparative account of integument, skeletal components, their functions and modifications in different vertebrates.
2. Understand the evolution of heart, modification in aortic arches, structure of respiratory organs.
3. Learn the about the importance of sense organs and excretory organs of vertebrates.
4. Understand the early embryonic developmental processes such as gametogenesis, fertilization, cleavage pattern, gastrulation, induction and organization.
5. Learn about the late embryonic developmental processes such as implantation and placentation.

Course Contents-

Units	Topics	Lecture (Hrs.)
Unit 1	**Integumentary System** General Structure & Derivatives of integument with reference to glands from fish to Mammalia; Feathers in birds; Hair, horn and antler in mammals.	**5**
Unit 2	**Skeletal System** General idea of axial and appendicular skeleton; Evolution of visceral arches.	**3**
Unit 3	**Digestive System** Comparative account of digestive system in vertebrates with special reference to ruminant stomach in mammals; Dentition in mammals.	**5**
Unit 4	**Respiratory System**	**5**

	Brief account of gills and swim bladder in fishes, air sacs in birds and lungs in mammals.	
Unit 5	**Circulatory System** Comparative account of heart and aortic arch with their evolutionary significance in vertebrates.	**5**
Unit 6	**Urinogenital System** Types and development of kidneys and their ducts in anamniotes and amniotes.	**3**
Unit 7	**Nervous System & Sense Organs** Comparative account of brain in vertebrates; Classification of receptors, Brief account of auditory receptors in vertebrate.	**5**
Unit 8	**Early Embryonic Development** Gametogenesis: Spermatogenesis and oogenesis with reference to mammals; Fertilization: Types of fertilization & process of fertilization in mammals; Cleavage: Planes and patterns of cleavage; cleavage process in frog; Types of blastula; Fate maps; Gastrulation: Morphometric movements and process of gastrulation in frog.	**10**
Unit 9	**Late Embryonic Development** Fate of germ layers; Extra-embryonic membranes in Chick; Structure, types and functions of placenta.	**4**

MI-07P: Comparative Anatomy & Developmental Biology of Vertebrates (Practical) Credits 01 (30 hrs)

1. Demonstration (through dissection/video/chart/model) & identification of different parts of Brain, Afferent and Efferent branchial system in Tilapia/Rohu.
2. Dissection and mounting of pituitary gland in Tilapia/Rohu and Pecten in fowl.
3. Mounting of cycloid, ctenoid and placoid scale in fish.
4. Identification of limb bones, girdles and vertebrae of *Bufo, Collumba and Cavia*.
5. Identification of skull in toad, turtle, poisonous snake, *Coulmba, & Cavia*.
6. Study of developmental stages - whole mounts and sections through permanent slides or photomicrographs – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
7. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.

Suggested reading:

1. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.
2. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
3. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
4. Jordon & Verma . Chordate Emcryp;gy. S. Chand Pub. New Delhi.
5. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
6. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
7. Saxena, R.A. & Saxena, S. Coperative Anatomy of Vertebrates. Viva Publication.
8. Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.

SEMESTER-VIII

MAJOR (MJ)

MJ-16: Advanced Parasitology & Immunology **Credits 04 (FM:75)**

About the Course:

The course is designed to enlighten students not only on the basic aspects of Parasitology but also on how different parasites cause diseases such as Malaria, Kala-azar, Filaria, and Schistosomiasis in human beings. The course also highlights the role of insect and arachnid vectors in the spread of several diseases in human populations. In addition, the course will provide an overview of the management and control of various parasitic diseases, as well as their vectors.

Moreover, the course focuses on the etiology of various immunological disorders, including autoimmune diseases, hypersensitivity reactions, and immunodeficiency. Further, the course highlights the role of vaccination in promoting public health. Finally, the course will enlighten the students on the basic principles of different immunodiagnostic techniques.

Course Outcomes:

Upon completing the course, the students will be able to understand:

1. The basic concepts of Parasitology and different terminology used in Parasitology.
2. The life-cycle, transmission, pathogenicity, and control of different protozoan and helminthic parasites.
3. The role of insect and arachnid vectors in spreading different diseases in human populations. Also, the principles of integrated vector management.
4. The cause and consequence of immunological disorders like autoimmune diseases, hypersensitivity reactions, and immunodeficiency.
5. The role of vaccination in promoting public health.
6. The basic principles of different immunodiagnostic techniques.

MJ-16T: Advanced Parasitology & Immunology (Theory) *Credits 03 (45 hrs.)*

Course Contents:

Unit	Course Contents	Lectures (Hrs.)
Unit 1:	**Basic concept:** Distinction between parasitism, commensalism, amensalism, predation and phoresis; Types of parasites and hosts; Zoonosis and anthroponosis; Mechanical and biological vectors of diseases; Mechanical and biological (propagative, cyclo-propagative, cyclo-developmental) and transovarian transmission of parasites.	**6**

