(DRAFT)

SYLLABUS for

POST-GRADUATE Programme in

ZOOLOGY

Under the National Education Policy (NEP) 2020

(Semester Programme)

Vidyasagar University

Midnapore-721102,

West Bengal

(w.e.f. session 2025 -2026)

PREAMBLE

The course curriculum of the Department of Zoology has been systematically designed and developed with due emphasis on both the **classical foundations** of the subject and its **contemporary scientific advancements**, thereby aligning with global trends in higher education. The **classical components** of Zoology encompass essential areas such as **Anatomy, Biosystematics, Histology, Animal Physiology, Evolution, and Adaptation**. These provide students with a strong conceptual framework and a comprehensive understanding of structural–functional organization in animals. Complementing these, the curriculum integrates modern domains including **Molecular Biology, Genetics, Biotechnology, Bioinformatics, Biochemistry, Biostatistics, Histochemistry, Developmental Biology, Immunology, Parasitology, and Neurobiology,** which reflect current developments and applications in the biological sciences. This integrated approach has significantly contributed to the **academic performance and achievements** of both present and former students, many of whom have successfully qualified in **national and state-level competitive examinations**. The Department offers **four special papers**: Fishery, Ecology, Genetics & Molecular Biology, and Parasitology, which provide students, particularly those from rural backgrounds, with enhanced opportunities for **academic recognition and professional placement** in subject-related services. The Department also undertakes **outreach and extension programs**, wherein students are actively engaged as part of their practical curriculum. These initiatives have had a notable impact on the **livelihood generation of marginalized communities** in the region, thereby strengthening the social relevance of the curriculum. All courses are structured to prepare students for **competitive examinations (e.g., CSIR-UGC-DBT-NET, ICMR JRF Exam, GATE, SET) and to develop** research proposal writing and grant acquisition skills. During the curriculum development process, the guidelines of the National Education Policy (NEP) 2020 have been duly incorporated, with a particular emphasis on **employability, entrepreneurship, skill development, and digital literacy**. Additionally, the syllabus addresses cross-cutting issues, including **ethics, gender sensitization, human values, environmental awareness, and sustainability**, thereby ensuring holistic student development and alignment with national academic priorities.

PROGRAMME OUTLINES

1	**Type of Program**	This is a regular master's program that follows the guidelines of NEP 2020.
2	**Credit system**	Each academic paper comprises four credits, including three credits for theoretical study and one credit for practical work, thereby ensuring coherence in the learning process.
3	**Duration and Eligibility Criteria**	The department offers two Master of Science programs in Zoology. Students who have completed a three-year Honors degree in zoology are eligible for admission to the two-year M.Sc. program. In contrast, those who have completed a four-year Honors degree in zoology (with or without a research component) are eligible for admission to the one-year M.Sc. program.
4	**Intake capacity**	As per the Vidyasagar University admission rules.
5	**Admission procedure**	As per the Vidyasagar University admission rules.
6	**Evaluation Process**	• Continuous Evaluation (CE) accounts for 20% of the total marks, while the End-of-Semester Examination accounts for 80%. • Two CEs will be conducted for each paper/course, and the average of these two will determine the final CE marks. The CEs may be undertaken in various formats, such as multiple-choice questions (MCQs), short-answer questions, case studies, assignments, or small projects. • The end-of-semester examination will comprise short-answer, medium-answer, and long-answer questions to evaluate students' understanding and analytical skills comprehensively.
7	**Teaching Methods**	• To realize the desired learning outcomes, the subsequent teaching–learning strategies will be utilized: • Lecture-based Instruction – Systematic dissemination of fundamental concepts via classroom lectures. • Collaborative Learning – Engaging students in group discussions and activities to foster teamwork and exchange of ideas. • Autonomous Learning – Encouraging independent study and self-directed learning to enhance conceptual understanding. • Technology-Enhanced Learning – Incorporation of digital tools, software, and online resources to facilitate interactive and innovative learning experiences. • Peer Instruction – Students articulating concepts to their peers, thereby promoting active engagement and reinforcement of knowledge. • Problem-solving Methodology – Approaching learning through experimental, on-field problems, case studies, and practical exercises to cultivate analytical and critical thinking abilities.
8	**Special Instructions**	To align with NEP 2020, several general courses, including Indian Knowledge System (IKS), IPR, Research Methodology and Ethics, Social Service, Internship/Industry visits, Field Visits, Research projects, and Vidyasagar's Life and Philosophy, are compulsory. Core courses strengthen foundational knowledge in a subject, and electives offer flexibility. Semesters III and IV include four special papers, from which students must choose one.
9	**Field Visits**	Semester II offers a field visit; the field visit location is determined at the departmental committee meeting.
10	**Research Projects**	The mentor will distribute the research project to fourth-semester students.

Program Outcomes (POs)

On successful completion of the M.Sc. in Zoology program, the students will develop the following skills: -

PO1. Comprehensive Knowledge: Demonstrate a deep understanding of animal structure, function, diversity, evolution, genetics, molecular biology, and physiology.

PO2. Practical Competence: Apply laboratory and field techniques to investigate animal biology, analyze data, and interpret scientific observations.

PO3. Research and Inquiry: Design, conduct, and report scientific research in zoology, integrating modern methodologies and ethical practices.

PO4. Critical and Analytical Thinking: Analyze complex biological data, discuss contemporary issues in biodiversity, and solve zoological problems scientifically.

PO5. Technological Application: Utilize bioinformatics, biostatistics, remote sensing, and microscopy as tools for animal research and management.

PO6. Communication and Teamwork: Present scientific ideas and research findings effectively; collaborate in academic, research, and professional settings.

PO7. Ethics and Responsible Practice: Demonstrate ethical responsibility towards animals and promote sustainable practices in animal biology and conservation.

PO8. Interdisciplinary Skills: Integrate zoological knowledge with related fields such as biotechnology, botany, physiology, environmental science, and public health.

PO9. Career Readiness and Entrepreneurship: Prepare for teaching, research, conservation, and industry roles, and pursue professional development through entrepreneurship.

Programme Specific Outcomes (PSOs)

After the successful completion of the M.Sc. in Zoology program, the students are expected to:

PSO1. Improve their biological knowledge: Gain an in-depth understanding of animal diversity, physiology, ecology, genetics, and evolution.

PSO2. Gain research & technical skills: Apply modern laboratory, field, and analytical techniques for studying animals and ecological systems.

PSO3. Apply critical thinking: Analyze biological data and address conservation and wildlife management issues.

PSO4. Expertise in technological applications: Use tools like Microscopy, instrumentation, GIS, remote sensing, and bioinformatics in animal research.

PSO5. Follow ethical and sustainability principles: Practice ethical and sustainable approaches in zoology and conservation.

PSO3. Communication & Professionalism: Effectively present scientific findings and work collaboratively in academic and research settings.

Semester	Code	Course Details	Credit	Marks
Sem-I	ZOOC401X1	Functional anatomy and Physiological process	3	50
	ZOOC401X8	Lab exercise based on the course ZOOC401X1	1	
	ZOOC402X1	Cytogenetics and Evolutionary Process	3	50
	ZOOC402X8	Lab exercise based on the course ZOOC402X1	1	
	ZOOC403X0	Research Methodology and Ethics	4	50
	ZOOE404A1	Bioinformatics & Biostatistics	1	50
	ZOOE404A8	Lab exercise based on the course ZOOE404A1	3	
	ZOOE404B1	Applied Zoology	3	
	ZOOE404B8	Lab exercise based on course ZOOE404B1	1	
	ZOOE405A1	Biotechnology & Public Health	3	50
	ZOOE405A8	Lab exercise based on courses ZOOE405A1	1	
	ZOOE405B1	Insect Vector and Management	3	
	ZOOE405B8	Lab exercise based on courses ZOOE405B1	1	
	ZOO-O406VC	Indian Knowledge System	2	25
	ZOO-O407NC	Vidyasagar Life and Philosophy	Compulsory non-credit course	
Sem-I	***Total***		***22***	***275***
Sem-II	ZOOC451X1	Advanced Parasitology & Clinical Immunology	3	50
	ZOOC451X8	Lab exercise based on the course ZOOC451X9	1	
	ZOOC452X1	Cell and Molecular Biochemistry	3	50
	ZOOC452X8	Lab exercise based on the course ZOOC452X1	1	
	ZOOE453A1	Embryology	3	50
	ZOOE453A8	Lab exercise based on the course ZOOE453A1	1	
	ZOOE453B1	Human Genetics	3	
	ZOOE453B8	Lab exercise based on the course ZOOE453B1	1	
	ZOOE454A1	Biophysics and Microscopy	3	50
	ZOOE454A8	Lab exercise based on the course ZOOE454A1	1	
	ZOOE454B1	Biosystematics & Applied Entomology	3	
	ZOOE454B8	Lab exercise based on the course ZOOE454B1	1	
	ZOOE455A1	Wildlife Ecology	3	50
	ZOOE455A8	Lab exercise based on the course ZOOE455A1	1	
	ZOOE455B1	Environmental Issues & Management	3	
	ZOOE455B8	Lab exercise based on the course ZOOE455B1	1	
	ZOOC456X9	Field Visit	2	25
Sem-II	***Total***		***22***	***275***
Total: 1st Year of PG			***44***	***550***

Semester	Code	Course Details	Credit	Marks
Sem-III	ZOOC501X0	MOOC	4	50
	ZOOC502X1	Environmental Microbiology	3	50
	ZOOC502X8	Lab exercise based on the course ZOOC502X1	1	
	ZOOC503X1	Histochemistry and Neurobiology	3	50
	ZOOC503X8	Lab exercise based on the course ZOOC503X1	1	
	ZOOE504A1	Special Paper: Fishery (Theory) *(Fish Anatomy and Culture System)*	2	50
	ZOOE504A2	Special Paper: Fishery (Theory) *(Marine Fisheries)*	2	
	ZOOE504B1	Special Paper: Ecology (Theory) *(Aquatic Ecology)*	2	
	ZOOE504B2	Special Paper: Ecology (Theory) *(Biodiversity Conservation and Management)*	2	
	ZOOE504C1	Special Paper: Genetics & Molecular Biology (Theory): *(Genetics)*	2	
	ZOOE504C2	Special Paper: Genetics & Molecular Biology (Theory): *(Molecular Biology)*	2	
	ZOOE504D1	Special Paper: Parasitology (Theory) *(Diversity and Biology of Parasite Syllabus)*	2	
	ZOOE504D2	Special Paper: Parasitology (Theory) *(Immunoparasitology)*	2	
	ZOOE505A9	Special Paper: Fishery (Practical)	4	50
	ZOOE505B9	Special Paper: Ecology (Practical)	4	
	ZOOE505C9	Special Paper: Genetics & Molecular Biology (Practical)	4	
	ZOOE505D9	Special Paper: Parasitology (Practical)	4	
	ZOOC506VC	Social Service / Community Engagement	2	25
Total			***22***	***275***
Sem-IV	ZOOE551A1	Special Paper: Fishery (Theory) *(Fish Foods and Fish Health Management)*	2	50
	ZOOE551A2	Special Paper: Fishery (Theory) *(Fish Biotechnology and Fishery Extension)*	2	
	ZOOE551B1	Special Paper: Ecology (Theory) *(Terrestrial Ecology and Ecological Modelling)*	2	
	ZOOE551B2	Special Paper: Ecology (Theory) *(Human Ecology & Ecotourism)*	2	
	ZOOE551C1	Special Paper: Genetics & Molecular Biology	2	

		(Theory): *(Applied Genetics)*		
	ZOOE551C2	Special Paper: Genetics & Molecular Biology (Theory): *(Human genome and immunogenetics)*	2	
	ZOOE551D1	Special Paper: Parasitology (Theory) *(Vector Biology and Vector-borne Parasites)*	2	
	ZOOE551D2	Special Paper: Parasitology (Theory) *(Molecular Diagnosis and Clinical Parasitology)*	2	
	ZOOE552A9	Special Paper: Fishery (Practical)	4	50
	ZOOE552B9	Special Paper: Ecology (Practical)	4	
	ZOOE552C9	Special Paper: Genetics & Molecular Biology (Practical)	4	
	ZOOE552D9	Special Paper: Parasitology (Practical)	4	
	ZOOC553X9	Research Project/ Dissertation	8	100
	ZOOC554VC	Internship / Capstone Project/ Applied Field or Industry Project / Innovation & Incubation / Entrepreneurship / Start-up Proposal or Practice	4	50
	ZOOE555A0	Intellectual Property Rights and Biosafety	2	25
	ZOOE555B0	Mulberry silkworm rearing technology		
	ZOOE555C0	Verm technology and solid waste management		
	Total		***22***	***275***
Total: 2nd Year of PG			***44***	***550***

DETAILS OF THE COURSE OF SEMESTER - I

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PAPER: Functional Anatomy and Physiological Process Credit – 04

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 how animals survive and adapt 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 such as fish swimming and bird flight, using anatomical and vector-based approaches.

CO3. Apply systems biology tools, such as high-throughput methods, computational approaches, and network analysis, to biological problems.

CO4. Evaluate physiological and stress responses, including circulation, respiration, thermoregulation, and acclimatization to extreme environments.

Paper: ZOOC401X1: (Theory) **Credit- 03**

	Course Contents	Lectures / Hours
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)	4
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	4
Unit 3:	**Morpho-functional coordination and Bioengineering:**	3

	Swimming Mechanism in Fish (Anatomical structure &vector analysis) Flight mechanism of Birds (Anatomical structure &vector analysis)	
Unit 4:	**System Biology and its components:** Biological Problems High-Throughput Technologies Computation and Mathematics Data Integration Biological Networks	3
Unit 5:	**Punctuated equilibrium and Darwin's thoughts:** Stasis and Spurts Speciation Fossil record evidence Criticisms of Darwinian thoughts	4
Unit 6:	**Stress-Response mechanisms:** Homeostasis, feedback control systems Oxidative stress; Cellular response; Free radicals and antioxidants Acclimatization to extreme conditions like hypoxia & diving	4
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	5
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	5
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	4
	Total	**36**

Paper- ZOOC401X8: (Practical) **Credit- 01**

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.

PAPER: Cytogenetics and Evolutionary Process Credit – 04

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.

Paper-ZOOC402X1: (Theory) **Credits 03**

Course Contents	Hours
Unit 1: The structure and function of the eukaryotic chromosome: Polytene chromosome structure and sequence organization.	2 hrs
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.	5 hrs
Unit 3: Genetic fine structure: The rII fine structure, complementation, and deletion mapping	5 hrs
Unit 4: Genetic transfer and mapping in Bacteria and bacteriophages: Conjugation mapping, Transduction mapping	4 hrs
Unit 5: Medical genetics and cancer: Genetic analysis of human diseases, the genetic basis of cancer	4 hrs

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 hrs
Unit 7: Molecular Evolution: Molecules as documents of evolutionary history, molecular phylogenetics, and rates of molecular evolution	6 hrs
Total	**36 hrs**

Paper-ZOOC402X8: (Practical) **Credits 01**

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.

Paper- ZOOC403X0: Research Methodology and Ethics Credit – 04

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.

Paper: ZOOC403X0: Research Methodology and Ethics (Theory) Credit- 04

	Course Contents	Lectures / Hours
Unit 1:	**Facets of Research Design:** Importance and features of research; Research prototype; phenomenological and positivistic research; inductive and deductive reasoning	4
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 **Research design** – meaning, significance, and types (exploratory, descriptive, analytical, and experimental). Experimental design- informal and formal; concept of replicates and its application in biology	5
Unit 3:	**Data Collection** Types of data – primary and secondary; sources of data; methods of data collection – observation, interview, questionnaire, case study,	4

	experiment, content analysis**;** distinction between method and methodology	
Unit 4:	**Sampling Methods** Concept of sampling; probability sampling – simple, random, stratified, cluster, systematic; non-probability sampling – purposive, convenience, quota, snowball.	3
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	4
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	4
Unit 8:	**Research Metrics** Impact Factor, h-index, g-index, i10-index; altmetrics and their role in evaluating research impact.	4
Unit 9:	**Exercise:** Submission of Review of Literature or Project Proposal	10
	Total	**48**

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)

PAPER: Bioinformatics & Biostatistics Credits 04

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.

