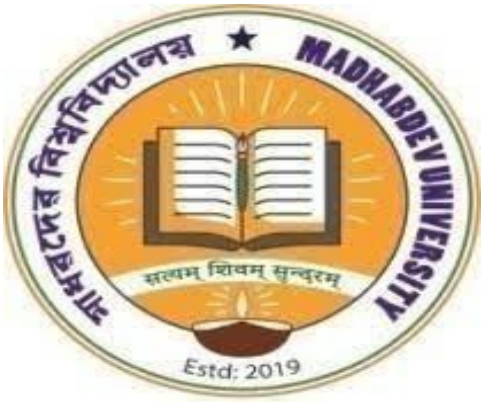


Syllabus of 2 Year PG Program
Department of Zoology
Madhabdev University, Narayanpur
Revised 2026

**About the Department:** Department of Zoology of Madhabdev University was established in 1967. The department was an important part of the Madhabdev College at that time. Madhabdev College was upgraded to the University in the year 2019. The department is providing now UG (NEP) course, PG course and PhD course. This PG and UG course include teaching in diverse areas, such as Chordates and Non chordates, Animal Physiology, Biochemistry, Fish Biology, Immunology, Developmental Biology, Genetics, Cell Biology, Taxonomy, Endocrinology, Bioinstrumentation, Biostatistics, Animal Behaviour and Evolutionary Biology. Apart from teaching, the faculty has been started research work in Biochemistry and Molecular Biology field.

The vision of the department is to develop an excellent centre in education & research in the field of It also aims to develop teaching and research programmes that have relevance to the society and employability. The M.Sc. programme is being revised under NEP scheme of UGC to meet the expectations of students and to fulfil the vision and mission of the Department.

**Programme Learning Outcomes (PLO):**

The programme outcomes (specific skills, generic skills and attributes) that a post-graduate student of Zoology will have at the end of the completion of M.Sc. degree in Zoology are as follows :

**PLO1. Disciplinary knowledge:** Apply knowledge of Zoology, Life Sciences, and related subjects to comprehend complex life processes and phenomena.

**PLO2. Reflective thinking and problem solving:** Identity, review, and analyse complex situations involving living forms. Design processes/strategies that meet the specified needs while taking into account public health and safety, as well as cultural, societal, and environmental factors.

**PLO3. Investigating complex problems:** To provide valid conclusions, apply research based knowledge and research methods such as experiment design, data analysis and interpretation, and information synthesis.

**PLO4. Social responsibility:** Apply reasoning informed by contextual knowledge to evaluate societal, health, safety, legal, and cultural issues, as well as the responsibilities that come with them, in the context of professional engineering practise.

**PLO5**. **Communication Skills**: To have the ability to present and express information, thoughts, experiments and results clearly and concisely for effective communication of any issues related to animals.

**PLO6**. **Understanding the environment:** Understanding the impact of natural and anthropogenic activities in societal and environmental contexts, as well as demonstrating knowledge of, and need for, sustainable development Identify and justify the conservation of a variety of invertebrates and vertebrates.

**PLO7. Ethics:** Apply ethical principles and commit to professional ethics, responsibilities, and work/research practise norms.

**PLO8. Project management:** Demonstrate knowledge and understanding of Zoology and management principles, and apply them to one's own work as a team member and leader.

**Programme Specific Outcomes (PSOs):**

It is expected that a student after successfully completing two semesters of M.Sc. in Zoology programme would be as follows:

**PSO1.** Students would be sufficiently skilled and empowered to solve the problems in the realms of Zoology and its allied areas.

**PSO2**. They would have plethora of job opportunities in the education, environment, agriculture-based, sericulture, aquaculture, health related sectors etc.

**PSO3**.The bright and ignited mind may enter into research in the contemporary areas of Zoological/Biological Sciences. The broad skills and the deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

## Semester wise distribution of credits

| Semester | Core course | Elective Course (EC) | Seminar/Presentation/ Internship /Research Project/Dissertation | Total |
|---|---|---|---|---|
| I | 16 | 04 | 02 | 22 |
| II | 16 | 04 | 02 | 22 |
| **Grand Total** | **24** | **08** | **08** | **40** |