Unit 2:	**Protozoan parasites:** Life-cycle, transmission, pathogenicity and control of *Girdia lamblia, Trypanosoma cruzi* and *Plasmodium falciparum.*	**3**
Unit 3:	**Helminthic parasites:** Life-cycle, transmission, pathogenicity and control of *Schistosoma mansoni* and *Wuchereria bancrofti*. Structural and physiological adaptation in parasitic helminthes. Structure and composition of helminth cuticle	**5**
Unit 4:	**Arthropod parasites:** Difference between hard and soft ticks; Role of hard and soft ticks in transmission of diseases. Difference between ticks and mites; Common mite diseases of man.	**3**
Unit 5:	**Integrated vector management:** Mechanical, chemical, biological and environmental control measures against mosquito, sandfly and ticks.	**3**
Unit 6:	**Host-Parasite Relationship:** Origin and evolution of parasitism; Host-parasite interactions; Immune evasive strategies of parasites with special reference to antigenic variation and molecular mimicry.	**4**
Unit 7:	**Autoimmunity**: Basic concept of Immunity, Antigen-Antibody interaction, Concept of self-tolerance and autoimmunity; Autoimmune disorders due to viral infection, molecular mimicry and autoantibody; Drug-induced autoimmunity; Female prevalence of autoimmune disorders.	**6**
Unit 8:	**Hypersensitivity:** Meaning of hypersensitivity; Mechanism and examples of types I, II, III and IV hypersensitivity reactions.	**3**
Unit 9:	**Vaccine biology:** Passive immunization vs vaccination; Characteristics and mode of action of killed, live but attenuated, subunit, recombinant antigenic, and non-antigenic molecular vaccines; Difficulties in development of HIV vaccine.	**5**
Unit 10	**Immunodeficiency disorders:** Primary immunodeficiency – SCID; Acquired immunodeficiency – AIDS.	**3**
Unit 11	**Immunodiagnostics:** Basic principles and applications of the Mantoux test, ELISA, RIA, Immunoelectrophoresis, and Rocket immunoelectrophoresis.	**4**

Course Outline:

1. **Identification of parasites and vectors with reasons**: Protozoan parasites (e.g., Signet ring of malaria parasite, *Entamoeba histolytica* (trophozoite), *Leishmania donovani*); Helminthic parasites (e.g., Liver fluke, *Ascaris sp*., Microfilaria larva); Vectors (e.g., Tick, Mite, Head of female *Anopheles* and *Culex* mosquitoes, *Pediculus sp*., *Cimex sp*.).
2. **Histological identification with reasons**: Mammalian spleen, thymus, lymph node and blood leucocytes.
3. **Staining of Parasite**: Staining of gut content of cockroach and rectal content of toad for demonstration of parasitic protozoa.
4. **Isolation of macrophage from white rat**
5. **Antigen-antibody reaction**: Determination of ABO blood group and Rh factor by *in vitro* antigen-antibody reaction.
6. Laboratory Note Book preparation.

Recommended Readings:

1. Bogitsh, B. J. and Cheng, T. C. (2000). Human Parasitology. 2nd Ed. Academic Press, New York.
2. Chandler, A. C. and Read. C. P. (1961). Introduction to Parasitology, 10th ed. John Wiley and Sons Inc., New Jersey, USA.
3. Chatterjee, K. D. (1981). Parasitology (Protozoology and Helminthology).13th ed. CBS Publishers, New Delhi.
4. Cheng, T. C. (1986). General Parasitology. 2nd ed. Academic Press, Inc., Orlando. U.S.A.
5. Cox, F. E. G. (1993). Modern Parasitology. 2nd ed. Blackwell Scientific Publications. Lea and Febiger, Philadelphia, USA.
6. Hati, A. K. (2001). Medical Parasitology. Allied Book Agency, Kolkata.
7. Kindt, T. J., Goldsby, R. A. and Osborne, B. A. (2006). Kuby Immunology, 6th edition, W. H. Freeman & Co Ltd., New York.
8. Noble, E. R. and Noble G. A. (1989). Parasitology. The Biology of Animal Parasites. 6th ed. Lea and Febiger, Philadelphia, USA.
9. Roberts, L. S., Janovy, J. and Nadler S. (2013). Gerald D. Schmidt & Lary S. Roberts' Foundation of Parasitology. 9th ed. McGraw-Hill International, New York, USA.
10. Delves, P. J., Martin, S. J., Burton, D. R. and Roitt, I. M. (2017). *Roitt's Essential Immunology*. 13th ed. John Wiley and Sons Inc., New Jersey, USA.
11. Smyth, J. D. (1994). Animal Parasitology. 3rd ed. Cambridge University Press, Cambridge, Shaftesbury Road, UK.
12. Weir, D. M. (1993). Immunology. 7th ed. Churchill Livingstone, Edinburgh, UK.

Major Elective – 04:

(Cell and Molecular Biochemistry OR Biophysics and Microscopy)

MJDSE-04: Cell and Molecular Biochemistry **Credits 04 (Full Marks: 75)**

About the Course

This course provides an advanced understanding of the molecular and biochemical basis of cellular structure, function, and regulation. It emphasizes protein structure and dynamics, metabolic regulation, signal transduction, intracellular protein trafficking, and cell cycle control. The course integrates biochemical pathways with cellular processes and highlights their relevance to physiology, disease mechanisms, and modern biomedical research. Students will develop the ability to analyze complex molecular interactions underlying normal cellular function and pathological conditions such as cancer and metabolic disorders.

Course Outcomes (COs)

After successful completion of this course, students will be able to:
CO1. Explain the structural organization, folding mechanisms, and functional regulation of proteins at the molecular level.
CO2. Analyze bioenergetic pathways and metabolic networks and explain their regulation under physiological and hormonal control.
CO3. Describe and interpret major cell signaling mechanisms and pathways involved in cellular communication and disease.
CO4. Understand molecular mechanisms of protein targeting, translocation, and intracellular trafficking across cellular compartments.
CO5. Explain the molecular regulation of the cell cycle, programmed cell death, and their implications in cancer and other diseases.