Paper-ZOOE404A1 (Theory) Credits 03

Course Contents	Hours
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.	5hrs
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).	5hrs

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.	13hrs
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).	13hrs

Paper-ZOOE404A8 (Practical) **Credits 01**

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.

PAPER: Applied Zoology Credits 04

About the Course

The Applied Zoology program focuses on developing theoretical and practical knowledge in sericulture, lac culture, apiculture, fisheries, dairy and poultry farming, vermiculture, and pearl culture, among others. Based on the experience acquired, students will be encouraged to pursue 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 of the basic procedures and methodologies of vermiculture.

CO5. Learn various aspects of beekeeping & lac culture.

CO6. Know the concepts of induced breeding techniques and post-harvesting techniques of fish.

Paper-ZOOE404B1 (Theory) Credits 03

Course Contents	Hours
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.	6 hrs
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.	6 hrs
2.2: **Apiculture:** Definition, Status and Scope, Products of Apiculture and their uses, Life Cycle of the Honey Bee	6 hrs
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 their advantages; Hazards of brackish water and fresh water prawn culture and their	6 hrs

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.	6 hrs
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.	6 hrs
Total	**36 hrs**

Paper-ZOOE404B8 (Practical) **Credits 01**

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.

PAPER: (Biotechnology and Public Health) Credits: 04

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.

PAPER CODE: ZOOE405A1 (Theory) **Credits: 03**

Course Contents	Hours
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).	5 hrs
Unit 2: White (Industrial) Biotechnology Need and advantage of biofuel production; Principles of bio-ethanol and bio-diesel production.	2 hrs
Unit 3: Red (Medical) Biotechnology Production of human insulin by genetic engineering	2 hrs

Unit 4: Green (Agricultural) Biotechnology Production and utility of golden rice; Controversies over genetically modified crops (GMC).	2 hrs
Unit 5: Blue (Aquacultural) Biotechnology Production of transgenic fish and its application	2 hrs
Unit 6: Environmental Biotechnology Bioremediation; Production of 'superbug'; Vermicomposting and its utility	3 hrs
Unit 7: Biotechnology-related laboratory techniques Agarose gel electrophoresis; Southern blotting hybridization, Western blotting hybridization, Polymerase chain reaction (PCR), Cell fractionation	4 hrs
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	3 hrs
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	6 hrs
Unit 10: Food and water-borne diseases Mode of transmission, pathogenicity and symptoms, diagnosis and treatment/control, and prophylaxis of Amoebiasis and Shigellosis.	3 hrs
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 hrs
Total	36 hrs

PAPER CODE: ZOOE405A8 (Practical) **Credits: 01**

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.
11. Lal, S., & Vikas. (2025). Public Health Management: Principles and Practice (4th Ed.). CBS Publishers & Distributors Pvt. Ltd.
12. Roberts, L. S., Janovy, J. and Nadler S. (2013) *Gerald D. Schmidt &Lary S. Roberts' Foundation of Parasitology*. 9th ed. McGraw-Hill International.
13. Lynne Shore Garcia (2007) Diagnostic Medical Parsitology (5thEdn) ASM press Washington D.C.
14. T.A. Brown (2010) Gene cloning an DNA analysis- An introduction (6thEdn) Willey Blackwell
15. iGenetics: A Molecular Approach by Peter J. Russell 3rd Edn. (2010)
16. Mosquito (2001) G. Chandra, Sribhumi Publ.

PAPER: Insect Vector and Management) Credits: 04

About the Course:

The course provides insight into common vector-borne diseases, their etiology, the role of vectors in their spread, the host-parasite relationship, and strategies to manage these diseases.

Course Outcomes:

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

CO1. Develop awareness about the causative agents and control measures of many commonly occurring diseases.

CO2. Develop an understanding of the favorable breeding conditions for the vectors.

CO3. Devise strategies to manage the vector population below threshold levels, with public health importance.

CO4. Undertake measures or start an awareness program for the maintenance of hygienic conditions, avoidance of contact with vectors, and destruction of breeding spots in the vicinity of houses and cattle sheds by a public health education campaign.

PAPER CODE: ZOOE405B1 (Theory) **Credits: 03**

Course Contents	Hours
Unit 1: Introduction to Insects General Features of Insects; Morphological features- Head & Eyes; Types of antennae: Mouth Parts.	4 hrs
Unit 2: Vector and Vector Bionomics Brief introduction; Types of vectors; Morphological peculiarities of different vectors; Host-vector relationship; Adaptations of vectors; Host specificity; Vectorial capacity.	4hrs
Unit 3: Insects as Vectors Detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata & Hemiptera.	4hrs
Unit 4: Dipteran as Disease Vectors Dipterans as important insect vectors – Mosquitoes, Sand flies, and Houseflies. Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes. Study of sand fly-borne diseases –Leishmaniasis; Control of Sand flies.	7 hrs
Unit 5: Siphonaptera as Disease Vectors Fleas are important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas.	4hrs
Unit 6: Siphunculata as Disease Vectors The human louse (Head, Body, and Pubic louse) is an important insect vector; control of human lice.	4 hrs
Unit 7: Hempitera as Disease Vectors Bugs as insect vectors; Blood-sucking bugs; Chagas disease; Bed bugs as	4hrs

mechanical vectors; Control and prevention measures.	
Unit 8: Vector management: Control of vectors through screening, traps, electrocution, poison baits, outdoor residual sprays, biological control, chemical control, sterile insect technique, and pheromones /allelochemicals.	4 hrs

PAPER CODE: ZOOE405B8 (Practical) **Credits: 01**

1. Study of the mouth parts of different insects.

2. Study of the following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles, Pediculus humanus capitis,* Phthirus *pubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica* through permanent slides/ photographs.

3. Study of different diseases transmitted by the above insect vectors.

4. Submission of a project report on any one of the insect vectors and diseases transmitted.

Recommended Readings:

1. Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK
2. Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK
3. Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication
4. Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell
5. Medical Entomology, Hati A. K Allied Book Agency, Kolkata

Paper Code: ZOO-O406VC (Indian Knowledge System) Credit 2

Preamble

The NEP 2020 recommends the incorporation of the Indian Knowledge Systems (IKS) into curriculums at all levels of education. The success of the policy relies heavily on the shoulders of inspired teachers. Most of the faculty in Higher Education Institutions (HEIs) across the country, although experts in their respective fields, may require additional familiarization efforts for the Indian Knowledge Systems.

The IKS aims to contribute to the second and third aspects of "PanchPran" resolutions i.e. "Erase all traces of servitude" and "Be proud of India's heritage and legacy" by the Hon'ble Prime Minister in his Independence Day speech.

The purpose of these guidelines for teacher during the program is to provide a roadmap to familiarize and enthuse students about the IKS in such a way that each and every student can acquire the knowledge of science taught in ancient India.

Course Structure: Indian Science Studies in Ancient India

Detailed Syllabus:

IKS-I: Physics in India

Theoretical framework for the practice of science in ancient India , Concept of Matter, Sāṅkhya-Pātañjala system, Evolution of different forms of matter (Pañcīkaraṇa) from the Vedāntic view, The atomic theory of the Buddhists and Jains, Gravity, Sage Agastya's Model of Battery, Velocity of Light, Vimana: Aeronautics, Vedic Cosmology and modern Concept, An overview of Indian contributions to technology, Technological Innovations.

IKS- II: Chemistry in India

The atomic theory of the Buddhists and Jains, Nyāya- Vaiseśika chemical theory, Chemistry in practice as gleaned from the medical schools of ancient India, Qualities of compounds; formation of molecular properties in chemical compounds, Chemistry of colors, measures of weight and capacity, size of the minimum visible, Ideas of chemistry as in bṛhatsaṁhitā Metallurgical heritage: Arthaśāstra as the earliest text describing gold, silver, and other metals; Processing of gold, silver, copper, iron, tin, mercury, and lead as mentioned in the Indian texts in the ancient and Medieval Period, Zinc distillation as mentioned in Rasārṇava and Rasaratnasamukāyā. Concepts of acid and bases in Indian chemistry from organic fruit, vegetable-based. Acids, plant-ash-based bases to mineral acids of the medieval period.

IKS- III: Mathematics in India

Mathematics in the Vedas and Śulva Sūtras: Mathematical references in Vedas. The extant Śulbasūtra texts & their commentaries. The meaning of the word Śulbasūtra. Qualities of a Śulbakāra. Finding the cardinal directions. Methods for obtaining perpendicular bisector. Bodhāyana's method of constructing a square. The Bodhāyana Theorem (so-called Pythagoras Theorem) Applications of Bodhāyana Theorem. Constructing a square that is the difference of two squares. Transforming a rectangle into a square. To construct a square that is n times a given square. Transforming a square into a circle (approximately measure preserving). Rational approximation for √2. Construction of Cities. Details of fabrication of bricks, etc. Pāṇini's Aṣṭādhyāyī, Piṅgala's Chandaḥśāstra & Mathematics in the Jaina Texts Āryabhaṭa, his period and his work Āryabhaṭīya, Area of a circle, trapezium, and other planar figures. Approximate value of π. Computation of tabular Rsines (geometric and difference equation methods), Ekavarṇa-samikaraṇa and anekavarṇa- samikaraṇa. Development of Combinatorics Līlāvatī of Bhāskarācārya, Bījaganita of Bhāskarācārya&Gaṇitakaumudī of Nārāyaṇa Paṇḍita Magic Squares, Trigonometry and Spherical Trigonometry.

IKS- IV: Astronomy in India

The science of Astronomy and the different units of time discussed in the texts, Systems employed for representing numbers, Spherical trigonometry &Celestial Sphere Division of the celestial sphere/ecliptic, significance by pointing out their basis, five elements that constitute Pañcāṅga– and their astronomical significance, computation of elements in a Pañcāṅga. Key concepts pertaining to planetary computations and Computation of the true longitudes of planets Precession of equinoxes – sāyana and nirayaṇa longitude Finding the cardinal directions and the latitude of a place. Determination of the variation of the duration of the day at a given location Lagna and its computation, Eclipses and their computation.

IKS- V: Economy in India

History of Indian Economy Thoughts, New Indian Economic Model & Sectorial Contribution Past vs Present History of Indian Economy Thoughts: Context from Dharmashastras, Shukraniti, Mahabharata, and Arthashastra. Kautiya's Economic thoughts in specific. India and Global GDP: Ancient India Beyond Capitalism and Communalism, Dharmic, Caste as Social Capital, Black Money, and Tax Heaven. Agriculture: Ancient India, Manufacturing: Ancient India, Education in India, Wealth in India, Governance, and Business in India, Where India Stands Globally. Indian Business Model: Based on 10-point formula: Family Base, High Level of avings, Self-Employment, Highly Entrepreneurial Nature, Non-corporate Sector as the Core

of the Economy, Community Orientation and Higher Social Capital, Faith and Relationship in Economic Affairs, A Society-driven Economy, Driven by Norms and Values.

IKS- VI: Life, Environment, Ecology and Health in India

Ethnic Studies, Life Science in Plants, Anatomy, Physiology, Agriculture, Ecology, Environment, Ayurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Surgery and Ygo.

IKS-VII: Geography in India

Geography of Bharatvarsh and Civilizational Journey, Origin of Sthapatyaveda, Concept of Space and Time, Vedic Yajna: Recreating the microcosmos, Vastu Purusha, Six Limbs of Indian Art and Architecture Harappan Town Planning, Early Historical Cities and Early Text (Arthshastra), Mud Forts of Chhattisgarh, Concept of Sacred and Profane, Techno-Typological Evolution & Regional Variations in Temple Architecture, Rock Cut Architecture, Structural Temple Architecture, Tirthkshetra- Kashi, Dwaraka, Kanchi, Avantika, Ayodhya, Prabhas-kshetra etc., Continuity of Traditional Town Planning: Jaipur, Madurai, Srirangam etc. Functional Aspects of Temples Sacred Forest (Naimisaranya, Panchvati, Dandkaranya etc.), Sacred Groves (Aaramika, Devkunj, etc.), Rainwater Harvesting System: Vav, Kund, Talavetc, Sacred Hills and Mountains (Kailash, Vindhyachal, Sahyadri, Satrunjay, Goverdhan), Kumbha: assimilation of ritual, myth, symbology, and cosmology. Anand K. Coomaraswamy, Patrick Geddess, Alice Boner, Kapila Vatsayayan, Stella Kramrisch and Adam Hardy Forest Management and Urban Planning: Agroforestry, Tank, Lakes, and Stepwells.

References:

- Dr. Subhash Kak , Computation in Ancient India,Mount, Meru Publishing (2016)
- Dharampal, Indian Science and Technology in the Eighteenth Century, Academy of Gandhian Studies, Hyderabad, 1971, republic. Other India Bookstore, Goa, 2000
- Alok Kumar, Sciences of the Ancient Hindus: Unlocking Nature in the Pursuit of Salvation, CreateSpace Independent Publishing, 2014
- B.V. Subbarayappa, Science in India: A Historical Perspective, Rupa, New Delhi, 2013
- S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks, Jnana Deep Publications, Bangalore, 3rdedn, 2004
- S. Balachandra Rao, Vedic Mathematics and Science in Vedas,Navakarnataka Publications, Bengaluru, 2019
- J. McKim Malville &Lalit M. Gujral, Ancient Cities, Sacred Skies: Cosmic Geometries and City Planning in Ancient India, IGNCA & Aryan Books International, New Delhi, 2000).
- Clemency Montelle, Chasing Shadows: Mathematics, Astronomy and the Early History of Eclipse Reckoning, Johns Hopkins University Press, 2011

- Thanu Padmanabhan, (ed.), Astronomy in India: A Historical Perspective, Indian National Science Academy, New Delhi & Springer (India), 2010
- Acharya Prafulla Chandra Ray, A History of Hindu Chemistry, 1902, republ., Shaibya Prakashan Bibhag, centenary edition, Kolkata, 2002
- R. Balasubramaniam, Marvels of Indian Iron through the Ages, Rupa& Infinity Foundation, New Delhi, 2008
- Fredrick W. Bunce:The Iconography of Water: Well and Tank Forms of the Indian Subcontinent, DK Printworld, New Delhi, 2013
- The Positive Sciences of the Ancient Hindus; BrijendraNath Seal; 4th Edition; 2016
- A Concise History of Science in India, ed. D M Bose, S N Sen and B V Subbarayappa; INSA; 2009
- Scientific and Technical Education in India, 1781-1900 by S N Sen; 1991
- Dwivedi D.N., Essentials of Business Economics, Vikas Publications, Latest Edition.
- Economic Sutras by Prof. Satish Y. Deodhar, IIMA Books series
- Black Money Tax Heaven by R Vaidyanathan, Westland ltd. Publication.
- Goswami Anandajit, Economic Modeling, Analysis, and Policy for Sustainability, IGI Global, Latest Edition.
- Ganguly Anirban, Redefining Governance, published by Prabhat Prakashan, Latest Edition.
- Vatasyayan, Kapila. 1997. The Square and the Circle of the Indian Arts, Abhinav Publication.
- Hardy, Adam. 2015. Theory and Practices of Temple Architecture in Medieval India: Bhoja's Samrangansutradhar and The Bhojpur Line Drawings, Dev Publishers & Distributors.
- B. Datta and A. N. Singh, History of Hindu Mathematics, 2 Parts, Lahore 1935, 1938; Reprint, Asia Publishing House, Bombay 1962; Reprint, Bharatiya Kala Prakashan, Delhi 2004.
- G. G. Emch, M. D. Srinivas and R. Sridharan, Eds., Contributions to the History of Mathematics in India, Hindustan Book Agency, Delhi, 2005.
- G. G. Joseph, Indian Mathematics Engaging the World from Ancient to Modern Times, World Scientific, London 2016.
- P. P. Divakaran, The Mathematics of India Concepts Methods Connections, Hindustan Book Agency 2018. Rep Springer New York 2018.
- Gaṇitayuktibhāṣā (c.1530) of Jyeṣṭhadeva (in Malayalam), Ed. with Tr. by K. V. Sarma with Explanatory Notes by K. Ramasubramanian, M. D. Srinivas and M. S. Sriram, 2 Volumes, Hindustan Book Agency, Delhi 2008.
- S. Balachandra Rao, Indian Astronomy an Introduction, Universities Press, Hyderabad, 2000
- History of Astronomy: A Handbook, Edited by K. Ramasubramanian, Aniket Sule and Mayank Vahia, S and HI, IIT Bombay, and T.I.F.R. Mumbai, 2016.
- B.V. Subbarayappa and K.V. Sarma, Indian Astronomy: A Source Book, Nehru Centre, Bombay, 1985.
- Tantrasaṅgraha of Nīlakaṇṭha Somayājī, Translation and Notes, K. Ramasubramanian and
- M. S. Sriram, Hindustan Book Agency, New Delhi 2011.