## Curriculum structure

### Semester-I

| Course | Course Code | Course Name | Type | Internal Assessment marks | End semester marks | Credit |
|---|---|---|---|---|---|---|
| Core Course-I | PZOC 101 | Evolutionary Biology | Theory | 30 | 70 | 4 |
| Core Course-II | PZOC 102 | Applied Zoology | Theory | 30 | 70 | 4 |
| Core Course-III | PZOC 103 | Wildlife Conservation and Management | Theory | 30 | 70 | 4 |
| Core Course-IV | PZOC 104 | Research Methodology | Theory | 30 | 70 | 4 |
| Minor / GE | PZOG 101 | Evolutionary Biology | Theory | 30 | 70 | 4 |
| Seminar/ Presentation / Internship /Research Project | | | | 30 | 70 | **2** |

### Semester-II

| Course | Course Code | Course Name | Type | Internal Assessment marks | End semester marks | Credit |
|---|---|---|---|---|---|---|
| Core Course-I | PZOC 201 | Aquatic Biology | Theory | 30 | 70 | 4 |
| Core Course-II | PZOC 102 | Histology | Theory | 30 | 70 | 4 |
| Core Course-III | PZOC 203 | Essentials of Biochemistry | Theory | 30 | 70 | 4 |
| Core Course-IV | PZOC 204 | Fundamental of Bioinformatics | Theory | 30 | 70 | 4 |
| Minor / GE | PZOG 201 | Aquatic Biology | Theory | 30 | 70 | 4 |
| Seminar/ Presentation / Internship /Research Project | | | | 30 | 70 | **2** |
| | | **Total** | | **120** | **280** | **20** |

Detailed syllabus of PG 1st semester
Title of the paper: Evolutionary Biology
Course Code: PZOC 101
Nature of course: Major/Minor
Total credit: 4
(60 Lectures, 52 Marks)

Course Objectives:
Understand the link between environment and evolution. Understand how we can determine whether or not a population is evolving for a specific character.

Unit1: Origin of Life: Primitive atmospheric conditions; chemogeny, biogeny and cognogeny; RNA world; origin of photosynthesis, evolution of eukaryotes

( 15 lectures)

Unit2:Evidences of evolution: Evidences in favour of evolution (homology and analogy, vestigial structure, biogenetic law, missing and connecting links, molecular evidence); neutral theory of molecular evolution; molecular clock; rocks and fossils; types and formation of fossils; geological time scale; carbon dating.

( 15 lectures)

Unit3:Theories of evolution: theories of evolution (Lamarckism, Darwinism,neo-Darwinism or modern synthetic theory), their evidence and criticism.Patterns of evolution (Divergent, parallel and convergent evolution): adaptive radiation (exemplified by Darwin's finches)

( 15 lectures)

Unit4:Causes of evolution: variation, types of variation: heritable variation and their role in evolution; genetic basis of variation (recombination, mutation and hybridisation); natural selection and artificial selection; changes in gene frequency (genetic drift, gene flow and genetic load); Hardy –Weinberg law and its application.

( 15 lectures)

PRACTICAL ( 18 Marks )

1. Study of homology and analogy from suitable specimens/models
2. Study of important transitional froms/connecting links: Peripatus, Neopilina, Balanoglossus, Protopterus, Chimaera, Platypus and Archaeopteryx
3. Study of important living fossils (Cyanobacteria, jellyfish, cockroach, sphenodon, opossum)
4. Study of materials/organisms of evolutionary significance;
5. Rocks(igneous,sedimentary,metamorphic)
6. Fossils(plantsandanimalsparts)

Reference book:


- Kliman, R.M.(2016). Encyclopediaof evolutionarybiology.Academic Press.
- Pigliucci,M.,&Kaplan,J.(2010). Making sense of evolution: The conceptual foundations of evolutionary biology. University of Chicago Press.
- Rose,M.R.(1994).Evolutionary biology of ageing.Oxford University Press.


MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)
InternalExamination-10Marks
Internal Examination / Seminar Presentation -10 Marks
Group Discussion /Assignment- 10 Marks
Attendance & Others-5 Marks

Learning outcomes:

- Students get information about the inheritance of modern organisms from ancient ones.
- Evolution describes our origin and relations to other living things.
- Variations are produced through which offspring can adapt to a new environment. It produces species diversity.