MJDSE-04T: Cell and Molecular Biochemistry (Theory) *Credits 03 (45 hrs)*

Course Content:

Unit	Course content	Hours
Unit-I	**Protein Structure, Folding, and Function** • Levels of protein structure: primary, secondary, tertiary, and quaternary • Protein folding mechanisms and folding pathways • Role of molecular chaperones and chaperonins • Protein stability and misfolding disorders • Post-translational modifications (phosphorylation, glycosylation, acetylation, ubiquitination)	**9**

	• Protein targeting signals and intracellular localization	

Unit II	**Moving Proteins into Membranes and Organelles**
	• Protein synthesis on free vs membrane-bound ribosomes
	• Signal peptides and signal recognition particle (SRP)
	  ○ Protein translocation into: Endoplasmic Reticulum, Mitochondria, and Nucleus
	• Nuclear localization and export signals
	  ○ Vesicular trafficking mechanisms: COPI, COPII, and Clathrin-coated vesicles
		9

Unit III	**Bioenergetics and Metabolic Regulation** • Enzyme regulation and allosterism • Principles of bioenergetics and ATP generation • Mitochondrial electron transport chain • Oxidative phosphorylation and chemiosmotic theory • Hormonal regulation of metabolism (insulin, glucagon, epinephrine)	**9**
Unit IV	**Cell Signaling Mechanisms** • Receptor–ligand interactions and signal specificity • Types of receptors: ion-channel-linked, GPCRs, enzyme-linked receptors • Second Messengers: cAMP, cGMP, Calcium signaling (Ca^{2+}), IP_3, and DAG • Signal Transduction Components: Protein kinases and phosphatases • Major Signaling Pathways: MAPK / ERK pathway, PI3K–Akt pathway, JAK–STAT pathway	**9**

Unit V	**Cell Cycle Regulation**
	• Overview of the cell cycle phases
	• Cyclins and cyclin-dependent kinases (CDKs)
	• Regulation of CDK activity
	• Molecular details of cell cycle checkpoints:
	  ○ G_1/S checkpoint
	  ○ G_2/M checkpoint
	  ○ Spindle assembly checkpoint
	• Programmed cell death: Apoptosis (intrinsic and extrinsic pathways)
	• Autophagy, necrosis, Pyroptosis, and Necroptosis
	Cell cycle deregulation and molecular basis of cancer
		9

1. Identification of different stages of cell division and cell organelle
2. Mitochondrial Staining from buccal epithelial cells
3. Cell isolation and cell counting
4. Quantitative estimation of protein- Lowry method and Bradford method
5. Protein denaturation and renaturation assay
6. Estimation of Glucose, cholesterol, total protein and urea from blood

Suggested reading:

1. *Cell and Molecular Biology: Concepts and Experiments* – Gerald Karp et al., 9th Edition (2021) Wiley.
2. *Lewin's Cells* – George Plopper, David Sharp & Eric Sikorski, 3rd Edition (2015) Edition: 3rd (2015), Jones & Bartlett.
3. *Molecular Cell Biology* – Harvey Lodish et al., 9th Edition (2021) Edition: 9th (2021), W.H. Freeman.
4. *Molecular Biology of the Cell* – Bruce Alberts et al., 7th Edition 2015
   Biochemistry – Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, 10th Edition (2023)
   Voet's Biochemistry – Donald Voet & Judith G. Voet, 4th Ed (2011), with adapted student versions published around 2021.
5. *Biochemistry* – Mary K. Campbell & Shawn O. Farrell 6th edition from 2009
6. *Lehninger Principles of Biochemistry* – David L. Nelson, Michael M. Cox & Aaron Hoskins, 8th Edition (2021)

OR

MJDSE-04: Biophysics and Microscopy **Credits 04 (Full Marks: 75)**

About the Course

This course provides an advanced understanding of the physical principles underlying biological systems and modern microscopic techniques used in life sciences research. It integrates concepts of membrane biophysics, thermodynamics, colloidal systems, radiation physics, and high-resolution imaging technologies. Emphasis is placed on applying biophysical methods, such as electron microscopy, atomic force microscopy, and diffraction techniques, to study biological structures. The course equips students with conceptual knowledge and practical exposure essential for research in molecular biology, structural biology, nanobiotechnology, and biomedical sciences.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1. Explain the physical principles governing biological membranes and biomolecular interactions.
CO2. Apply thermodynamic laws to interpret biological energy transformations and equilibrium processes.
CO3. Describe the properties and applications of colloidal systems in biological and medical sciences.
CO4. Understand radiation physics and evaluate its biological effects and research applications.
CO5. Demonstrate knowledge of advanced microscopy and diffraction techniques and interpret structural data obtained from these methods.
CO6. Develop analytical skills to correlate biophysical principles with experimental observations in modern life science research.

MJDSE-04T: Biophysics and Microscopy (Theory) *Credits 03 (45 hrs)*

Course Content:

Unit	Course content	Lecture (Hrs.)
Unit I	**Biological Membranes** • Fundamentals of membrane structure and organization • Lipid behavior and membrane fluidity • Membrane components: phospholipids, glycolipids, sterols, and proteins • Protein dynamics within membranes • Protein–lipid interactions • Specialized membrane structures: mitochondrial membrane and its functional organization	**7**
Unit II	**Thermodynamics in Biological Systems**	**8**

	• Introduction and basic thermodynamic concepts • First Law of Thermodynamics and energy equations in biological systems • Second Law of Thermodynamics • Entropy and free energy changes • Phase equilibrium and chemical equilibrium in biological systems • Applications of thermodynamics in biomolecular interactions	
Unit III	**Colloids and Biological Interfaces** • Classification of colloids • Properties of colloidal systems • Applications in biological systems • Dialysis, electrodialysis, and ultrafiltration • Role of colloids in biological fluids and drug delivery	**7**
Unit IV	**Radioactivity and Biological Systems** • Basics of radiation physics and radionuclide decay • Types of radiation and their properties • Detection and measurement of radioactivity • Environmental radioactivity monitoring • Effects of ionizing radiation on biological tissues • Applications of radioisotopes in biological research	**7**