Paper Code: ZOO-O407NC (Vidyasagar Life and Philosophy)

Compulsory non-credit course

DETAILS OF THE COURSE OF SEMESTER - II

DETAILS OF THE COURSE OF SEMESTER - II

PAPER: Advanced Parasitology and Clinical Immunology

Full marks: 50 **Credits: 04**

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.

PAPER CODE: ZOOC451X1 (Theory) **Full marks: 35** **Credits: 03**

Course content	Hours
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.	4 hrs
Unit-2: **Protozoan parasites:** Life-cycle, transmission, pathogenicity and control of *Girdia lamblia, Trypanosoma cruzi* and *Plasmodium falciparum.*	4 hrs
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	6 hrs

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 hrs
Unit-5: **Integrated vector management:** Mechanical, chemical, biological and environmental control measures against mosquito, sandfly and ticks.	3 hrs
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.	3 hrs
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.	3 hrs
Unit-8: **Hypersensitivity:** Meaning of hypersensitivity; Mechanism and examples of types I, II, III and IV hypersensitivity reactions.	3 hrs
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.	3 hrs
Unit-10: **Immunodeficiency disorders:** Primary immunodeficiency – SCID; Acquired immunodeficiency – AIDS.	3 hrs
Unit-11: **Immunodiagnostics:** Basic principles and applications of the Mantoux test, ELISA, RIA, Immunoelectrophoresis, and Rocket immunoelectrophoresis.	4 hrs
Total:	39 hrs

PAPER CODE: ZOOC451X8 (Practical) Full marks: 15 Credits: 01

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.).	4 hrs
2. **Histological identification with reasons:** Mammalian spleen, thymus, lymph node and blood leucocytes.	4 hrs
3. **Staining of Parasite:** Staining of gut content of cockroach and rectal content of toad for demonstration of parasitic protozoa.	6 hrs
4. **Isolation of macrophage from white rat**	4 hrs
5. **Antigen-antibody reaction:** Determination of ABO blood group and Rh factor by *in vitro* antigen-antibody reaction.	2 hrs
6. **Laboratory Note Book preparation.**	
Total:	20 hrs

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.

PAPER: Cell and Molecular Biochemistry

Full marks: 50 **Credits: 04**

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.

PAPER CODE: ZOOC452X1 (Theory) **Full marks: 35** **Credits: 03**

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) • Protein targeting signals and intracellular localization	8 hrs
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	8 hrs

	• Nuclear localization and export signals ○ Vesicular trafficking mechanisms: COPI, COPII, and Clathrin-coated vesicles	
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)	8 hrs
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	8 hrs

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
		8 hrs

	Total	**40 hrs**

PAPER CODE: ZOOC452X8 (Practical) **Full marks: 15** **Credits: 01**

Course content	**Hours**
Identification of different stages of cell division and cell organelle	4 hrs
Mitochondrial Staining from buccal epithelial cells	3 hrs
Cell isolation and cell counting	4 hrs
Quantitative estimation of protein- Lowry method and Bradford method	3 hrs
Protein denaturation and renaturation assay	3 hrs
Estimation of Glucose, cholesterol, total protein and urea from blood	4 hrs
Total	**20 hrs**

Reference Books:

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)

Paper: Embryology

Full marks: 50 **Credits: 04**

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.

PAPER CODE: ZOOE453A1 (Theory) **Full marks: 35** **Credits: 03**

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: o Chordin o Noggin o Follistatin • BMP inhibitors and neural induction • Induction of neural ectoderm and dorsal mesoderm	9 Hrs

	• 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	
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 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	12 Hrs
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	9 Hrs

	• Aging and insulin signaling cascade • Integration of conserved aging pathways • Environmental and epigenetic causes of aging	

Unit - IV	Stem Cell Concept
	4.1 Stem Cell Fundamentals
	• Stem cell vocabulary
	• Stem cell potency
	  o Totipotent
	  o Pluripotent
	  o 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
		5 Hrs

	Total	**35 Hrs**

PAPER CODE: ZOOE453A8 (Practical) **Full marks: 15** **Credits: 01**

Course content	**Hours**
Identification of different stages of the chick embryo (24 hrs, 36 hrs, 48 hrs, and 72 hrs)	6 hrs
Isolation and staining of chick embryo	6 hrs
Total	**12 hrs**

Reference books:

1. Developmental biology, 11th edition, 2016, by S. F. Gilbert

2. Principles of Development. 4th edition. Lewis Wolpert

Paper: Human Genetics

Full marks: 50 **Credits: 04**

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.

PAPER CODE: ZOOC453B1 (Theory) **Full marks: 35** **Credits: 03**

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	10 hrs
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	10 hrs
Unit III	**Modern Cytogenetic Techniques** • FISH • Comparative genomic hybridization (CGH)	10 hrs

	• Chromosomal microarray analysis **Molecular Diagnostic Techniques** • PCR and RT-PCR **Genetic Testing and Diagnosis** • Prenatal diagnosis (amniocentesis, CVS) • Newborn screening • Carrier testing • SNP analysis	
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	10 hrs
	Total	40 hrs

PAPER CODE: ZOOC453B8 (Practical) **Full marks: 15** **Credits: 01**

Human Pedigree Analysis	10 hrs
PCR	5 hrs
Karyotyping	4 hrs
Demonstration of RT-PCR	1 hrs
Total	20 hrs

Recommended Textbooks

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*

Paper: Biophysics & Microscopy

Full marks: 50 **Credits: 04**

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.

PAPER CODE: ZOOC454A1 (Theory) **Full marks: 35** **Credits: 03**

Unit	Course content	Hours
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 hrs**
Unit II	**Thermodynamics in Biological Systems** • Introduction and basic thermodynamic concepts	**7 hrs**

	• 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 hrs**
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	**6 hrs**

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
		7 hrs

Unit VI	**Diffraction Techniques** • Principle of X-ray diffraction • Electron diffraction • Neutron diffraction • Applications in structural biology and material sciences	**6 hrs**
Total		**40 hrs**

PAPER CODE: ZOOC454A8 (Practical) **Full marks: 15** **Credits: 01**

Course Content	**Hours**
Demonstration of membrane-related function using insect haemolymph	**6 hrs**
Crystal preparation from human blood samples	**6 hrs**
Demonstration and interpretation of electron micrographs	**6 hrs**
Laboratory visit to USIC, VU or equivalent advanced instrumentation facility	**2 hrs**

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 Tendeloo (Editor), “Electron Microscopy: Principles and Fundamentals”
4. Hayat, M. A.- “Principles and Techniques of Electron Microscopy: Biological Applications”.
5. Debajyoti Das- ‘Biophysics and Biophysical Chemistry’, for medical and biology students, Academic Publisher.
6. The Structure of Biological Membranes Hardcover – 18 July 2011
by Philip L. Yeagle (Editor)
7. Fundamentals of Thermodynamics, 8th Edition, Claus Borgnakke Richard E. Sonntag University of Michigan
8. 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

Paper: Biosystematics and Applied Entomology

Full marks: 50 **Credits: 04**

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.

PAPER CODE: ZOOC454B1 (Theory) **Full marks: 35** **Credits: 03**

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 • 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**	10 hrs

	• 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 hrs
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 hrs
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 hrs
Unit - IV	**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 hrs
Unit - V	**Forensic Entomology** Fundamentals of Forensic Entomology Methods and Techniques in Forensic Entomology Applied and Legal Aspects	6 hrs

PAPER CODE: ZOOC454B8 (Practical) **Full marks: 15** **Credits: 01**

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 REFERENCES

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*

Paper: Wildlife Ecology

About the Course:

Wildlife Ecology is a specialized branch of ecology that examines the interactions between wild animal populations and their biotic and abiotic environments across spatial and temporal scales. The course provides a comprehensive understanding of ecological principles such as population dynamics, species interactions (predation, competition, mutualism), habitat selection, niche theory, trophic structure, energy flow, and ecosystem functioning, with particular emphasis on wildlife species. It integrates theoretical frameworks—such as metapopulation models, carrying capacity, density-dependent regulation, and landscape ecology—with field-based methodologies including transect sampling, mark–recapture techniques, radio-telemetry, camera trapping, and GIS-based habitat analysis. Students gain insight into how environmental factors, climate variability, habitat fragmentation, invasive species, and anthropogenic disturbances influence wildlife distribution and abundance. The course also highlights conservation biology concepts, threatened species assessment, and adaptive management strategies essential for maintaining ecological resilience. By combining quantitative analysis, field techniques, and conservation applications, Wildlife Ecology equips students with the scientific foundation necessary for research, biodiversity monitoring, habitat restoration, and evidence-based wildlife management in rapidly changing ecosystems

Course Outcomes:

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

- Understand the fundamental principles of wildlife ecology, including population dynamics, community interactions, habitat ecology, and ecosystem processes influencing wildlife populations.
- Analyze factors regulating wildlife populations such as density dependence, carrying capacity, predation, competition, climate variability, and anthropogenic disturbances.
- Apply ecological theories and quantitative methods to assess wildlife distribution, abundance, and habitat suitability using field-based and analytical techniques.
- Evaluate conservation challenges including habitat fragmentation, invasive species, endangered species management, and human–wildlife conflict within an ecological framework.
- Develop practical skills in wildlife survey methods, data interpretation, and ecological reporting for evidence-based wildlife management and conservation planning.

Paper Code: ZOOE455A1 (Theory) **Full marks: 35** **Credit- 3**

Unit	Course Contents	Lectures / Hours
1.	Foundations of Wildlife Ecology: Definition and basic concepts of wildlife: Scope and importance of wildlife; Values of wildlife- Positive and negative. Status and distribution of major wildlife groups.	3
2.	Population and Community Ecology: Population concepts - structure (age, sex ratio), reproductive strategies, dispersal and migration; demographic parameters; population viability analysis. Carrying capacity; predator–prey interactions; metapopulation theory. Terrestrial and Aquatic Communities. Community interaction.	6
3.	Behavioral and Foraging Ecology: Foraging strategies and optimal foraging theory; home range and territoriality; mating systems and social organization; communication and anti-predator adaptations; behavioral responses to environmental stress.	5
4.	Wildlife Habitat Ecology and Landscape Management: Habitat components and requirements; habitat selection and suitability models; habitat fragmentation and edge effects; wildlife corridors and landscape connectivity.	5
5.	Trophic Ecology of Wildlife: Food chains and food webs; herbivores, carnivores, omnivores, and scavengers; Keystone, Umbrella and Apex species; trophic cascades in the wild; ecological roles of wildlife in maintaining ecosystem stability and resilience.	5
6.	Wildlife Conservation Strategies: Conserving Species; Ex-situ Conservation (Zoos, Aquaria, Botanical Gardens, DNA storage, Seed Banks). In-situ conservation (National Park, Sanctuary & Reserves). Protected Areas (PAs). IUCN categories. Role of Traditional Ecological Knowledge (TEK) in Biodiversity Conservation.	5
7.	Wildlife Monitoring Techniques: Preliminary idea on Wildlife census methods; line transects and distance sampling; radio-telemetry and GPS tracking; camera trapping; indirect evidences; role of GIS in wildlife studies. Environmental DNA.	6
	Total	**35**

ZOOE455A8 (Practical) Full Marks: 15 Credit- 01

1. Determination of the diversity of a habitat by the Species Area Curve method.
2. Evaluation of habitat structure using quadrat, line, or belt transect methods; measurement of vegetation parameters to assess wildlife habitat suitability.
3. Preliminary demonstration of wildlife Monitoring Techniques (camera trap records, and indirect sign survey methods).
4. Study of the behaviour of any selected wild animal - preparation of an Ethogram.
5. Study of selective fauna from live specimens (in and around the campus) /model/photograph/media/museum or visit to Zoological/Botanical Garden and submission of a report.

Recommended Readings

1. Wildlife Biology: An Indian Perspective by Goutam Kumar Saha and Subhendu Mazumdar, Pages: 328 pp.
2. Wildlife Ecology, Conservation, and Management– Illustrated, 2014 by Fryxell, John M., Sinclair, Anthony R. E., and Caughley, Graeme.

Paper: Environmental Issues & Management

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.

ZOOE455B1 (Theory) **Full Marks: 35** **Credit- 3**

Unit	Course Contents	Lectures / Hours
1.	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.	5
2.	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	6
3.	Sustainability & Sustainable development: SDGs, Sustainable use of resources and sustainable development. Impact of urbanization and industrialization on environment.	4
4.	Environmental Impact Assessment (EIA): Definition and types of EIA, Methodologies of EIA. LCA (Life cycle Assessment)	3
5.	Role of traditional knowledge in environmental management, people's participation, social forestry. Environmental movements: Arabari model. JFM, Chipko movement.	4
6.	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.	6
7.	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.	6
	Total	**36**

ZOOE455B1 (Practical) Full Marks: 15 Credits 01

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.

Recommended Readings

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

ZOOC456X9 (Field Visit) Credit: 2 Marks 25

Submission of the field visit report. The duration of the field visit must be correlated with the credit points.

DETAILS OF THE COURSE OF SEMESTER - III

DETAILS OF THE COURSE OF SEMESTER - III

ZOOC501X0: MOOCs (Massive Open Online Courses)

Full marks: 100 **Credits: 04**

SWAYAM: India's national platform offering over 2,150 courses across various disciplines, often allowing academic credits.

About SWAYAM: SWAYAM is a program initiated by the Government of India and designed to achieve the three cardinal principles of Education Policy, viz., access, equity, and quality. The objective of this effort is to take the best teaching and learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and are unable to join the mainstream of the knowledge economy.

Students will select one course from the Swayam Platform in consultation with the departmental MOOC course coordinator. The passing criteria for internal assessment and end-semester examinations are as per the rules and regulations laid down by SWAYAM and Vidyasagar University.

Internal Assessment: 30 Marks

End-of-Semester Examination: 70 Marks

The course must have the following criteria:

Category: PG; Credit: 4

Paper: Environmental Microbiology

Full Marks: 50 **Credit 04**

About the Course:

Environmental Microbiology focuses on the study of microorganisms in natural and engineered environments and their roles in maintaining ecological balance. The course introduces students to the diversity, distribution, and functional significance of microbes in soil, water, and air, emphasizing their involvement in nutrient cycling and ecosystem processes. It explores microbial interactions, community dynamics, and the influence of environmental factors on microbial growth and activity. The overall idea is the role of microorganisms in biogeochemical cycles, including the carbon, nitrogen, sulfur, and phosphorus cycles, highlighting their importance in sustaining life on Earth. The course also covers applied aspects such as wastewater treatment, bioremediation, and pollution control, demonstrating how microbes are utilized to manage environmental issues and restore degraded ecosystems. Students are introduced to techniques used in environmental monitoring, microbial analysis, and ecological assessment.