Detailed syllabus of PG 1st semester
Title of the paper: Applied Zoology
Course code: PZOC 102
Nature of course: Major
Total credit: 4
(60 Lectures, 52Marks)

Course Objective: Applied Zoology is a specialisation within zoology that uses the knowledge and methods of zoology to solve real-world problems

UNIT1:Basic concepts: Inland fisheries, Marine fisheries & Aquaculture, Sports and ornamental fishes. Problems of aquaculture: Fish parasites, identification, classification and control measure Natural breeding and induced breeding of Carps. Composite fish culture &integrated farming; Types of fish food: Natural food organisms and artificial fish feed.

( 15 lectures)

UNIT2: (12 Lectures,12Marks)
Sericulture in N.E. India: Mulberry and non-mulberry silkworms, their host plants, life history and commercial culture; Diseases of silkworm-Prophylaxis, symptoms and control; Apiculture: Different species of honey bees, social organisation, Life history, Commercial culture, Commercial products and Economic importance, Diseases of honeybee: prophylaxis, symptoms and control

( 15 lectures)

UNIT3:(12 Lectures,10Marks)
Biology of composting earthworm, methods and processing of vermicomposting, advantages of vermicompost, Life history of lac insect, cultivation of lac, composition and properties of lac, enemies of lac cultivation, economic importance of lac

( 15 lectures)

UNIT4:(12 Lectures,10Marks)
Major insect pests of rice, tea and maize: Biology, damage and their control; Defoliators and borers of forest trees and their control. Pests of crops and vegetables and their control. Different groups of pesticides and their mode of action; Pest Control: Mechanical, Biological, Genetic, Pheromonal, Insect growth regulators; Integrated Pest Management: Principle and strategies

( 15 lectures)

PRACTICAL ( 18 Marks )

1. Study of important pests of paddy, tea, vegetables and stored grains and their submission.
2. Identification of silkworms (eri, muga and mulberry), immature and adult stages.
3. Submission of life cycles of eri/muga/mulberry silkworms.
4. Identification of economically important indigenous fishes.
5. Identification of common aquatic weeds, planktons and insects.

Reference Book:

Griffiths,M.(2015).Echidnas: International Series of Monographs in Pure and Applied Biology: Zoology (Vol. 38). Elsevier.

Schmidt, D. (2003). Guide to reference and information sources in the zoological sciences. Bloomsbury Publishing USA.

MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)

InternalExamination-10Marks

Internal Examination / Seminar Presentation -10 Marks

Group Discussion /Assignment- 5 Marks

Attendance & Others-5 Marks

Learning outcomes:

- Students will be able to integrate and analyse information across levels of organisation ranging from cells to ecosystems within the zoological sciences to formulate arguments and critically evaluate scientific claims

Detailed syllabus of PG 1st semester
Title of the paper: Wildlife Conservation and Management
Course code: PZOC 103
Nature of course: Major
Total credit: 4
(60Lectures, 52Marks)

Course Objectives:
Provide information and advice on specific wildlife management problems.

Unit1:
Introduction to wildlife conservation: values of wildlife (positive and negative); conservation ethics; importance of conservation; causes of depletion; world conservation strategies

( 15 lectures)

Unit2:(12 Lectures,12Marks)
Evaluation and management of wildlife: Habitat analysis: physical parameters; topography, geology, soil and water; biological parameters; food, cover, forage, browse and estimation; standard evaluation procedure; remote sensing and GIS.

( 15 lectures)

Unit3:(12 Lectures,10Marks)
Management of habitats: Setting back succession; grazing, logging; mechanical treatment; advancing the successional process; cover construction; preservation of general genetic diversity; restoration of degraded habitats

( 15 lectures)

Unit4:(12 Lectures,10Marks)
Management planning of wildlife: Estimation of carrying capacity, ecotourism/ wildlife tourism in forest; concept of climax persistence; ecology of perturbence Legislations and convention on wildlife (national and international parks and wildlife sanctuaries, biosphere reserve; community reserve; important features of protected area in Assam; tiger convention in India; Management challenges in tiger reserve.

( 15 lectures)

PRACTICAL ( 18 Marks )

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies: use, care and maintenance (compass, binoculars, spotting scope, range finders, global positioning system, various types of cameras and lenses)
3. Familiarisation and study of animal evidence in the field; identification of animals through pug marks, hoof marks, scats, pellet groups, nests, antlers, etc.
4. Demonstration of different field techniques for flora and fauna.