Unit V	**Advanced Microscopy Techniques**
	High-Resolution Electron Microscopy
	• **SEM (Scanning Electron Microscopy)**
	  ○ Principle, Instrumentation, and Operating Modes
	  ○ Applications in biological sciences
	• **TEM (Transmission Electron Microscopy)**
	  ○ Principle, Sample preparation, Imaging modes, and Applications
	Atomic Force Microscopy (AFM)
	• Mechanism and instrumentation
	• Operating modes (contact, non-contact, tapping mode)
	• Applications in biological imaging
	• Data analysis and interpretation
		10

Unit VI	**Diffraction Techniques** • Principle of X-ray diffraction • Electron diffraction • Neutron diffraction • Applications in structural biology and material sciences	**6**

MJDSE-04P Biophysics and Microscopy (Practical) *Credits 01 (30 hrs)*

1. Demonstration of membrane-related function using insect haemolymph
2. Crystal preparation from human blood samples
3. Demonstration and interpretation of electron micrographs
4. Laboratory visit to USIC, VU or equivalent advanced instrumentation facility

Reference Books:

1. P Narayanan- “Essentials of Biophysics”, University of Bombay, New Age International Publishers, © 2026.
2. M. V. Volkenshtein- “Biophysics”, Mir Publisher, Moscow
3. S. Amelinckx (Editor), Dirk van Dyck (Editor), J. van Landuyt (Editor), Gustaaf van
4. Tendeloo (Editor), “Electron Microscopy: Principles and Fundamentals”
5. Hayat, M. A.- “Principles and Techniques of Electron Microscopy: Biological Applications”.
6. Debajyoti Das- ‘Biophysics and Biophysical Chemistry’, for medical and biology students, Academic Publisher.
7. The Structure of Biological Membranes Hardcover – 18 July 2011 by Philip L. Yeagle (Editor)
8. Fundamentals of Thermodynamics, 8th Edition, Claus Borgnakke Richard E. Sonntag University of Michigan 2nd Edition “Colloids and Interfaces in Life Sciences and Bio nanotechnology” By Willem Norde
9. “Handbook of Radioactivity Analysis” Edited by: Michael F. L' Annunziata
10. Electron Microscopy: Principles and Techniques for Biologists Hardcover :25 November 1998 by John J. Bozzola &Lonnie D. Russell

MAJOR ELECTIVE- 05

[to be studied by Honours students only]

(Environmental Issues & Management OR Biosystematics & Applied Entomology)

MJDSE-05: Environmental Issues & Management **Credits 04 (Full Marks: 75)**

About the Course:

Environmental Issues & Management is an interdisciplinary course that examines the scientific basis, socio-economic dimensions, and policy frameworks associated with contemporary environmental problems and their mitigation. The course explores major global and regional challenges such as climate change, biodiversity loss, deforestation, land degradation, water scarcity, air and soil pollution, waste management, and emerging contaminants. It integrates principles from ecology, environmental chemistry, atmospheric science, and resource economics to analyze the causes, impacts, and management strategies of these issues. Emphasis is placed on environmental impact assessment (EIA), sustainable resource utilization, conservation planning, environmental legislation, disaster risk reduction, and climate adaptation and mitigation strategies. The course also addresses the role of governance, environmental ethics, community participation, and technological innovations in achieving sustainable development. Through case studies, policy analysis, and applied management approaches, students develop critical thinking and problem-solving skills necessary for designing effective environmental management plans that balance ecological integrity with human development needs.

Course Outcomes:

Upon successful completion of the course, students will be able to:

- Understand fundamental environmental concepts, including ecosystem structure and function, biogeochemical cycles, and the scientific basis of major environmental problems.
- Analyze contemporary environmental issues such as climate change, biodiversity loss, pollution, deforestation, and resource depletion using scientific and analytical approaches.
- Evaluate environmental impacts and interpret relevant policies and legislation in the context of environmental governance and sustainable development.
- Apply sustainable resource management and pollution control strategies for the conservation of natural resources and environmental quality.
- Develop critical thinking, problem-solving, and basic field-based analytical skills for environmental monitoring and management.

MJDSE-05T: Environmental Issues & Management (Theory) *Credits 03 (45 hrs)*

Course Content:

Unit	Course Contents	Lectures / Hours
Unit-I	**Humans and the Environment:** The man-environment interaction through time; Industrial revolution and its impact on the environment. The emergence of environmentalism: Anthropocentrism, ecocentrism and Environmental feminism. Environmental World Views.	**6**
Unit-II	**Major environmental issues:** Climate change- Causes, Impacts on various ecosystems, Adaptation and Mitigation, Ozone layer depletion, depletion of resources, urbanization. Mitigation of climate change: Green House Gas (GHG) reduction vs. sink enhancement; Concept of carbon neutrality. Projections of global climate change with special reference to temperature, rainfall, climate variability and extreme events	**10**
Unit-III	**Sustainability & Sustainable development:** SDGs, Sustainable use of resources and sustainable development. Impact of urbanization and industrialization on environment.	**4**
Unit-IV	**Environmental Impact Assessment (EIA):** Definition and types of EIA, Methodologies of EIA. LCA (Life cycle Assessment)	**4**
Unit-V	**Role of traditional knowledge in environmental management**, people's participation, social forestry. Environmental movements: Arabari model. JFM, Chipko movement.	**5**
Unit-VI	**Introduction to environmental laws and Environmental regulation**: Environmental audit and impact assessment; Environmental risk assessment, Waste Management- Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Ecomark scheme.	**8**
Unit-VII	**Major Environmental Agreements**: CBD, CITES, UNCCD, UNFCCC, Kyoto protocol, Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing, The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981.	**8**

Practical:

1. Environmental Quality Assessment: Evaluation of water & soil quality- basics
2. Carbon Footprint Analysis: Collect data on energy usage and transportation. Use online carbon footprint calculators to assess emissions.
3. Report on sustainable urban planning & Environmental Audit of the area in and around the campus.
4. Visit a local area to document environmental resources in and around the campus
5. To prepare and submit a report on pollution– Urban/Industrial/Agricultural landscapes.