Course Outcomes:

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

CO1: Understand microbial diversity, structure, and roles in different environments.
CO2: Explain microbial interactions and their involvement in biogeochemical cycles.
CO3: Analyze factors affecting microbial growth and ecological functions.
CO4: Evaluate the role of microorganisms in wastewater treatment, bioremediation, and environmental management.
CO5: Assess the importance of microbes in sustainability, agriculture, climate change mitigation, and ecosystem balance.

ZOOC502X1 Environmental Microbiology Theory Marks 35 Credit 3

Unit	Course Contents	Lectures / Hours
1.	**Microbial Diversity and Ecology** • Microbial ecology in different environments • Microbial diversity: Bacteria, Algae, Fungi, Viruses, and Protozoa • Microbial populations in soil, water, and air • Extremophiles: Thermophiles, Psychrophiles, Acidophiles, Halophiles • Microbial community dynamics; Biofilms and Quorum Sensing	**7**
2.	**Microbial Metabolism and Physiology** • Role of microbial flora in maintaining health • Metabolic pathways: aerobic and anaerobic respiration, fermentation • Biogeochemical cycling by microbes: carbon, nitrogen, sulfur, phosphorus • Environmental response via Chemotaxis	**6**
3.	**Bioremediation** • Bioremediation processes: bioaugmentation, biodegradation, bioimmobilization, bioleaching, biostimulation	**6**

	• Microbial degradation of pollutants • Waste treatment: sewage, industrial effluents, solid waste management.	
4.	**Techniques in Environmental Microbiology** • Microbial enumeration: direct and indirect methods; Molecular techniques and Metagenomics • Identification of Bacteria: Culture-dependent and culture-independent methods; Identification of microbial isolates via biochemical assays (Catalase test, Oxidase test, etc.) • Microbial Bioinformatics	**7**
5.	**Applied Environmental Microbiology** • Microbial influence on water quality and drinking water • Impact of Microbes on climate change and greenhouse gas mitigation • Role of microbes in sustainable agriculture and forestry • Biomonitoring and Biosensors	**6**
	Total	**32**

ZOOC502X8 Practical Environmental Microbiology Marks 15 Credit 1

1. Monitoring and Analysis of Environmental samples: Microbial Isolation from soil, water, and air.
2. Various culture methods for bacteria and fungi from environmental samples.
3. Microscopy and Staining for microbial identification- Gram stain and other differential stains; Direct microscopic counts.
4. Enumeration and Viability Tests - Serial dilution and plate count techniques; Indirect counts- Test for Potability- Most Probable Number (MPN) method.
5. Bioremediation Experiments- Evaluation of microbial activity and pollutant degradation.
6. Analysis of Microbial Database Using Bioinformatics

Recommended Readings

1. Environmental Microbiology – Ian L. Pepper, Charles P. Gerba, Terry J. Gentry; Academic Press (Elsevier); 3rd Edition, 2015.
2. Microbiology: An Introduction – Gerard J. Tortora, Berdell R. Funke, Christine L. Case; Pearson; 13th Edition, 2018.
3. Environmental Microbiology – Ralph Mitchell, Ji-Dong Gu; Wiley-Blackwell; 2nd Edition, 2010.
4. Principles of Microbial Ecology – Ronald M. Atlas, Richard Bartha; Benjamin/Cummings; 4th Edition, 1998.
5. Environmental Microbiology – Ronald M. Atlas, Richard Bartha; Pearson; 2nd Edition, 1998.
6. Manual of Environmental Microbiology – Edited by Christon J. Hurst et al.; ASM Press; 4th Edition, 2015.
7. Bioremediation and Biotechnology – Martin Alexander; Academic Press; 2nd Edition, 1999.
8. Environmental Microbiology – P. D. Sharma; Rastogi Publications; Latest edition.
9. Microbiology – Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg; McGraw-Hill; 5th Edition.

Paper: Histochemistry and Neurobiology

Full Marks: 50 **Credit 04**

About the Course:

The course Histochemistry and Neurobiology is designed to provide students with fundamental and advanced knowledge of tissue staining techniques, histochemical methods, enzyme histochemistry, immunohistochemistry, and the structure and function of the nervous system and neuroendocrine system in both invertebrates and vertebrates. The course also covers neural communication in sensory organs, neurodegenerative diseases, and regenerative neural cells with special emphasis on glial cells and neural immunity.

Course Outcomes (CO)

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

CO1: Understand the principles of fixation, staining, dyes, and tissue processing techniques used in histochemistry and micro-techniques. Classify different types of dyes and stains and explain double and triple staining methods used in biological tissue analysis.
CO2: Perform histochemical identification of proteins, lipids, and carbohydrates using Crystal Violet, Sudan Black B, Alcian Blue, and PAS techniques. Explain enzyme histochemical techniques for the localization of Acid phosphatase, Alkaline phosphatase, Peroxidase, and Acetylcholinesterase.
CO3: Understand the principles and applications of immunohistochemistry, immunofluorescence staining, and colloidal gold techniques.
CO4: Describe neuroendocrine structures in invertebrates and vertebrates and explain the neuroendocrine axis in vertebrates. Explain neural communication in sensory systems, including olfactory receptors, retinal neurons, auditory neural pathways, and specialized neural communication in vertebrates such as snakes.
CO5: Understand the causes, symptoms, and treatment of major neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, Bell's palsy, and Multiple Sclerosis.

ZOOC503X1 (Theory) **Full Marks: 35** **Credit- 3**

Unit	Course Contents	Lectures / Hours
I	Introduction to fixation, Dye, Stain, and Micro techniques. a) Type of fixation and fixatives. b) Classification of dye and stain. c) Biological tissue processing methods. d) Double and Triple staining.	**6**
II	Histochemical methods for protein, lipid, and carbohydrate. a) Histochemical identification of protein using Crystal violet. b) Lipid droplets identification by Sudan Black – B. c) Identification of Carbohydrates by Alcian blue / PAS technique.	**5**
III	Enzyme histochemical techniques a) Acid phosphatase. b) Alkaline phosphatase. c) Peroxidase. d) Acetylcholinesterase.	**5**
IV	Immunohistochemistry a) Tissue fixation b) Immunofluorescence markers.	**5**

	c) Immunofluorescence staining methods. d) Colloidal Gold technique.	
V	Neuroendocrine structure in Invertebrates and Vertebrates. a) General neural components in invertebrate and vertebrate animals. a) Neuroendocrine structure in Insect b) Neuroendocrine glands in mammals. c) Neuroendocrine axis in vertebrates	**5**
VI	Neural communication in sensory structures. a) Olfactory neural cells b) Different types of neural cells in the retina and their function c) Auditory neural components in mammals d) Special type of neural communication in vertebrates (snake)	**5**
VII	Neurodegenerative diseases. a) Alzheimer's disease, cause, symptoms, and treatment b) Parkinson's disease, cause, symptoms, and treatment c) Bell's Palsy disease, cause, symptoms, and treatment d) Multiple Sclerosis (MS) disease, cause, symptoms, and treatment	**5**
VIII	Regenerative neural cells and immunity a) Progenitor cells b) Glial cells c) Oligodendrocytes d) Astrocytes	**5**

ZOOC503X8 (Practical) **Full Marks: 15** **Credit- 1**

1. Micro techniques (Tissue fixation / Block preparation, cutting, staining)

2. Histological identification of Thyroid, Parathyroid, Prostate gland, Testis, Uterus, Ovary, Tongue, Eye, and Neuroepithelium.

3. Biomolecule identification by histochemical technique.

4. Neural structure demonstration in model specimen.

5. Neural subcellular structure demonstration.

Reference Books:

1. J. A. Kiernan – "Histological and Histochemical Methods" Theory and Practice, Fifth edition © Scion Publishing Ltd, 2015.
2. Carlo Pellicciari, Marco Biggiogera, Manuela Malatesta- Histochemistry of Single Molecules, Publisher: Humana New York, NY, Published: 25 September 2022.
3. Jeffrey L. Cummings and Jagan A. Pillai Neurodegenerative Diseases: Unifying Principles, Publisher: OUP USA, 8 December 2016.
4. The Structure of Biological Membranes Hardcover – 18 July 2011 by Philip L. Yeagle (Editor).
5. Zdeněk Lojda, Reinhart Gossrau, Theodor Heinrich Schiebler, Enzyme Histochemistry, Publisher: Springer Berlin, Heidelberg, 1979, 1st Edition.
6. David H Cormack, Ham's Histology, Publisher: Lippincott Williams & Wilkins Publication: 1 April 1987, Ninth Edition.
7. P. H. Bach and John R. Baker "Histochemical and Immunohistochemical Techniques: Application to Pharmacology and Toxicology"
8. Authors V.B. Wigglesworth, Insect Physiology, Publisher: Springer Dordrecht, 8th Edition, 1985.
9. Anthony Guy Everson Pearse, Histochemistry, Theoretical and Applied, Publisher: Edinburgh; New York: Churchill Livingstone; New York: Distributed by Longman, Publishing: 1980

Special Paper

Special Paper: Fishery (Credit 4)

Paper Code- ZOOE504A1: Fish Anatomy and Culture System

About the Course:

This course introduces the classification, anatomy, reproduction, and development of fishes and shellfish. It covers aquaculture systems such as integrated culture, induced breeding, cage, pen, and biofloc systems. The course also includes shellfish culture, fisheries economics, fish harvesting and processing, and provides insights into entrepreneurship and fishery management.

Course Outcomes (CO)

1. Understand the classification of fish and shellfish up to the order level.
2. Describe basic fish anatomy and physiological structures.
3. Explain reproductive systems and endocrine glands in fish.
4. Understand developmental stages in fish and shellfish.
5. Learn major aquaculture practices and culture systems.
6. Explain shellfish fisheries and their economic importance.
7. Understand fisheries planning, harvesting, and processing.
8. Develop basic knowledge of fishery entrepreneurship and management.

ZOOE504A1 (Theory) **Full Marks: 25** **Credit- 2**

Unit	Course Contents	Lectures / Hours
I	Classification of fishes and shellfish (up to Order).	**3**
II	Anatomy of fish: Skin, Scale, Gill, Swim bladder, and GI tract.	**3**
III	Reproductive structures of fish and Endocrine glands (*i.e.,* pituitary, thymus, testis, and ovary).	**3**
IV	Developmental stages in fishes and shellfish.	**3**
V	System of Aquaculture: Integrated fish culture, Induced breeding, Pen Culture, Cage culture, and Bio-flock culture system.	**3**
VI	Shellfish Culture and its importance, Prawn fishery, Crab fishery, and Molluscan Fishery.	**3**
VII	Fisheries Planning and Economics.	**3**

VIII	Fish Harvesting and Processing, Fish Seed Transport, Fish Byproducts, and Fishery Co-operatives and Entrepreneurship in Aquaculture.	**4**

Reference Books:

1. Gary A. Wedemeyer – "Physiology of Fish in Intensive Culture Systems" Edition: 1st ed. 1996, © Atlantic Publishers and Distributors (P) Ltd.

2. V.G. Jhingram- "Fish and Fisheries of India" 3rd edition, Hindustan Publishing.

3. William S. Hoar and D J Randall- "Fish Physiology" Publisher: Elsevier

Paper Code- ZOOE504A2: Marine Fisheries

About the Course

This course provides knowledge about ocean characteristics, estuarine ecosystems, marine fishery resources, fishing methods, marine pollution, and modern tools such as remote sensing and GIS used in fisheries management. It also covers marine fisheries harvesting and processing, as well as their role in trade and commerce, helping students understand both the ecological and economic aspects of marine fisheries.

Course Outcomes

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

1. Understand the important physical and biological characteristics of oceans.
2. Describe the structure, function, and fishery resources of estuaries.
3. Explain oceanic and deep-sea fishery resources.
4. Identify tools and technologies used for marine fisheries development.
5. Understand different kinds of marine fisheries, harvesting, and processing methods.
6. Explain marine pollution and environmental hazards.
7. Understand the application of remote sensing and GIS in fisheries management.
8. Explain the role of marine fisheries in trade and commerce.

ZOOE504A2 **Full Marks: 25** **Credit- 2**

Unit	Course Contents	Lectures / Hours
I	Important characteristics of oceans.	**3**
II	Estuary- Structure, Function, and Fishery Resources.	**3**
III	Oceanic and deep-sea fishery and fishery resources.	**3**
IV	Tools for Marine Fisheries development.	**3**
V	Kinds of marine fisheries, harvesting, and processing.	**3**
VI	Marine pollution and hazards.	**3**
VII	Application of remote sensing and GIS in the fishery.	**3**
VIII	Marine Fisheries in trade and commerce.	**4**

Reference Books:

1. Simon Oakenfold – "Marine Fisheries Management" Publisher: Callisto

2. N.K.G. Pillai – "Marine Fisheries and Mariculture in India" Publisher: Narendra Publishing House.

3. Wetzel's – "Limnology Lake and River Ecosystems" 4th Edition, AP Publisher.

Special Paper: Ecology (Credit 4)

Paper Code- ZOOE504B1: Aquatic Ecology

About the course

Aquatic Ecology explores the structure and functioning of freshwater and marine ecosystems, focusing on the interactions between physical, chemical, and biological components of aquatic environments. The course provides an understanding of different aquatic habitats such as rivers, lakes, wetlands, estuaries, and oceans, along with their unique ecological characteristics.

It examines the diversity, distribution, and adaptations of aquatic organisms including plankton, nekton, and benthos, and highlights their ecological roles in maintaining ecosystem stability. Emphasis is placed on key processes such as primary productivity, energy flow, nutrient cycling, and trophic interactions within aquatic food webs.

The course also addresses important ecological phenomena such as thermal stratification, mixing patterns, and seasonal dynamics that regulate aquatic life. In addition, it covers the functioning and ecological significance of wetlands and their role in water purification and biodiversity conservation.

Applied aspects include the study of water quality, pollution, eutrophication, and the impacts of human activities and climate change on aquatic ecosystems. Overall, the course equips students with the knowledge required to understand, assess, and manage aquatic resources for sustainable use and conservation.

COURSE OUTCOME:

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

CO1: Understand the structure, classification, and physicochemical characteristics of freshwater and marine ecosystems.
CO2: Explain the distribution, adaptations, and ecological roles of aquatic organisms including plankton, nekton, and benthos.
CO3: Analyze trophic interactions, energy flow, and nutrient cycling in aquatic ecosystems.
CO4: Evaluate ecological processes such as stratification, productivity, and succession in aquatic environments.
CO5: Assess the impact of environmental stressors, pollution, and climate change on aquatic biodiversity and ecosystem health.