Suggested reading:

1. Environmental Science. By G. Tyler Miller & Scott E. Spoolman Brookes/Cole, Belmont, USA, 14th edition, 2013, 411 pp
2. Environmental Issues: Awareness, Concern, and Management 2018 by U R Zargar

OR

MJDSE-05: Biosystematics & Applied Entomology **Credits 04 (Full Marks: 75)**

About The Course

This postgraduate course integrates the theoretical foundations of **Biosystematics** with the practical and economic applications of **Entomology**. It emphasizes classical and modern taxonomic principles, phylogenetic reconstruction, molecular systematics, biodiversity assessment, and bioinformatics tools.

The Applied Entomology component focuses on economically significant insects in agriculture, medicine, veterinary science, industry, and environmental management. Special attention is given to integrated pest management (IPM), biological control strategies, insect vectors of disease, stored-grain pests, and insect-based industries such as sericulture, apiculture, and lac culture. The course aims to develop analytical skills in classification, species identification, pest diagnosis, and sustainable insect management practices relevant to contemporary ecological and agricultural challenges.

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

1. Explain the principles and scope of classical and modern biosystematics.
2. Apply different species concepts in taxonomic studies.
3. Construct and interpret phylogenetic trees using morphological and molecular data.
4. Use taxonomic keys and digital databases for insect identification.
5. Classify major insect orders and recognize diagnostic characters.
6. Identify economically important insect pests and their life cycles.
7. Develop Integrated Pest Management (IPM) strategies.
8. Understand insect vectors and mechanisms of disease transmission.
9. Apply entomological knowledge in sericulture, apiculture, and lac culture.
10. Conduct field surveys and prepare taxonomic documentation and pest assessment reports.

MJDSE-05T: Biosystematics & Applied Entomology (Theory) *Credits 03 (45 hrs)*

Course Content:

Unit	Course content	Hours
Unit-I	**Principles and Concepts of Biosystematics** **1.1 Foundations of Taxonomy** • History and development of systematics • Species concepts: Morphological, Biological, Evolutionary, Phylogenetic	**10**

	• Taxonomic hierarchy and nomenclature (ICZN rules) • Type concept and typification **1.2 Methodologies in Systematics** • Alpha, Beta, and Gamma taxonomy • Numerical taxonomy (Phenetics) • Cladistics and phylogenetic systematics • Molecular systematics and phylogenomics • DNA barcoding and molecular markers **1.3 Modern Tools in Biosystematics** • Cytotaxonomy and karyosystematics • Chemotaxonomy • Role of population genetics in systematics • Bioinformatics tools and biodiversity databases • Systematics in conservation biology	
Unit-II	**Insect Diversity and Classification** **2.1 General Organization of Insects** • External morphology and tagmatization • Metamorphosis and developmental patterns • Evolution and adaptive radiation of insects **2.2 Classification and Diagnostic Features** • Basis of insect classification • Salient features of major insect orders • Comparative study of economically important orders such as Lepidoptera, Diptera, Coleoptera, Hymenoptera, Hemiptera, and Orthoptera • Phylogenetic relationships among insect orders	**10**
Unit-III	**Agricultural and Stored Grain Entomology** • Types of insect pests (monophagous, oligophagous, polyphagous) • Major pests of cereals, pulses, oilseeds, vegetables, and fruits • Stored grain pests and their management • Pest surveillance, monitoring, and forecasting • Insecticides: classification, mode of action, and resistance • Integrated Pest Management (IPM) principles • Biological control: predators, parasitoids, and pathogens • Biopesticides and eco-friendly pest control strategies	**8**
Unit-IV	**Medical and Veterinary Entomology** • Insects as vectors of human and animal diseases • Modes of disease transmission (mechanical and biological) • Mosquitoes and mosquito-borne diseases • Houseflies and other mechanical vectors • Fleas, lice, ticks, and mites of veterinary importance • Vector control strategies and public health measures • Role of entomology in epidemiology	**8**

Unit-V	**Economic and Industrial Entomology** • Apiculture: species of honey bees, hive management, and honey production • Sericulture: life cycle of silkworm, rearing techniques, and silk production • Lac culture and commercial importance of lac insects • Insects in pollination biology • Forensic entomology • Insects as bioindicators of environmental health • Insect-based biotechnology and waste management applications	**8**
Unit-VI	**Forensic Entomology** Fundamentals of Forensic Entomology Methods and Techniques in Forensic Entomology Applied and Legal Aspects	**6**

MJDSE-05P Biosystematics & Applied Entomology (Practical) *Credits 01 (30 hrs)*

1. Study of insect morphology and identification using taxonomic keys
2. Identification of major insect orders and families
3. Preparation and preservation of insect collections
4. Construction of dichotomous keys
5. Demonstration of molecular tools in systematics (conceptual/practical exposure)
6. Study of pest life cycles and plant damage symptoms
7. Preparation of IPM models
8. Visit to local agricultural farms, sericulture, or apiculture units

Suggested reading:

1. Mayr, E. & Ashlock, P.D. – *Principles of Systematic Zoology*
2. Chapman, R.F. – *The Insects: Structure and Function*
3. Triplehorn, C.A. & Johnson, N.F. – *Borror and DeLong's Introduction to the Study of Insects*
4. Pedigo, L.P. & Rice, M.E. – *Entomology and Pest Management*
5. Ross, H.H. – *A Textbook of Entomology*

MAJOR ELECTIVE- 06

[to be studied by Honours students only]

(Embryology OR Human Genetics)

MJDSE-06: Embryology **Credits 04 (Full Marks: 75)**

About the Course

This course provides an advanced understanding of the molecular and cellular mechanisms governing early development, fertilization, regeneration, aging, and stem cell biology. Emphasis is placed on classical experimental embryology integrated with modern molecular insights. Key model systems such as amphibians, sea urchins, hydra, planaria, axolotl, newt, cockroach, and mammals are discussed to illustrate conserved developmental pathways. The course explores axis formation, morphogen gradients, organizer function, fertilization mechanisms, regenerative biology, conserved aging pathways, and stem cell niches. It bridges classical embryological experiments with contemporary molecular genetics and signaling pathways, equipping students with both conceptual and mechanistic understanding.

Course Outcomes

Upon successful completion of this course, students will be able to:

1. Explain the molecular basis of dorsal–ventral axis formation and organizer function in amphibians.
2. Critically analyze classical embryological experiments and correlate them with modern molecular findings.
3. Describe mechanisms of neural induction, regional specification, and left–right axis determination.
4. Compare and contrast external and internal fertilization mechanisms at the cellular and molecular levels.
5. Interpret calcium signaling, membrane fusion, and polyspermy prevention mechanisms.
6. Differentiate between morphallaxis and epimorphosis in regeneration.
7. Explain blastema formation, positional identity, and nerve dependency in amphibian limb regeneration.
8. Analyze conserved molecular pathways regulating aging.
9. Distinguish between different stem cell types and describe stem cell niche regulation.
10. Integrate developmental biology principles with regenerative medicine and aging research.

Course Content:

Unit	Course Content	Hours

Unit- I	**Molecular Mechanisms of Amphibian Axis Formation**
	
	1.1 Establishment of Dorsal–Ventral Axis
	• The dorsal signal: β-catenin stabilization pathway
	• Ventral signal: TGF-β–like signaling pathway
	• Role of Wnt pathway proteins in dorsal–ventral axis specification
	1.2 The Organizer and Its Molecular Mechanism
	• Functions of organizer proteins:
	  ○ Chordin
	  ○ Noggin
	  ○ Follistatin
	• BMP inhibitors and neural induction
	• Induction of neural ectoderm and dorsal mesoderm
	• Cerberus, Frzb, Dickkopf (Dkk)
	• Model for the action of the Spemann organizer
	1.3 Experimental Embryology
	• Summary of experiments by Nieuwkoop (Nieuwkoop center concept)
	• Summary of experiments by Nakamura and Takasaki
	1.4 Neural Induction and Regional Specification
	• Epidermal inducers: BMPs
	• Regional specificity of neural induction
	• Head induction: Wnt inhibitors
	• Trunk patterning: Wnt signaling and retinoic acid
	• Specification of the left–right axis
		12

Unit-II	**Fertilization – Beginning a New Organism** **2.1 General Principles** • Recognition of egg and sperm • Morphogen gradients and cell specification • Fusion of genetic material **2.2 External Fertilization in Sea Urchins** • Sperm attraction • Acrosome reaction • Recognition of the egg's extracellular coat • Fusion of egg and sperm membranes • Block to polyspermy • Cortical granule reaction • Activation of egg metabolism via intracellular Ca^{2+} release • Fusion of genetic material	**12**

	2.3 Internal Fertilization in Mammals • Sperm translocation and capacitation • Hyperactivation • Thermotaxis and chemotaxis • Recognition at the zona pellucida • Gamete fusion • Prevention of polyspermy • Fusion of genetic material • Nonequivalence of mammalian pronuclei • Activation of the mammalian egg	
Unit-III	**Regeneration and Aging** **3.1 Modes of Regeneration** • Morphallaxis and epimorphosis • Signal gradient model in Hydra head organizer • Regeneration in Planaria **3.2 Amphibian Limb Regeneration** • Cell dedifferentiation and blastema formation • Lineage restriction in axolotl limb blastema • Role of nerves in regeneration • Positional values and cell surface properties • Proximo-distal patterning and retinoic acid effects • Regeneration in cockroach and mammals • Compensatory regeneration in mammalian liver **3.3 Genes and Aging** • Genes encoding DNA repair proteins • Aging and insulin signaling cascade • Integration of conserved aging pathways • Environmental and epigenetic causes of aging	**11**

Unit-IV	**Stem Cell Concept**
	4.1 Stem Cell Fundamentals
	• Stem cell vocabulary
	• Stem cell potency
	  ○ Totipotent
	  ○ Pluripotent
	  ○ Multipotent
	• Progenitor cells
	• Adult stem cells
	4.2 Hematopoietic Stem Cells
	• Blood-forming stem cells
	• Bone marrow niches
	• Adult stem cell niches
	4.3 Mesenchymal Stem Cells
	• Multipotent adult stem cells
	• Therapeutic significance
		10

MJDSE-06P: Embryology (Practical) *Credits 01 (30 hrs)*

Practical:

1. Identification of different stages of the chick embryo (24 hrs, 36 hrs, 48 hrs, and 72 hrs)
2. Isolation and staining of chick embryo.