ZOOE504B1 Aquatic Ecology (Theory) Full Marks: 25 Credit- 2

Unit	Course Contents	Lectures / Hours
1.	Components of aquatic ecosystems - Abiotic factors: light - temperature - salinity – pressure; Biotic factors: Aquatic biota – Macrophytes/ Hydrophytes, phytoplankton, zooplankton, periphyton, benthos, nekton, etc., and ecological interactions.	4
2.	Different types of aquatic ecosystems: Freshwater, Wetlands, Estuarine and marine ecosystems.	6

	Freshwater Ecosystem: o Lentic water bodies – classification; ponds, lakes. Indian lakes and reservoirs; Physiography of lentic ecosystems: origin, stratification, distributions and mixing patterns. o Lotic water bodies: ecology of streams, springs, rivers; o River Ecosystem: Riparian zones. River-continuum concept; Fluvial hydrology; Catchment and drainage basins; Hydrochemical dynamics. o Major Biodiversity of Indian rivers- Namami Ganga project.	
3.	Wetland Ecosystem: o Definition, distribution, classification, zonation and succession, significance and values; Ramsar sites in India.	3
4.	Estuarine Ecosystem: o Definition, classification, structure – biotic assemblage, function.	3
5.	Marine and Coastal Ecosystem: o Extent and zonation; geomorphological features, physical processes, significance, integrated coastal zone management. o Global and marine diversity. Structure and function – biotic assemblage. o Intertidal ecology – zonation and habitats; mangroves, coral reef, lagoons, sand dunes. o Mangrove Ecosystem: Definition, speciality, structure and function with special reference to Sundarbans of India; Problems and Management. o Coral Ecosystem: types and distribution; role with regard to biodiversity, productivity and ecosystem functioning; Threats.	6
6.	o Ecological adaptations of aquatic flora and fauna: freshwater, estuarine, pelagic, inter-tidal, tide pools and deep sea. o Water Pollution and Eutrophication- Algal blooms	3
	Total	25

References

1. Olandao Martin. (2017). Aquatic Ecology and Biodiversity. Publisher: Callisto ISBN: 9781632398215, 1632398214.
2. Vincent Jennings, (2016). Aquatic Ecology. Publishing House Syrawood,
3. Walter Dodds and Matt Whiles. (2010). Freshwater Ecology -Concepts and Environmental Applications of Limnology 2nd Edition eBook ISBN: 9780080884776: Academic Press.
4. Nybakkan J.N. (1997). Marine Biology-An ecological approach. Additon Wesley, Educational publication Inc. 3. Puglisi, M. P., & Becerro, M. A. (Eds.). (2018). Chemical ecology: the ecological impacts of marine natural products. CRC Press.
5. McClintock, J. B., & Baker, B. J. (2001). Marine chemical ecology. CRC press.
6. Limnology: Lake and River Ecosystems - Robert G. Wetzel. 2001. Third Edition.
7. Freshwater Ecology: Concepts and Environmental Applications of Limnology - Walter K. Dodds, Matt R Whiles. 2010.
8. Riverine Ecology (2024) - Susanta Kumar Chakraborty. (Volume 1 and 2) Springer Nature

Paper Code: ZOOE504B2 (Biodiversity Conservation and Management)

About the course:

The unit Biodiversity Conservation focuses on the study of the diversity of life at genetic, species, and ecosystem levels, and the strategies required to conserve and sustainably manage biological resources. The course introduces students to patterns of biodiversity distribution, with special emphasis on global and Indian biodiversity hotspots and their ecological significance.

It explores the major threats to biodiversity, including habitat loss, fragmentation, invasive species, overexploitation, pollution, and climate change. Students gain an understanding of extinction processes and the importance of preserving ecological balance and ecosystem resilience.

The course covers both in situ and ex situ conservation approaches, including protected areas, wildlife sanctuaries, national parks, biosphere reserves, zoos, botanical gardens, and gene banks. It also highlights the role of community participation, traditional knowledge, and policy frameworks in conservation efforts.

Additionally, the course introduces concepts such as ecosystem services, sustainable development, and conservation planning. Legal and institutional measures for biodiversity protection, including national and international conventions, are also discussed.

Course Outcome:

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

CO1: Know the status of the planet's biological diversity and value of biodiversity and drivers of its loss

CO2: Understand basic concepts and scientific principles of conservation and global patterns in biodiversity

CO3: Enhance current efforts to conserve biodiversity on global, national and regional scales;

CO4: Learn about the ethics and laws regarding wildlife, forests and environment.

CO5: Resolve practical issues with regional conservation.

ZOOE504B2 Biodiversity Conservation and Management (Theory) FM:25 Credit- 2

Unit	Course Contents	Lectures / Hours
1.	Necessity and Objectives of Biodiversity Conservation and Wildlife management: o Benefits of and threats to biodiversity; Causes and consequences of biodiversity declines. o Megadiversity countries and Biodiversity hotspots. o Biodiversity as bioresources – use and values (consumptive and productive uses).	4
2.	Biodiversity- levels and measurement: o Species richness & abundances; o Diversity indices – Shannon-wiener, Simpson & Fisher's.	4
3.	Major approaches of Biodiversity Conservation; o Conserving Species; Population and Landscapes. IUCN Red List Version 3.1; IUCN categories of Protected Areas- National Parks, Sanctuaries, UNESCO Biosphere Reserves. World Heritage Sites.	5

	○ Overview of conservation efforts: global protected area network; Protected areas and its roles; IUCN species conservation status categories: critically endangered, endangered, vulnerable, near threatened, etc.; Red Data Book. ○ Endemic Areas; Important Bird Areas (IBAs) – examples.	
4.	Regulation of biodiversity: ○ Convention on Biological Diversity, National Biodiversity Authority, WCMC, CITES. ○ Ethics of Wildlife Management and Conservation. ○ Wildlife crime, Indian scenario. Wildlife (Protection) Act, 1972.	4
5.	○ Biodiversity prospecting and Indigenous Knowledge systems Community Biodiversity Registers. ○ Indian case studies on conservation/management strategies ○ Human-wildlife conflict resolution; wildlife corridor planning	3
6.	Technologies for Wildlife Research and Management: ○ Specialised Tools and techniques for wildlife study. ○ Captive breeding; Species reintroduction, Species translocation. ○ Remote sensing: GIS and GPS and its application in habitat & wildlife conservation. Citizen Science	5

Recommended Readings

1. Morin, P. J. (2009). *Community ecology*. John Wiley & Sons.
2. Peter Stiling (2015). Ecology: Global Insights & Investigations. 2nd Edition. McGraw-Hill international edition
3. Singh, V. (2024). *Textbook of Environment and Ecology* (pp. 225-236). Singapore: Springer.
4. *Ecology by William Bowman & Sally Hacker. 6th Ed. Oxford*
5. *Southwood's Ecological Methods by P. A. Henderson · 2021. Pages: 528. Oxford University Press*
6. *Fred Van Dyke, Rachel L. Lamb (2020). Conservation Biology: Foundations, Concepts, Applications. Springer International Publishing*
7. Global Action for Biodiversity: An International Framework for Implementing the Conservation on Biological Diversity; Timothy Swanson; Earthscan Publications Ltd. London.
8. Conservation Biology; Andrew S. Pullin; Cambridge University Press; Page 1-342. Biodiversity and Global Change; O.T. Solbrig, H.M. Van Emden and P.G.W.J. Van Oordt; Cab International, International Union of Biological Sciences; Page 1-223.

Special Paper: Genetics and Molecular Biology

Paper Code- ZOOE504C1: Genetics

About the course:

This course covers eukaryotic genome organization, gene expression, RNA processing, recombination, and sex determination in mammals and Drosophila. It explains chromatin structure, epigenetics, RNA splicing, recombination models, and genetic control mechanisms. The first part discusses genome organization, including nucleosome structure, chromatin remodeling, histone modifications such as acetylation and methylation, centromeric and telomeric DNA, epigenetics, and apoptosis, all of which are vital for chromosome stability and gene regulation. The second part focuses on RNA splicing and rRNA transcription, including mRNA production, 5′ capping, 3′ polyadenylation, RNA editing, and self-splicing, showing how primary transcripts become functional RNA. The third part explains recombination and crossing over, covering models such as the Holliday, Meselson–Radding, and double-strand break repair models, which elucidate recombination during meiosis. The final part examines sex determination and dosage compensation, including primary and secondary sex determination, the roles of the Y chromosome, SRY, SOX9, and DAX1, hormonal regulation, and genetic mechanisms involving the Sxl, transformer, and doublesex genes in Drosophila. Overall, it integrates molecular biology, genetics, genomics, and developmental biology, giving students a comprehensive view of genome organization and gene regulation.

Course Outcomes (CO)

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

CO1: Describe the organization of the eukaryotic genome, nucleosome structure, and chromatin organization.
CO2: Explain chromatin remodeling and histone modifications, such as acetylation and methylation, and their role in gene regulation and epigenetics.
CO3: Understand the structure and function of centromeric DNA, telomeric DNA, epigenetic regulation, and apoptosis mechanisms.
CO4: Explain the mechanism of RNA splicing and the production of mature mRNA in eukaryotes, including 5′ capping, 3′ polyadenylation, and RNA editing.
CO5: Describe transcription of rRNA genes and self-splicing reactions.
CO6: Explain the molecular mechanism of genetic recombination and crossing over using the Holliday model, the Meselson–Radding model, and the double-strand break repair model.
CO7: Understand primary and secondary sex determination in mammals and the role of SRY, SOX9, and DAX1 genes in sex determination.
CO8: Explain hormonal regulation of sexual phenotype and dosage compensation in mammals.
CO9: Describe the mechanism of sex determination in Drosophila, including the role of the Sxl gene, transformer gene, and doublesex protein.
CO10: Apply knowledge of genome organization, gene regulation, recombination, and sex determination in genetics, molecular biology research, and biotechnology.

ZOOE504C1 (Theory) **Full Marks: 25** **Credit- 2**

Unit	Course Contents	Lectures / Hours
I	Organization of the eukaryotic genome: Nucleosome structure, Chromatin remodeling, Histone modification-acetylation, methylation, Centromeric & Telomeric DNA, Epigenetics, Apoptosis.	4
II	Post-transcriptional Control of Gene Expression: mRNA stability, Casin mRNA stability, Transferin receptor mRNA stability, TfR mRNA stability	4
III	RNA interference: Mechanism of RNA interference, Role of RNAi Machinery to heterochromatin formation and gene silencing, Piwi-interacting RNAs and transposon control. MicroRNA, silencing of translation by miRNAs	4
IV	Mechanism of RNA Splicing & Transcription of rRNA gene: Production of mature mRNA in eukaryotes, 5′ and 3′ modification of eukaryotic mRNA, RNA editing, and transcription of rRNA genes. Self-splicing reaction.	4
V	Mechanism of Crossing Over: The Holliday model of crossing over, the Meselson-Radding Model of Recombination, and the double-strand-break repair model of recombination.	5
VI	Sex determination and Dosage compensation in Mammals and Drosophila: Primary and Secondary sex determination in mammals. The Y chromosome sex determinant, Sry, Sox 9 gene product, the role of DAX 1 gene, hormonal regulation of the sexual phenotype, Mechanism of sex determination in Drosophila, the role of sxl gene, transformer gene, and double sex protein.	5

Recommended Text Books

1. Introduction to Genetic Analysis – J. F. Griffiths, W. M. Gelbart, J. H. Miller and R. C. Lewontin.
2. Genes VIII – Benjamin Lewin.
3. Genetics: Analysis and Principles – Robert J. Brooker.
4. An Introduction to Genetic Analysis – David T. Suzuki.
5. Genetics: A Conceptual Approach – Benjamin A. Pierce.
6. iGenetics: A Molecular Approach – Peter J. Russell.
7. Principles of Genetics – Peter Snustad and Michael J. Simmons.

Paper Code- ZOOE504C2: Molecular Biology

About the Course

This course focuses on signal transduction pathways, transposable genetic elements, DNA repair mechanisms, cancer genetics, epigenetics, gene therapy, and transgenesis. It provides knowledge of molecular mechanisms that control gene expression, genome stability, and cell signaling. The course also highlights the role of epigenetics and genetic mutations in human diseases and cancer.

Course Outcomes

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

1. Understand major signal transduction pathways such as TGF-β, Wnt, JAK-STAT, Hedgehog, Notch, TLR, and NF-κB pathways.
2. Explain transposable genetic elements, mechanisms of transposition, and transposons in maize and Drosophila.
3. Describe DNA mutation and DNA repair mechanisms, including excision repair, mismatch repair, recombination repair, and non-homologous end joining.
4. Understand molecular genetics of cancer, including oncogenes, tumor suppressor genes, angiogenesis, metastasis, and cancer therapies.
5. Explain epigenetics, DNA methylation, genomic imprinting, stem cells, and epigenetic regulation in human diseases.
6. Understand gene therapy methods, including gene targeting, stem cell therapy, siRNA/miRNA, and retroviral gene therapy.

ZOOE504C2 (Theory) **Full Marks: 25** **Credit- 2**

Unit	Course Contents	Lectures / Hours
I	**Signal Transduction Pathway controlling gene expression** • TGFβ pathway • Wnt pathway • Jak-Stat pathway • Hedgehog Pathway • Notch Delta • TLR pathway • NF-β pathway	7
II	**Transposable Genetic Element:** IS element: its property and transposition, Non-composite and Composite transposition. Cointegration model for transposition. The AC-DC controlling factors in corn, Hybrid dysgenesis, and P-elements in *Drosophila*. Sleeping	5

	Beauty model of the transposon. Retroposons & retrotransposons, LTR and Non-LTR transposition, Strategies and Controls, human disease	
III	**Genetics of Cancer** Cell transformation, Tumorogenesis, Oncogenes, Tumor suppressor genes, Genomic instability, Epigenetic modification, Angiogenesis, Metastasis, and Current therapies with special emphasis on Immunotherapy (Immune Checkpoint Inhibitors, CAR-T cell therapy, and mAb therapies)	5
IV	**Epigenetics and genome imprinting** - DNA methylation in mammals, genomic imprinting in mammals, germ line and pluripotent stem cells, epigenetic control of lymphopoiesis, nuclear transplantation and the reprogramming of the genome. Epigenetics and human disease, epigenetic determinants of cancer.	5

Reference books:

1. Molecular Cell Biology by Harvey Lodish 8th Ed. (2016).
2. Molecular Biology by Robert F. Weaver 5th Ed (2012).
3. Molecular Biology of the Gene by James D. Watson 7th Ed (2014).
4. iGenetics: A Molecular Approach by Peter J. Russell 3rd Ed (2010).
5. Human Molecular Genetics by Tom Strachan & Andrew P Read 3rd Ed (2004)
6. Principles of Gene Manipulation and Genomics by S.B.Primrose 7th Ed (2006)

Special Paper: Parasitology

Paper code: ZOOE504D1 (Diversity and Biology of Parasite Syllabus)

About the Course:

The course will acquaint students with host-parasite interactions, complement activation, TLR recognition and signaling, and hypersensitivity, with special reference to asthma. The course will enlighten students about various modern diagnostic methods for identifying parasitic infections. Vector biology and epidemiology will be another focus for understanding the transmission dynamics of vector-borne diseases and for the proper formulation of vector control strategies.

Course Outcome

1. Understand fundamentals of parasitology.
2. Classify major parasitic groups (protozoans, cestodes, trematodes, nematodes).
3. Describe morphology, anatomy, and life cycles of parasites.
4. Explain transmission, adaptation, physiology, and pathogenicity.
5. Understand host immune responses and parasite immune evasion.
6. Learn immune escape mechanisms in tumor cells.
7. Study immunosuppressants and immune boosters.
8. Gain knowledge of key clinical techniques (PCR, blotting, immunofluorescence, immunohistochemistry, hybridoma for MAb).

ZOOE504D1 (Theory) Full Marks: 25 Credit- 2

Unit	Course Contents	Lectures / Hours
I	**Introduction to Parasitology** i. Basic concepts- parasite systematics, ecology, and evolution ii. Host-parasite interactions	2L 1L
II	**Protozoology** i. Classification of Protozoa with suitable example up to subclasses following Levine et al. (1980) ii. Structure of Apical complex iii. Life cycle, pathogenicity and control of *Entamoeba histolytica, Balantidium coli* iv. Primary Amoebic Meningoencephalitis	2L 1L 2L 1L
III	**Helminthology** i. Structure, composition and function of the tegument of parasitic helminths ii. Life cycle, pathogenicity and control of *Diphyllobothrium latum, Echinococcus granulosus, Schistosoma haematobium,*	2L 6L

	Paragonimus westermani, Trichinella spiralis, Loa loa iii. Carbohydrate and protein metabolism in Nematode and Trematode iv. Mode of action of anthelmintic drugs v. Different types of scolex in Cestoda vi. Types of cercariae in digenetic trematode	 2L 1L 1L 1L
IV	**Major parasitic diseases of fish:** i. **Fish parasites:** Ectoparasites and Endoparasites; protozoa, worms (helminths), and crustaceans; infective stages, symptoms, and diagnosis. ii. **Common Protozoan Parasites:** *Ichthyophthirius sp., Trichodina sp.* and *Myxobolus sp.* iii. **Monogeneans (Skin/Gill Flukes):** *Gyrodactylus sp.* and *Dactylogyrus sp.* iv. **Helminths (Worms):** *Lytocestus sp. Clinostomum sp.* and *Capillaria sp.* v. **Crustacean Parasites:** *Argulus sp.* and *Lernaea sp.*	5L

Paper Code: ZOOE504D2 (Immunoparasitology)

About the Course

This course provides a comprehensive understanding of immunology and clinical parasitology, focusing on how the immune system defends the body against pathogens and disease. It covers immune responses to bacteria, viruses, and parasites, as well as the development and function of T-cells and B-cells. The course also explores inflammation, transplantation immunology, and tumor immunology, including mechanisms of immune surveillance and modern immunotherapies such as checkpoint inhibitors and CAR-T cell therapy. Additionally, it introduces key laboratory techniques used in diagnosis and research, including PCR, blotting methods, immunofluorescence, and hybridoma technology. Overall, the course integrates fundamental concepts with advanced applications, providing both theoretical knowledge and practical insights into immunological research and clinical diagnostics.

Course Outcome

1. Understand immune mechanisms against pathogens and parasites.
2. Explain T-cell and B-cell development and immune tolerance.
3. Describe inflammation and its role in disease and therapy.
4. Analyze transplantation immunology and immunomodulation strategies.
5. Understand tumor immunology and modern cancer immunotherapies.
6. Apply knowledge of key laboratory techniques in clinical parasitology and immunology.

ZOOE504D2 (Theory) **Full Marks: 25** **Credit- 2**

Unit	Content	Lectures/ Hours
I	**Immunity and host defense:** Immune response to the bacteria, Immune response to the Virus, Immune response to the Parasites, TLR response	3
II	**T-cell development:** Early thymocyte development, Positive and negative selection, lineage commitment, and self-tolerance.	5
III	**B-cell development:** B-cell development in bone marrow, early and late stages of B-cell development, B-2 B-cell, Development of B-1 and marginal zone B-cell	5
IV	**Inflammation and Immunity:** Overview of Inflammation, Inflammatory mediators, Inflammation and Disease, Therapeutic Aspect	2
V	**Transplantation Immunology and Immunomodulation:** Molecular basis of graft vs. host reaction. Acute, hyperacute, and chronic Graft rejection, Modern techniques of transplantation (e.g., BMT, liver, cornea, etc.) Mechanism of action of common immunosuppressant drugs,	3

	Immunoboosters	
VI	**Tumor Immunology:** Angiogenesis, Metastasis, Concepts of Immune Surveillance, Mechanism of Immune Escape by Tumor, Anti-Tumor Immune Response. Modern Immunotherapy of Cancer, and Current Therapies with Special Emphasis on Immunotherapy (Immune Checkpoint Inhibitors, CAR-T Cell Therapy, and mAb therapies)	5
VII	**Techniques in Clinical Parasitology:** Gel electrophoresis, Southern blotting, Western blotting, Immunofluorescence, Immunohistochemistry, Hybridoma technique for MAb, and PCR	3

Reference books:

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.
3. Chatterjee, K. D. (1981). *Parasitology (Protozoology and Helminthology)*.13th ed. CBS. 4.Cheng, T. C. (1986). *General Parasitology*. 2nd ed. Academic Press, Inc. Orlando. U.S.A.
4. Cox, F. E. G. (1993). *Modern Parasitology*. 2nd ed. Blackwell Scientific Publications. Lea and Febiger, Philadelphia.
5. Hati, A. K. (2001). *Medical Parasitology. Allied* Book Agency, Kolkata.
6. Noble, E. R. and Noble G. A. (1989). *Parasitology. The Biology of Animal Parasites.* 6th ed. Lea and Febiger, Philadelphia.
7. Roberts, L. S., Janovy, J. and Nadler S. (2013) *Gerald D. Schmidt &Lary S. Roberts' Foundation of Parasitology*.9th ed. McGraw-Hill International.
8. Schmidt, G. D. and Roberts, L. S. (2001). *Foundation of Parasitology.* 3rd ed. McGraw Hill Publishers.
9. Schmidt, G. D. (1989). *Essentials of Parasitology*. Wm. C. Brown Publishers (Indian print;1990, Universal Book Stall).
10. Smyth, J. D. (1994). *Animal Parasitology*.3rd ed. Cambridge University Press. 12. Soulsby,
11. E. J. L. (1982). *Helminths, Arthropods and Protozoa of domesticated animals.* ELBS and BaillereTindall. London.
12. Heinz Mehlhorn (2007) Parasitology in focus. (Encclopedic approach) ,3rd Ed. Springer- Verlag, Germany
13. W. Peters and R. Killick-Kendrick (1897) THE LEISHMANIASIS in Biology and Medicine. Academic Press (Inc) Ltd.
14. Abbas, A. K., Lichtman, A. H. and Pillai, S. (2006). *Cellular and molecular Immunology*. 6th ed. Saunders.
15. Abbas, A. K. and Lichtman, A. H. (2006). *Basic Immunology*. 2nd ed. Elsevier. 17. Coico R, Sunshine, G., Benjamini, E. (2003). *Immunology: A Short Course*. 5th ed. Wiley-Liss: New Jersey.
16. Goldsby, R. A., Kindt, T. J., Kuby, J. and Osborne, B. A. (2013). *Immunology*. 7th ed. W. H. Freeman and Co.
17. Khan F. H. (2009). *The Elements of Immunology*. Prentice Hall India.
18. Kindt, T., Goldsby, R. Osborne, B. (2007). *Kuby*'s *Immunology*. 6th ed. W.H. Freeman and Co. 22. Male, D., Brostaff, J., Roth, D. and Roitt, I. (2006). *Immunology*. 7th ed. Mosby. 23. Rao, C. V. (2002). *Immunology*. Narosa Publishing House, New Delhi.
19. 24. Roitt, I. M. and Delves, P. J. (2001). *Roitt's Essential Immunology*. 10th ed. Blackwell Science Ltd.

Fishery Special

Paper Code- ZOOE505A9 (Practical)

Full Marks 50 **Credit 04**

1. Identification of freshwater and marine fishes.

2. Identification of Molluscs, shellfish, aquatic insect, aquatic weeds and live fish food organism.

3. Model demonstration of fish anatomical structures.

4. Determination of the abiotic factors of a particular freshwater body for aquaculture practices.

5. Fish physiology (Fish age determination, calculate the fecundity of a fish species, Gonadosomatic index determination, gastro somatic index, and length-weight relationship).

6. Visit a fish farm / local area and assess the environmental impact on that particular unit (Field Report).

Reference Books:

1. K P Biswas – "Practical Manual of Fisheries" Publisher: Daya Publishing House

2. K C Jayram- "The Freshwater Fishes of the Indian Region" **Publisher:** Narendra Publishing House, 2nd edition.

3. V. Ravi "Practical Manual on Keys to Marine fish Identification" **Publisher:** Narendra Publishing House, First edition.

Ecology Special

Paper Code- ZOOE505B9 (Practical)

Full Marks 50 **Credit- 4**

A. Aquatic Ecology

1. Determination of physico-chemical parameters of water (temperature, pH, dissolved oxygen, turbidity, conductivity). Estimation of transparency (using Secchi disc), TSS, TDS, conductivity, hardness, salinity and alkalinity of water.
2. Estimation of Biochemical Oxygen Demand (BOD) and chlorophyll content in water samples. Analysis of nutrient levels (nitrates, phosphates) in water samples.
3. Collection, identification and enumeration and preservation of - nekton, benthos, phytoplankton and zooplankton from freshwater bodies.
4. Identification of aquatic macrophytes and their ecological roles.
5. Ecological comments on major aquatic biota; Bioindicator species.

B. Biodiversity Conservation and Management

6. Quadrat sampling.
7. Population Estimation: Demonstration of different field techniques for flora and fauna. Trail /transect monitoring for abundance and diversity estimation of animals/plants - Census, line and point transect, distance sampling, Capture-recapture analysis.
8. Evidence in the field: (direct and indirect evidence) Identification of animals through calls, pugmarks, hoof marks, scats, pellets, nests, antlers, etc.
9. Demonstration of basic equipment needed in biodiversity studies - Compass, Binoculars, Range Finders, Global Positioning System, Cameras and lenses, etc.

C. Field trip to an area of ecological importance and submission of a report.

D. Submission of Laboratory notebook.

Special Paper: Genetics & Molecular Biology

Paper Code- ZOOE505C9 (Practical)

Full Marks 50 **Credit- 4**

1. Preparation of the mitotic metaphase chromosome of the rat.
2. Bacterial Genomic DNA Isolation
3. Culture and maintenance of Recombinant Bacteria
4. Plasmid DNA Isolation
5. Estimation of DNA
6. Restriction digestion of the plasmid DNA
7. Agarose gel electrophoresis
8. Genomic DNA isolation from blood and restriction digestion
9. Visit to a Research Institute/ University with a high-end research laboratory/ Sophisticated Laboratory, and submission of a report
10. Submission of laboratory notebook.

Special Paper: Parasitology

Paper Code- ZOOE505D9 (Practical)

Full Marks 50 **Credit- 4**

1. Staining of blood film from pigeon blood for the identification of protozoan parasites
2. Smear preparation and staining of rectal content of Bufo /gut content of Cockroach for identification of protozoan parasites/examination of the gut of fish for identification of endoparasites
3. Whole mount preparation of Ectoparasites
4. Isolation and staining of parasites from Indian Major Carp
5. Staining and identification of helminth parasites from live specimens
6. Cestode and Trematode with acetocarmine
7. Nematode with lactophenol
8. Identification of parasites (Protozoa, Helminthes, Arthropods) with reasons
9. Visit to a renowned Research Institute/ Sophisticated Laboratory and submission of a report
10. Laboratory Notebook preparation

ZOOC506VC: Social Service/ Community Engagement

Full marks: 25 **Credits: 2**

About the Course:

In the present context of the increased incidence of infectious and lifestyle diseases, along with the rapid spread of environmental pollution throughout human dwellings and societies, students of every academic discipline have to shoulder minimal responsibilities to promote awareness among their neighbouring human communities about various health and environmental issues. The present course attempts to fulfill these objectives, using limited resources and manpower as well as a short time frame.

Course Outcomes:

Through the proposed course, the students will directly interact with the local rural communities and will attempt to promote their awareness of different health issues and environmental issues:

1. They will gain a clear idea of the awareness of the local rural communities on different infectious diseases.
2. They will carry out some sanitation activities in the local rural areas.
3. They will organize awareness camps on different health issues and environmental issues amidst the local rural communities.
4. They will also promote wildlife awareness among the local rural communities.
5. Further, they will assess the water quality of the water bodies being used by the local rural populations for their daily life.

Sl. No.	Topic	Hours
1.	Survey of community awareness on any health issue in any local village (E.g., Malaria / Dengue /Anemia/ Food and water-borne disease); Preparation of survey report.	09 hours
2.	Sanitation activity in any local village (E.g., Spray of bleaching powder on roadsides / Spray of phenyl in open drains).	5 hours
3.	Organization of awareness camp in the locality on any health issue (E.g., Air pollution, / Water pollution, / Lifestyle diseases, / Smoking-related diseases, / Child vaccination, / Public health and hygiene).	5 hours
4.	Analysis of water quality in local water bodies (E.g., Estimation of dissolved O_2, free CO_2, hardness, and TDS).	4 hours
5.	Organization of a wildlife awareness rally / Plantation activity in the locality.	2 hours
6.	Preparation of Survey Notebook	

DETAILS OF THE COURSE OF SEMESTER - IV

Special Paper: Fishery (Credit 4)

Paper Code- ZOOE551A1: Fish Foods and Fish Health Management

About the Course

This course focuses on fish nutrition, feed technology, fish health, and fish immunology in aquaculture systems. It covers the mechanisms of fish food digestion, nutritional requirements, and formulation of artificial feeds for aquaculture. The course also includes fish feed manufacturing processes, fish diseases caused by environmental stress, infectious and non-infectious diseases, and strategies for their management and prevention. Additionally, the course introduces fish immunology with emphasis on immunostimulants and probiotic applications for disease resistance and health management in aquaculture.

Course Outcome

After completing the course, students will be able to:

1. Understand the mechanism of digestion and the nutritional requirements of fish.
2. Explain formulated feeds and the development of artificial feeds for aquaculture.
3. Describe fish feed manufacturing and processing techniques.
4. Identify fish diseases related to environmental stress.
5. Differentiate between infectious and non-infectious fish diseases.
6. Explain fish disease management, surveillance, and prevention strategies.
7. Understand basic fish immunology and the role of immunostimulants and probiotics in aquaculture health management.

ZOOE551A1 (Theory) **Full Marks: 25** **Credit- 2**

Unit	Content	Lectures / Hours
I	Mechanism of fish food digestion.	3
II	Consideration of the general nutritional requirements of fish and Formulated feeds of fish.	3
III	Artificial feeds for aquaculture.	3
IV	Processing involved in Fish feed manufacturing.	4
V	Fish disease related to environmental stress.	4
VI	Infectious and non-infectious diseases in fish.	3
VII	Management and surveillance of Fish disease: a strategy for preventing Infections.	4
VIII	Fish Immunology: Immuno-stimulants and application of Probiotics.	3

Reference Books:

1. Ronald J Roberts- "Fish Pathology" Publisher: Wiley India Pvt. Ltd, 4th edition.

2. Dr. Sambhaji Ovhal and Dr. Sandeep Anarse **"**A manual of - Fish pathology" Novateur Publication.

3. S.S. de Silva, T.A. Anderson- "Fish Nutrition in Aquaculture" Chapman and Hall Publisher.

Paper Code- ZOOE551A2: Fish Biotechnology and Fishery Extension

About the Course

This course focuses on modern tools and advanced technologies in fisheries and aquaculture, including modern taxonomic and fish assessment tools, induced breeding using synthetic hormones, fish hybridization, and cryopreservation techniques. It also covers advanced fish disease diagnosis using genetic tools, wastewater fisheries, eco-engineering for water treatment, hydroponics systems, and fish sanctuary management. The course further emphasizes non-formal scientific knowledge, traditional technologies, and sustainable skills in fish culture systems.

Course Outcome

After completing the course, students will be able to:

1. Understand modern taxonomic and fish stock assessment tools.
2. Explain induced breeding techniques, synthetic hormones, and fish hybridization.
3. Describe cryopreservation techniques and their applications in fisheries.
4. Understand advanced fish disease diagnosis using genetic tools.
5. Explain wastewater fisheries and eco-engineering processes for water treatment.
6. Apply sustainable fish culture practices and traditional aquaculture knowledge.
7. Understand hydroponics systems and their applications.
8. Explain the concept and importance of fish sanctuaries in conservation and fisheries management.

ZOOE551A2 (Theory) **Full Marks: 25** **Credit- 2**

Unit	Content	Lectures / Hours
I	Modern Taxonomic and assessment tools in fisheries.	3
II	Fish-induced breeding by synthetic hormones and Fish Hybridization.	4
III	Cryopreservation and its application in fisheries.	4
IV	Advance Fish disease diagnosis by Genetic tools.	4
V	Wastewater Fishery and eco-engineering process for water treatment.	3
VI	The non-formal scientific knowledge, technology, and sustainable skills on the fish culture system.	3
VII	Hydroponics system and its application.	3
VIII	Fish Sanctuary.	2

Reference Books:

1. S.K. Dubey and Bandana Ghosh – "Fish Biotechnology"

2. V Suvetha and S Felix "Fundamentals of Fisheries Extension Education" Publisher: Astral Publishing, Authors Across the Globe

3. K.C Jayaram, "Fundamentals of Fish Taxonomy," Narendra Publishing House.

Special Paper: Ecology (Credit 04)

Paper code-ZOOE551B1: Terrestrial Ecology and Ecological Modelling

About the course

Both theoretical and practical learning processes are to acquaint students with the essential conventional/modern components of ecological sciences, in order to develop a sound knowledge base to tackle ongoing ecological changes in and around human settlements, with special emphasis on the landscapes & ecosystems of West Bengal. The major emphasis was laid on developing the syllabus to cover not only traditional aspects but also modern developments in the sphere of ecological sciences. Terrestrial and Mathematical Ecology combines land-based ecosystem studies with quantitative modeling, bridging field ecology of forests, grasslands, and soils with analytical tools for population dynamics, community assembly, and spatial processes. The syllabus strengthens the linkages between forest ecology and the terrestrial system while maintaining mathematical rigor.