Suggested Readings:

1. Developmental biology, 11th edition, 2016, by S. F. Gilbert
2. Principles of Development. 4th edition. Lewis Wolpert

OR

MJDSE-06: Human Genetics **Credits 04 (Full Marks: 75)**

About the Course

Human Genetics is an advanced course designed to provide comprehensive knowledge of the genetic principles underlying human inheritance, genetic disorders, molecular diagnostics, population genetics, and genomic medicine. The course integrates classical genetics with modern molecular approaches and emphasizes clinical applications, genetic counseling, and ethical considerations in genetic testing and therapy.

Course Outcomes (COs)

After completion of the course, students will be able to:

CO1. Analyze patterns of human inheritance using pedigree and molecular approaches.

CO2. Interpret chromosomal abnormalities using classical and modern cytogenetic techniques.

CO3. Explain molecular mechanisms underlying single-gene and complex genetic disorders.

CO4. Apply principles of population genetics to study allele distribution and disease prevalence.

CO5. Evaluate modern genomic technologies and their clinical, ethical, and therapeutic implications.

MJDSE-06T: Human Genetics (Theory) *Credits 03 (45 hrs)*

Course Content:

Unit	Course content	Hours
Unit I	**Principles of Human Genetics** • Mendelian inheritance patterns • Pedigree analysis and risk calculation • Autosomal dominant and recessive inheritance • X-linked and Y-linked inheritance • Mitochondrial inheritance • Incomplete dominance and codominance • Multiple alleles and gene interactions	**15**
Unit II	**Cytogenetics and Chromosomal Disorders** • Chromosome morphology and karyotyping • Banding techniques (G-banding, Q-banding, C-banding) Aneuploidy and polyploidy • Trisomies (e.g., Down syndrome) • Sex chromosome abnormalities (e.g., Turner, Klinefelter syndromes) • Deletions, duplications, inversions, translocations • Microdeletion syndromes	**15**

Unit III	**Modern Cytogenetic Techniques** • FISH • Comparative genomic hybridization (CGH) • Chromosomal microarray analysis **Molecular Diagnostic Techniques** • PCR and RT-PCR **Genetic Testing and Diagnosis** • Prenatal diagnosis (amniocentesis, CVS) • Newborn screening • Carrier testing • SNP analysis	**15**
Unit IV	**Genetic Disorders** **Single-Gene Disorders** • Cystic fibrosis • Sickle cell anemia • Huntington's disease **Multifactorial and Complex Disorders** • Diabetes mellitus • Cardiovascular diseases • Cancer genetics (oncogenes and tumor suppressor genes) **Inborn Errors of Metabolism** • Introduction • Classification of Inborn Errors of Metabolism • Molecular and Biochemical Basis	**15**

MJDSE-06P: Human Genetics (Practical) *Credits 01 (30 hrs)*

1. Human Pedigree Analysis
2. PCR
3. Karyotyping
4. Demonstration of RT-PCR

Suggested Reading:

1. Thompson & Thompson – *Genetics in Medicine*
2. Strachan & Read – *Human Molecular Genetics*
3. Emery's *Elements of Medical Genetics*
4. Nussbaum et al. – *Genetics in Medicine*
5. Snustad & Simmons – *Principles of Genetics*

PROJECT / DISSERTATION (RD)

[to be undertaken by students opting for and eligible for Hons. with Research]

DISSERTATION:
Credit: 8; Full Marks: 150

Guidelines:

- Students will prepare a **dissertation of 10,000 words (approx.)** with a suitable title
- **Writing the Dissertation**:
  Introducing the area of research, Literature Review, Locating research gaps, Spelling out the central argument/hypothesis, Preparing the theoretical framework, Making the core chapters, Conclusion and Scope for further research, Endnotes to individual chapters, List of Works Cited/Bibliography, Appendix, if any.

Structure of the dissertation

Preliminary Pages

- Title Page: Includes name of the student, university, degree, and submission date.
- Certificate/Declaration: Signed statement of originality and supervisor's approval
- Abstract: A 250-350 word summary covering research problem, methodology, and core findings.
- Acknowledgements: To supervisors and others, if any.
- Table of Contents: Clear hierarchical mapping of chapters with page number
- List of Abbreviations: Specialized terms, if any

Introduction

- Background & Context: Situates the topic in historical or theoretical context.
- Research Problem & Objectives: The specific question or gap the research is addressing.
- Thesis Statement/Hypothesis: The core argument the dissertation intends to prove.
- Scope and Significance: Why the study matters.
- Literature Review & Theoretical Framework

Literature Review: Analyzes existing scholarly works to show the gap the study fills.

- Theoretical Framework: Identifies the philosophers, critics, or schools of thought shaping the analysis in the dissertation.

Methodology

- Describes *how* the research was conducted - Anyone or a combination of textual analysis/ archival research/ conducting interviews/ ethnographic/semi-ethno-graphic research involving both textual analysis and field visit etc.
- Thematic or Analytical Chapters

The Core Body: Usually 3 to 4 chapters focusing on the core concerns of the study.

- Structure: Each chapter introduces its specific theme, analyzes primary and secondary sources, and contributes to the overarching thesis.

Conclusion

- Summary & Synthesis: Recaps your main points without simply repeating them.

Final Verdict: Answers the research questions posed in the introduction.

Future Scope: Suggests how future scholars can build upon your work.

- Works Cited/ Reference, and/or Bibliography: A comprehensive list of all primary and secondary sources cited as per the latest MLA style.