COURSE OUTCOME:

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

CO1: Describe terrestrial processes, with detailed forest structure and functioning.

CO2: Build and analyze models for populations, communities, and forest disturbances.

CO3: Use statistical tools for niche, spatial, and temporal ecology.

CO4: Apply integrated approaches to terrestrial conservation, including forests.

CO5: To understand the role of physical environmental factors in forest dynamics.

CO6: Master modelling ecosystem processes, analyzing resilience to disturbances, and linking biophysical systems with socio-economic drivers for applications in conservation and land management.

ZOOE551B1 Terrestrial Ecology and Ecological Modelling (Theory) FM: 25 Credit- 2

Unit	Course Contents	Lectures / Hours
1.	Overview of Terrestrial Biomes: o Forests, grasslands, savannas, deserts o Soil ecology as foundation; basic soil properties; edaphic fauna. o Edges and ecotones.	5
2.	Major Forest types in India. o Champion & Seth's classification; Afforestation; Plantation. o The Forest (Conservation) Act, 1980. o Human Disturbances - Forest fire, grazing, deforestation; o Silviculture- Assessment of vegetation health	4
3.	Ecological processes in Tropical Forest ecosystem: o Vertical stratification of plants and animals and their niche. o Key processes: Primary Production and nutrient cycling. Leaf litter decomposition.	5
4.	Metapopulation concept: o Metacommunity Models and dynamics.	6

	○ Spatial heterogeneity, scale, hierarchy; patch-mosaic paradigm. ○ Landscape structure: patches, corridors, matrix, Fragmentation.	
5.	Basic concept of Ecological Modeling: ○ Deterministic and Stochastic models. ○ Levels of species diversity and its measurement; Alpha, beta, gamma diversity. ○ Patterns of Spatial distribution - Random, clumped and uniform; coefficient of Dispersion. ○ Index of Similarity and Index of Association.	7
6.	○ Animal-plant interaction: Network analysis ○ Pollination as a key driver of agro-ecosystems ○ Role of animals in seed dispersal and soil fertility	6

Recommended Readings

1. Wildlife Biology: An Indian Perspective. Goutam Kumar Saha and Subhendu Mazumdar, Pages: 328 pp.
2. Wildlife Ecology, Conservation, and Management– Illustrated, 2014 by Fryxell, John M., Sinclair, Anthony R. E., and Caughley, Graeme.
3. Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). Conservation biology for all. Oxford University Press.
4. McCune, B.P. & Grace, James. (2002). Analysis of Ecological Communities. 10.1016/S0022-0981(03)00091-1.
5. Verhoef, Herman A., and Peter J. Morin (eds), Community Ecology: Processes, Models, and Applications (Oxford, 2009; online ed., Oxford Academic, 2010). https://doi.org/10.1093/acprof:oso/9780199228973.001.0001
6. Smith TM, Smith R L. 2006. Elements of Ecology. 6th Ed. Pearson Education.

Paper Code- ZOOE551B2: Human Ecology & Ecotourism

Human Ecology examines human interactions with ecosystems, population dynamics, and sustainability. The unit refers to the structured ways human societies perceive, interact with, value, and transform natural environments through cultural, economic, political, and technological processes. It's a core concept in social ecology that examines how societal metabolism (material/energy flows) and worldviews shape environmental change, distinct from purely biophysical ecology.

This also refers to integrated systems where social (human) and ecological (biotic/abiotic) components interact dynamically through feedbacks, flows, and governance structures. This framework analyzes the sustainability of resources like forests, fisheries, and wildlife habitats by identifying variables across resource units, users, governance, and external drivers.

Course Outcome:

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

CO1: Map societal relations to nature and identify key feedbacks.

CO2: Understand the need and importance of ecotourism.

CO3: Know the objective and avenues of achieving sustainable development goals.

CO4: Determine the relationship between ecotourism and sustainable development.

CO5: Evaluate carrying capacity models and predict sustainability limits for human populations in specific biomes

CO6: Analyze interactions between human activities (agriculture, urbanization, industry) and biodiversity loss, including trophic cascades and ecosystem services degradation.

ZOOE551B2 Human Ecology & Ecotourism (Theory) Full Marks: 50 Credit: 2

Unit	Course Contents	Lectures / Hours
1.	○ Human dimensions in ecology. ○ Global Environmental Issues. Effect of urbanization on biodiversity. ○ Carbon sequestration and landscape change. Bioinvasion. ○ Developing Resilient Urban Ecosystem - Significance of Urban green spaces	4
2.	○ Overview of United Nations Sustainable Development Goals (SDGs). ○ Sustainable use of resources and sustainable development.	2
3.	○ Environmental Impact Assessment (EIA) –process and methodologies. ○ Sustainable Environmental Management System; Ecomark.	3
4.	○ Role of traditional knowledge and community participation. ○ Social forestry: Joint Forest management- Arabari concept, Chipko movement.	4
5.	○ Sustainability modeling: scenarios for Restoration ○ Ecological Restoration (ER): Philosophy and types of ER;	4

	○ Process of ER. Model sites.	
6.	○ Foundations of Ecotourism ○ Sustainable development and ecotourism, merits and demerits. ○ Ecotourism policies and standards. ○ Ecotourism Activities & Impacts. Ecotourism in Protected Areas. Successful Ecotourism sites in India. ○ Ecotourism Guidelines. Roles and responsibilities of Stakeholders - Characteristics of Ecotourists. ○ Planning ecotourism for entrepreneurship, management issues.	6
7.	○ Ecosystem services (ES) and human wellbeing: ○ Significance; Categories of ES; examples. ○ Ecological Economics.	3

Recommended Readings:

3. Environmental Science. By G. Tyler Miller & Scott E. Spoolman Brookes/Cole, Belmont, USA, 14th edition, 2013, 411 pp
4. Environmental Issues: Awareness, Concern, and Management 2018 by U R Zargar
5. Environmental Management: Environmental Issues, Awareness and Abatement – Basharat Mushtaq, Suhaib A. Bandh, Sana Shafi; Springer; 2020.
6. Environmental Management: Issues and Concerns in Developing Countries – Edited by Pradip K. Sikdar; Springer; 2021.
7. Environmental Principles and Policies – Sharon Beder; Routledge; 2006.
8. Managing Green Issues – Tom Curtin, Jacqueline Jones; Palgrave Macmillan; 2000.

Special Paper: Genetics and Molecular Biology (Credit 04)

Paper code-ZOOE551C1: Applied Genetics

About the course

This course provides knowledge of molecular biology techniques, genetic analysis, recombinant DNA technology, genome editing, and gene therapy. It covers DNA markers, blotting techniques, sequencing methods, cloning vectors, CRISPR-Cas9 and TALEN genome editing systems, and modern gene therapy approaches, including stem cell therapy, siRNA, and miRNA regulation. The course emphasizes both fundamental molecular techniques and their applications in biotechnology, medicine, and genetic engineering.

Course Outcome

After completing the course, students will be able to:

1. Understand DNA markers and PCR-based genetic analysis techniques.
2. Explain blotting techniques, fluorescence methods, and sequencing technologies.
3. Describe recombinant DNA technology and cloning strategies.
4. Understand genome editing tools such as TALEN and CRISPR–Cas9.
5. Explain gene therapy methods, including ex vivo and in vivo therapy.
6. Understand the role of siRNA and miRNA in gene regulation.
7. Apply molecular biology techniques in genetic engineering, biotechnology, and biomedical research.

ZOOE551C1 Applied Genetics (Theory) Full Marks: 25 Credit- 2

Unit	Content	Lectures/ Hours
I	**DNA Markers in Genetic Analysis and the study of gene expression** • Restriction Fragment Length Polymorphism (RFLP) • Tandem Nucleotide Repeat Markers (VNTR, STR) • PCR-based markers, Nested PCR, Multiplex PCR • Random Amplified Polymorphic DNA (RAPD) • DNA amplification by Polymerase Chain Reaction (PCR) and its variations • Reverse Transcription PCR (RT-PCR) • **qPCR**: Basics, Melting curve, Dyes: SYBR green, TaqMan, Scorpion; CT value	4
II	**Protein Blotting and Fluorescence** • Western Blotting for protein analysis • Mechanism of Fluorescence and Phosphorescence • Flowcytometry • In situ localization by Fluorescence In Situ Hybridization (FISH)	5
III	**DNA and RNA Sequencing** • Southern Blotting and DNA analysis	5

	• Northern Blotting and RNA analysis • Sanger Dideoxy DNA Sequencing • Second-generation DNA sequencing (Pyrosequencing) • Single-cell sequencing	
IV	**Recombinant DNA Technology and Cloning Vectors** • Restriction Endonucleases • Recombination of DNA fragments • Plasmid cloning vectors and expression vectors • Linker DNA, Homopolymer tailing, Blunt-end ligation • Shotgun cloning, cDNA cloning, cDNA microarray, T–A cloning	4
V	**CRISPR–Cas9 and applications** 1. **Cas9 enzyme** 2. **Guide RNA (gRNA)** 3. **PAM sequence (Protospacer Adjacent Motif)** 4. **Mechanism:** i. Guide RNA binds to the target DNA sequence. ii. Cas9 enzyme cuts the DNA at a specific site (double-strand break). iii. Non-homologous end joining (NHEJ) → gene knockout iv. Homology-directed repair (HDR) → gene insertion or correction	4
VI	**Gene Therapy** • TALEN genome editing system • Methods of gene targeting • Gene therapy: Ex vivo and In vivo therapy • Stem cell therapy • siRNA and miRNA basics • Regulation of transcription and translation by miRNA • Retroviral-mediated gene therapy	4

Reference books:

1. Molecular Cell Biology by Harvey Lodish 8th Ed. (2016).
2. Molecular Biology by Robert F. Weaver 5th Ed (2012).
3. Molecular Biology of the Gene by James D. Watson 7th Ed (2014).
4. iGenetics: A Molecular Approach by Peter J. Russell 3rd Ed (2010).
5. Human Molecular Genetics by Tom Strachan & Andrew P Read 3rd Ed (2004)
6. Principles of Gene Manipulation and Genomics by S.B.Primrose 7th Ed (2006)
Targeted Genome Editing Using Site-Specifc Nucleases by Takashi Yamamoto (2015)

Paper code-ZOOE551C2: Human genome and immunogenetics

About the Course

This course focuses on the genetic basis of the vertebrate immune system and human genome analysis. It covers genetic changes involved in immune cell differentiation, genetic control of human antibodies, multigene organization of immunoglobulin genes, and the mechanism of V(D)J recombination. The course also includes B-cell and T-cell receptor genes and their expression. Additionally, the course introduces the Human Genome Initiative, positional cloning, identification of disease genes using RFLP, vectors used in large-scale genome projects, and comparative genomic studies.

Course Outcome

After completing the course, students will be able to:

1. Understand genetic regulation of vertebrate immune cell differentiation.
2. Explain genetic control and multigene organization of immunoglobulin genes.
3. Describe the mechanism of V(D)J recombination.
4. Understand B-cell and T-cell receptor genes and their expression.
5. Explain the Human Genome Project and positional cloning techniques.
6. Understand identification of disease genes using RFLP and genomic analysis tools.
7. Describe vectors used in large-scale genome projects and comparative genomics.

ZOOE551C2 Human genome and immunogenetics (Theory) Full Marks: 25 Credit- 2

Unit	Content	Lectures/ Hours
I	Genetic changes in differentiation of vertebrate immune cells, Genetic control of human antibody, Multigene organization of Ig gene, The mechanism of V(D)J recombination, B cell and T cell receptor genes and expression.	8
II	The Human Genome Initiative: classical tools of positional cloning, identifying genes mutated in Huntington's disease by RFLP, vectors for large-scale genome project, studying and comparing Genomic sequences, the human genome.	8
III	Apoptosis, Morphological and Biochemical Changes, Molecular Mechanism of Apoptosis, Intrinsic (mitochondrial) pathway Extrinsic (death receptor) pathway, Regulation of Apoptosis, Apoptosis in Health and Disease, Methods to Detect Apoptosis	8

Reference books:

1. Molecular Biology of the Gene by James D. Watson
2. Genetic: Analysis and Principles by Robert J. Brooker
3. Genetics:A Conceptual Approach by Benjamin A.Pierce
4. iGenetics: A Molecular Approach by Peter J. Russell
5. Principle of Genetics by Peter Snustad
6. Human Molecular Genetics by Tom Strachan
7. Gene Cloning and Manipulation by Christopher Howe
8. Principles of Gene Manipulation and Genomics by S.B.Primrose

Special Paper: Parasitology

(Vector Biology and Vector-borne Parasites and Molecular Diagnosis and Clinical Parasitology)

About the Course:

The course will acquaint students with host-parasite interactions, complement activation, TLR recognition and signaling, and hypersensitivity, with particular reference to asthma. The course will enlighten students about various modern diagnostic methods for identifying parasitic infections. Vector biology and epidemiology will be another focus for understanding the transmission dynamics of vector-borne diseases and for properly formulating vector control strategies.

Course Outcome:

The proposed syllabus deals with the bionomics, importance, and control of different vectors (viz., mosquitoes, sandflies, fleas, ticks, mites, black fly, and tsetse fly) which transmit a number of parasitic diseases (viz., malaria, filaria, kala-azar, sleeping sickness, Lyme disease, babesiosis, scabies etc.) in tropical areas including the Indian subcontinent. The syllabus also includes epidemiology (incidence, distribution, and spread) of different parasitic diseases. The syllabus will also include certain advanced and modern branches of Parasitology, such as Molecular Diagnosis and Clinical Parasitology. These advanced branches will cover the laboratory diagnosis of several pathogenic parasites, including Entamoeba histolytica, Toxoplasma gondii, Trichomonas vaginalis, Hymenolepis nana, Clonorchis sinensis, Enterobius vermicularis, and Dracunculus medinensis. Moreover, xeno-diagnosis and immune-diagnosis of various parasites will be additional attractive topics within the proposed syllabus. Overall, the syllabus will be an ensemble of both basic and advanced aspects of Parasitology.