Appendices: Transcripts, interview logs, or raw archival data, if any.

Marks distribution-

Sl. No	Particulars	Marks
1	Research Project / Dissertation Report	70
	▪ Proposal and Abstract (along with some keywords)	10
	▪ Literature Review &Theoretical Framework	10
	▪ Methodology and Research design	10
	▪ Thematic Analysis (Chapter-wise)	20
	▪ Report Quality	20
2	Seminar Presentation	30
3	Viva-Voce	50
Total		**150**

MINOR (MI)

Minor (MI)-08: Molecular Biology & Biotechnology **Credits 04 (Full Marks: 75)**

MI-08T: Molecular Biology & Biotechnology (Theory) *Credits 03 (45 hrs)*

About the Course

This course is designed to know basic of molecular biology and scientific technologies applied in biological sciences. The students may get knowledge of central dogma of molecular biology (replication, transcription, translation of nucleic acid) and gene regulation. It primary objectives to empower students with molecular technology particularly genetic engineering or recombinant DNA technology and their application in medicine and industry for the benefit of living organisms.

Course Outcomes

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

1. Understand structure and properties of DNA & RNA.
2. Explain the underpinnings of central dogma of molecular biology (replication, transcription, translation of nucleic acid) and gene regulation.
3. Understand the principles of genetic engineering, how genes can be cloned in bacteria and the various technologies involved in it.
4. Know the applications of biotechnology in various fields like agriculture, industry and human health.
5. Understand about utility of genetic engineering in forensic sciences.

Course Contents-

UNIT	Details	Lecture (Hrs.)
Unit 1	**Nucleic Acids** Salient features of DNA and RNA; Chargaff's Rule; RNA types & Function; Watson and Crick Model of DNA; DNA packaging (Nucleosome model) in eukaryotic chromosome.	**4**
Unit 2	**DNA Replication** Mechanism of DNA replication in Prokaryotes; RNA priming; Replication of telomeres.	**5**

Unit 3	**Transcription & Post Transcriptional Modifications of Eukaryotic RNA** Mechanism of Transcription in prokaryotes and eukaryotes; Transcription factors; Difference between prokaryotic and eukaryotic transcription; Capping and Poly A tail formation in mRNA; Splicing mechanism; Alternative splicing; Exon shuffling; RNA editing.	**6**
Unit 4	**Translation** Structure and charging of tRNA; Mechanism of protein synthesis in prokaryotes; Ribosome structure and assembly in prokaryotes; Genetic code; Degeneracy of the genetic code and Wobble Hypothesis.	**5**
Unit 5	**Gene Regulation** Regulation of Transcription in prokaryotes: lac operon and trp operon. Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing.	**5**
Unit 6	**Introduction to Biotechnology** Concept and Scope of Biotechnology; Red biotechnology, green biotechnology, white biotechnology & blue biotechnology; Concept of genomics and proteomics.	**4**
Unit 7	**Gene manipulation through recombinant DNA technology** Types of Restriction enzymes; Cloning vectors: Characteristics of plasmids, cosmids & phagemids; Detailed study of Sanger dideoxy enzymatic chain termination method; Basic steps of DNA cloning; Genomic library and cDNA library.	**6**
Unit 8	**Molecular Techniques in Biotechnology** Principle, protocol and application of agarose gel electrophoresis, polyacrylamide gel electrophoresis, Southern blotting, northern blotting, western blotting, polymerase chain reaction, Gene therapy, DNA micro array (DNA chip) and DNA fingerprinting.	**6**
Unit 9	**Genetically Modified Organisms** Production and utility of transgenic animals and crop plants; Methods of introducing transgene for production of transgenic animal, Production of insulin and growth hormones,	**4**

Practical:

1. Identification of giant chromosomes from photograph.
2. Demonstration of isolation and quantification process of genomic DNA using spectrophotometer.
3. Study and interpretation of electron micrographs / photographs showing DNA replication and transcription.
4. Construction of circular and linear restriction map from the supplied data.
5. Find out the correct banding pattern of DNA fingerprint from the supplied data.
6. Problems related to the mutations of lac operon through merozygotic condition.

Suggested Reading:

1. Allison LA. 2007. Fundamental Molecular Biology. Blackwell Publishing. W.H. Freeman
2. Cooper GM, Hausman RE. 2009. The Cell: A Molecular Approach. ASM
3. Harvey L. 2004. Molecular Cell Biology. W.H. Freeman
4. Karp G. 2008. Cell and Molecular biology: Concepts and Application. John Wiley.
5. Lodish, B, Matsudaira, K B, Plough, A and Martin ;2016. Molecular Cell Biology. W.H. Freeman.
6. Russel PJ. 2010. iGenetics: A Molecular Approach, Pearson Benjamin.
7. Turner, McLennan, Bales & White ;2005. Instant Notes in Molecular Biology. Taylor Francis
8. Twyman, Advanced Molecular Biology. Viva Publication.
9. Primrose & Twyman. Principles of Gene Manipulation and Genomics. 7th edition.
10. Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
11. Brooker, R.J. 1999. Genetics-Analysis and Principles. Addison-Wesley Longman, Inc.New, California.
12. Griffith, A.J.F., Miller, J.H., Suzuki, D.T. Lewonton, R.C., Gelbart, W.M., (2000). An Introduction to Genetic Analysis. VII edition. W.H.Freeman, New York.
13. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
14. Dubey, R.C., 2014. Advanced Biotechnology, S. Chand & Company Ltd., New Delhi.
15. Weaver. Molecular Biology of Gene. 5th edition.

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