ZOOE551D1: (Vector Biology and Vector-borne Parasites); Full Marks 25 Credit 02

Content	Lectures/ Hours
General concept about vector- mode of transmission	2
Biology, importance and control of some vectors a) Mosquito (Anopheles, Culex, Aedes) b) Sandfly c) Fleas d) Ticks e) Mites f) Black fly g) Tsetse fly	2 1 1 1 1 1 1
Life cycle, pathogenicity, and control of some vector-borne parasites: Plasmodium, Leishmania, Wuchereria, and Babesia	4
General idea on Zoonosis and Myiasis	3
Lice as vectors of human disease: Typhus, Trench fever, Relapsing fever	4

Climate change: Impact on vector-borne diseases	3
Laboratory diagnosis of *Wuchereria bancrofti*	1

ZOOE551D2: Molecular Diagnosis and Clinical Parasitology; Full Marks 25 Credit 02

Content	**Lectures/ Hours**
General concept of molecular diagnosis for parasitic infection Fundamental techniques used in the molecular diagnosis of endoparasites	2
Parasitic adaptation: Morphological, Anatomical, Physiological, and Biochemical	2
Biology, clinical and laboratory diagnosis of *Hymenolepis nana, Clonorchis sinensis, Enterobius vermicularis, Dracunculus medinensis, Toxoplasma gondii and Trichomonas vaginalis*	4
Clinical features of hookworm anaemia	2
Laboratory diagnosis of Amoebiasis	1
Xenodiagnosis of Parasites	2
Parasites as Therapeutic Organisms	1
Marker molecule-based immunodiagnosis of endoparasites: Immunoassay or serological techniques for laboratory diagnosis of endoparasites, such as *Giardia intestinalis*, *Balantidium coli*, *Entamoeba histolytica*, *Leishmania donovani*, *Plasmodium sp*., using a) ELISA, RIA b) Counter Current Immunoelectrophoresis (CCI) c) Complement Fixation Test (CFT) d) PCR, DNA, RNA probe e) Indirect fluorescence antibody test f) Rapid test and strip test	2 1 1 1 1 1 1
Epidemiology: Classification, landscape epidemiology, methods of epidemiological studies Epidemiology of Filaria, Kala-azar	3

Reference books:

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 andSons Inc.
3. Chandra, G. (2000). Mosquito. SreeBhumi Publication Co. Kolkata.
4. Chatterjee, K. D. (1981). Parasitology (Protozoology and Helminthology).13th ed. CBS.
5. Cheng, T. C. (1986). General Parasitology. 2nd ed. Academic Press, Inc. Orlando. U.S.A.
6. Cox, F. E. G. (1993). Modern Parasitology. 2nd ed. Blackwell Scientific Publications. Lea and Febiger, Philadelphia.
7. Hati, A. K. (2001). Medical Entomology. Allied Book Agency, Kolkata.
8. Kettle, D. S. (1995). Medical and veterinary Entomology. 2nd Ed. CAB International.
9. Mullen, G. R. and Durden, L.A. (2009). Medical and Veterinary Entomology. 2nd Ed. Academic Press.

10. Noble, E. R. and Noble G. A. (1989). Parasitology. The Biology of animal Parasites. 6th ed. Lea and Febiger, Philadelphia.
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. Schmidt, G. D. and Roberts, L. S. (2001). Foundation of Parasitology. 3rd ed. McGraw Hill Publishers.
13. Schmidt, G. D. (1989). Essentials of Parasitology. Wm. C. Brown Publishers (Indian print;1990, Universal Book Stall).
14. Smyth, J. D. (1994). Animal Parasitology. 3rd ed. Cambridge University Press. 16. Soulsby,
15. J. L. (1982). Helminths, Arthropods and Protozoa of domesticated animals. ELBS and BailliereTindall. London.
16. R Beaglehole, R Bomta and T Kjelstorm (1993) BASIC EPIDEMIOLOGY Orient Longman in collsboration with WHO, Geneva.
17. W. Peters and R. Killick-Kendrick (1897) THE LEISHMAANIASIS in Biology and Medicine. Academic Press (Inc) Ltd
18. Lynne Shore Garcia (2010) Dignostic Medical Parasitology 5th Edn ASM Press, Washington DC 20. John Hyde (1996) Molecular Parasitology Open University Press
19. J Joseph Marr and Miklos Muller (1995) Biochemistry and Molecular Biology of Parasites 2nd Edn Academic Press

Special Paper: Fishery

(Practical)

Paper Code- ZOOE552A9 Full Marks: 50 Credit: 04

1. Morphometric characterization of fish using the modern genetic tools/gadgets.

2. Fish food preparation.

3. Fish health assessment through microbiological technique and DNA isolation from fish parasites.

4. Pathogen identification within the fish tissue system using proper histological technique (fixation, embedding, block preparation, staining, and viewing under LM and High-resolution Microscope).

5. Pathogenic cell structure characterization under High-resolution Microscope.

Reference Books:

1. J. A. Kiernan – "Histological and Histochemical Methods" Theory and Practice, Fifth edition © Scion Publishing Ltd, 2015.
2. John J. Bozzola &Lonnie D. Russell, Electron Microscopy: Principles and Techniques for Biologists

Special Paper: Ecology

(Practical)

ZOOE552B9 (Practical) Full Marks: 50 Credit: 04

A. Terrestrial Ecology and Ecological Modelling

1. Analysis of the structure of biotic community: Calculation of diversity indices (Shannon, Simpson & Fisher's); Importance Value Index.
2. Ecological comments on soil biota.
3. Estimation of the degree of faunal similarity and association between species; Computation of micro-distribution pattern for spatial distribution.
4. Estimation of alpha, beta, and gamma diversity.
5. Estimation of textural composition and Water Holding Capacity of soil.
6. Evaluation of Restoration Sites
7. Study of forest/vegetation health- Estimation of tree height, DBH, stand density, canopy density, and tree biomass
8. Preparation of Climograph

B. Human Ecology & Ecotourism

9. Participatory mapping of a local system; Evaluating ES of an ecosystem.

10. Case studies of Nature-based or Wildlife-based ecotourism or performing a demo EIA of a site.
11. Visit to a sacred grove or a particular ecosystem linked to TEK

C. Submission of Laboratory notebook.

Special Paper: Genetics and Molecular Biology
(Practical)

ZOOE552C9 (Practical) **Full Marks: 50** **Credit: 04**

1. Family pedigree analysis for autosomal /sex-linked, dominant /recessive trait.
2. Isolation & purification of proteins from cells and tissues
3. Characterization of proteins through SDS-PAGE
4. Western blotting (AP and HRP)
5. PCR and colony PCR
6. Demonstration of Real-time PCR
7. Submission of laboratory notebook

Special Paper: Parasitology
(Practical)

ZOOE552D9 (Practical) **Full Marks: 50** **Credit: 04**

1. Localization of DNA by the Feulgen reaction in protozoa
2. Localization of Glycogen by Periodic Acid Schiff's (PAS) reaction in protozoa
3. Stain preparation and identification of blood parasites from fish
4. Preparation of blood film from humans for identification of microfilaria
5. Staining of scolex and proglottids of Cestodes
6. Whole mount preparation of the mouth parts of the mosquito vector
7. Identification (Spot) and clinical significance of microscopic and macroscopic parasites
8. Submission of prepared (permanent) slides
9. Laboratory Notebook preparation

Paper Code: ZOOC553X9

Research Project/ Dissertation

Full Marks: 100 **Credit: 08**

Content	Marks
Submission of the Project/ Dissertation Report	75
Presentation	15
Viva voce	10

Paper Code: ZOOC554VC

Internship / Capstone Project/ Applied Field or Industry Project / Innovation & Incubation / Entrepreneurship / Start-up Proposal or Practice

Full Marks: 50 **Credit: 04**

Content	Marks
Submission of the Report	35
Presentation	10
Viva voce	05

Paper Code: ZOOE555A0

Intellectual Property Rights and Biosafety

Full Marks: 25 **Credit: 02**

Course Objective:

To provide knowledge about intellectual property rights, patents, copyrights, trademarks, geographical indications, plant variety protection, biodiversity laws, biosafety, and bioethics related to biological research and innovation.

Course Outcomes (CO):

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

CO1. Understand the concept, importance, and different types of Intellectual Property Rights and their role in research, innovation, and industry.

CO2. Explain the principles of patents, patentable subject matter, patent filing procedure, patent search, and patent infringement.

CO3. Describe copyright, trademark, industrial design, trade secrets, and their legal protection mechanisms.

CO4. Understand Geographical Indications, Plant Variety Protection, Farmers' Rights, the Biodiversity Act, and the protection of traditional knowledge.

CO5. Explain biosafety, bioethics, and ethical issues related to biotechnology, genetic engineering, cloning, and biomedical research.

CO6. Understand technology transfer, patent licensing, commercialization of research, and the role of IPR in entrepreneurship and startups.

ZOOE555A0 Intellectual Property Rights and Biosafety (Theory) FM: 25 Credit- 2

Unit	Content	Lectures/ Hours
I	Introduction to Intellectual Property Rights • Concept and importance of Intellectual Property • Types of Intellectual Property Rights • Need for IPR in research, innovation, and industry • IPR in Biological Sciences and Biotechnology • International organizations and agreements related to IPR	6
II	Patents • Definition and concept of Patent • Patentable and non-patentable inventions • Patentable subject matter in Biotechnology and Life Sciences • Patent search and patent databases • Indian Patent Act and amendments	6
III	Copyright, Trademark, and Industrial Design • Copyright: definition, scope, and duration • Copyright in books, software, databases, research articles	6

	• Trademark: definition, registration and protection • Industrial design and layout design • Trade secrets and confidential information	
IV	Geographical Indications and Biodiversity Protection • Geographical Indications (GI) • GI Act in India • Plant Variety Protection and Farmers' Rights • Protection of traditional knowledge • Biodiversity Act and access to biological resources	6
V	Biosafety, Bioethics and IPR in Biological Research • Biosafety levels and laboratory safety • Bioethics in biological research • Ethical issues in genetic engineering, cloning, stem cell research	6

Suggested Readings

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill, New Delhi.
2. Ahuja, V. K. (2017). Law Relating to Intellectual Property Rights (3rd ed.). LexisNexis, New Delhi.
3. Ahuja, V. K. (2015). Intellectual Property Rights in India (2nd ed.). LexisNexis.
4. Reddy, G. B. Intellectual Property Rights. Satyam Law International.
5. Cornish, W. R. (2013). Intellectual Property: Patents, Copyright, Trade Marks and Allied Rights (8th ed.). Sweet & Maxwell.

Skill-Enhanced Course

Paper Code-ZOOE555B0: Mulberry silkworm rearing technology

Full Marks = 25 **Credits 02**

About the Course:

The course is designed to introduce students to the basic theoretical and technological aspects of silkworm rearing and related sericulture topics. The knowledge thus gained by the students could not only be useful to them as extension specialists in sericulture but would also be helpful if they wish to pursue self-employment or generate supplementary income.

Course Outcomes

The course provides a detailed insight into basic aspects of practicing sericulture. It also provides an account of management and various technological improvements in silkworm rearing. Upon completion of the course, students will be able to understand both the practical and commercial aspects of silkworm rearing.

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

- Gain knowledge for the rearing of silkworm, silkworm pathology,
- Apply the skill for Mulberry nursery management,
- Evaluate the quality of silkworms and their products.
- Create awareness on the economic importance and suitability of sericulture in Indian conditions.
- Enhance collaborative learning, communication, and technical skills through practical sessions, teamwork, group discussions, assignments, and field projects

ZOOE555B0: Mulberry silkworm rearing technology (Theory) FM: 25 Credits 01

Unit	Course content	Lectures/ Hours
I	Systematic position & classification of silkworm races based on origin and geographical distribution, based on voltinism and moultinism, and cocoon color. Life cycle of the mulberry silkworm *Bombyx mori*	8
II	Silkworm rearing house - Requirements for an ideal rearing house: orientation, site selection, and size of the rearing house, as per the CSB model. Low-cost rearing houses in India Rearing appliances –. Disinfection - objectives and methods. Disinfectants – types and their concentrations.	10
III	Selection of silkworm breeds/hybrids for rearing. Estimation of leaf quality and leaf yield for silkworm rearing.	6
IV	Incubation - methods of incubation; black boxing; brushing - preparation for brushing, brushing methods, selection of leaf for brushing, advantages and disadvantages of different brushing methods.	6
V	Chawki rearing - environmental conditions, Chawki rearing methods. Leaf requirement for early age worms, Late age rearing - environmental conditions care during pre-molting, molting, and post-molting. Different rearing	8

	methods- shelf, shoot, and floor rearing - Advantages and disadvantages. Leaf requirement for late-age worms.	
VI	Spinning and Mounting - methods of mounting, Types of mountages- Cocoon Harvesting - time of harvest of seed crop and hybrid crop. sorting, storage/preservation, packaging and transportation of cocoons. Leaf-cocoon ratio.	8

Suggested Readings

- Ganga, G., (2003) Comprehensive Sericulture- Vol.-1 Moriculture, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Ganga, G., (2003) Comprehensive Sericulture- Vol.-2 Silkworm Rearing and Silk Reeling, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Singh, Tribhuwan and Sarachandra, Beera (2004) Principles and Techniques of Silkworm Seed Production. Discovery Publishing House, New Delhi.
- Rajan, R. K., and Himantharaj, M. T. (2005) Silkworm Rearing Technology. Central Silk Board, Bangalore.
- Johnson, M. and Kesary, M. (2020). Sericulture. (Ed. 1). Saras Publication.
- Sarkar, S. (2022). A Textbook on Sericulture. (Ed. 1). Publisher Techno World.
- Sarwar, S., Hussain, I. and Ahmad, A. Introduction to Sericulture Industry (Latest Edition).
- Chawala, N. K., (2017). Comprehensive Sericulture: Silkworm Rearing and Silk Rearing. Indian Books and Periodicals.
- Madan Mohan Rao, M. (2019). An Introduction to Sericulture. (Ed. 2). B S Publications. 10. Ramamoorthy, R., Umapathy, G., Ambethgar, V. and Selvanarayanan, V. (2019). Glossary of Sericulture. (Ed. 1). Aknik Publications.
- Bhaskar, R. N. and Anusha, H. G. (2002) Objective Question Bank on Sericulture, Agri Biovet Press.

Skill-Enhanced Course

Paper Code-ZOOE555C0: Vermitechnology and solid waste management

Full Marks: 25 **Credits 02**

About the Course:

Solid Waste Management through Vermitechnology (also called vermicomposting) is an eco-friendly, user-friendly method for converting organic waste into nutrient-rich compost using earthworms. Organic wastes pose a serious environmental problem globally. Vermitechnology is the use of earthworms (commonly *Eisenia fetida*) to decompose biodegradable waste into high-quality, value-added manure, known as vermicompost. Based on their vermicomposting experience, students are encouraged to enhance their practical skills and knowledge in organic waste management. Through hands-on training, they develop competencies in compost preparation, waste segregation, and maintenance of vermicomposting units.

Course Outcomes:

Vermitechnology and solid waste management deal with the application of Zoological knowledge for the welfare of mankind. At the end of the course, the student will be able to:

- Develop an understanding and gain practical skills in eco-friendly solid waste management through the use of vermicomposting technology.
- Gain the skills to produce high-nutritional vermicompost for improving soil health, along with the preparation of vermiwash for scientific and sustainable crop production.
- Expand knowledge about indigenous varieties of earthworms and their role in efficient vermicomposting
- Generate self-employment opportunities by producing and marketing worms, vermicompost, and vermiwash
- Spread awareness and knowledge among educational institutions to utilize organic waste effectively and produce compost for maintaining gardens and green spaces.

ZOOE555B0: Vermitechnology and solid waste management (Theory) FM: 25 Credits 01

Unit	Course Content	Lectures /Hours
I	Morphology & Anatomy: Earthworms Taxonomic position, external features- shape, size, color, segmentation, setae& clitellum. coelom, locomotion, digestive, excretory & nervous system	5
II	Biology Reproductive system: Male & Female, copulation, cocoon formation & fertilization, development of earth worm.	5
III	Habitat Ecology: Burrowers, casts, nocturnal, poikilothermal, ecological grouping – Epigeic species, Endogeic species and Anecics	5
IV	Diversity of species: Detailed study of Lumbricus terrestris, Eisenia fetida, Eudrilus eugenie, Amynthas gracilus, Perionyx excavates.	5
V	Vermiculture: Definition of vermiculture, vermicomposting, and vermibed; Suitable species of earthworm for vermiculture; Vermiculture process; Advantages and disadvantages of vermicomposting; Prospects of vermiculture. Vermiwash.	5
VI	Applications of vermiculture: Vermiculture Bio-technology, vermi-composting, use of vermicastings in organic farming/horticulture,	5

	earthworms for management of municipal/selected biomedical solid wastes; as feed/bait for capture/culture fisheries; forest regeneration.	

Suggested Readings

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
2. Bhatnagar & Patla,2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi
3. Mary Violet Christy,2008. Vermitechnology, MJP Publishers, Chennai.
4. Aravind Kumar, 2005.Verms & Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
5. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
6. Bhatnagar & Patla,2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi.
7. Edwards, C.A & P.J Bohlen, 1996. Biology and ecology of earthworms III Edn. Chapman & Hall N.Y.U.S.A.
8. Lee, K.E. 1985. Earthworms their ecology and relationships.