Reference Book:


- Krausman,P.R.,&Cain,J.W.(Eds.).(2022).Wildlife management and conservation:contemporaryprinciples andpractices. JHU Press.
- Princee, F. P. (2016). Exploring studbooks for wildlife management and conservation (Vol. 17). Cham, Switzerland: Springer.
- Silvy,N.J.(Ed.).(2020).TheWildlifeTechniquesManual: Volume1:Research. Volume 2: Management. JHU Press.


MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)
InternalExamination-10Marks
Internal Examination / Seminar Presentation -10 Marks
Group Discussion /Assignment- 5 Marks
Attendance & Others-5 Marks

Learning outcomes:

- Students will be able to identify species, characteristics, habitat requirements and life cycles of birds, fish and/or mammalian wildlife species.□
- Students will be able to apply knowledge to solve problems related to wildlife conservation and management.

Detailed syllabus of PG 1st semester
Title of the paper: Research Methodology
Course code: PZOC 104
Nature of course: Major
Total credit: 4
(60Lectures, 52Marks)

Course objective:
A research methodology provides a framework and guidelines for the students to clearly define research questions, hypotheses, and objectives. It helps researchers to identify the most appropriate research design, sampling technique, and data collection and analysis methods.

Course content:
UNIT 1: Concept and nature of research, Types of research, Significance of research, Formulation of research problem, Novelty of research in support of existing literature, Setting the hypothesis or objective, criteria of good research, problems encountered by researchers in India. (13 lectures)
UNIT 2: Definition of sampling, Sampling designs and types, Types of data collection, introduction to data presentation, statistical analysis of data and interpretation of data. (13 lectures)
UNIT 3: Different forms of scientific writing- article, reports, notes, review article; Dissertation writing format: content, writing style, drafting titles/ subtitles, chapterization, Proper description of methods and methodology, presentation of data with statistical analysis, writing results, discussion and conclusion. Bibliography and referencing style, Appendices. (18 lectures)

UNIT 4: Utility of computer/software- MS Office, Excel, PowerPoint, graphics, SPSS; Use of internet for research purposes- Email, WWW, web browsing, Use of E-journals, use of E-library. (16 lectures)

PRACTICAL (18 Marks)

1. MS Word – Preparation of a mini research article, Citation, and referencing
2. MS Excel – Statistical analysis, Graphical representation of research data
3. PowerPoint – Scientific presentation preparation
4. Searching research articles using Google Scholar and PubMed.

Reference Book:

- Business Research Methods- Donald Cooper & Pamela Schindler, TMGH, 9th edition.
- Business Research Methods- Alan Bryman & Emma Bell, Oxford University Press.
- Research Methodology- C. R. Kothari 4. Select references from the Internet

Learning outcomes:

By studying the course, the students will have a clear idea about research, how to identify the research gap, setting the objective of the study and also will have the knowledge on how to write a dissertation or any other research article. They will also gain basic knowledge of computers and different computer applications.

Detailed syllabus of PG 1st semester
Title of the paper: Evolutionary Biology
Course code: PZOG 101
Nature of course: Major
Total credit: 4
(60Lectures, 52Marks)

Course Objectives:
Understand the link between environment and evolution. Understand how we can determine whether or not a population is evolving for a specific character.

Unit1: Origin of Life: Primitive atmospheric conditions; chemogeny, biogeny and cognogeny; RNA world; origin of photosynthesis, evolution of eukaryotes

( 15 lectures)

Unit2:Evidences of evolution: Evidences in favour of evolution (homology and analogy, vestigial structure, biogenetic law, missing and connecting links, molecular evidence); neutral theory of molecular evolution; molecular clock; rocks and fossils; types and formation of fossils; geological time scale; carbon dating.

( 15 lectures)

Unit3:Theories of evolution: theories of evolution (Lamarckism, Darwinism,neo-Darwinism or modern synthetic theory), their evidence and criticism.Patterns of evolution (Divergent, parallel and convergent evolution): adaptive radiation (exemplified by Darwin's finches)

( 15 lectures)

Unit4:Causes of evolution: variation, types of variation: heritable variation and their role in evolution; genetic basis of variation (recombination, mutation and hybridisation); natural selection and artificial selection; changes in gene frequency (genetic drift, gene flow and genetic load); Hardy –Weinberg law and its application.

( 15 lectures)

PRACTICAL ( 18 Marks )

7. Study of homology and analogy from suitable specimens/models
8. Studyofimportanttransitionalfroms/connectinglinks: Peripatus, Neopilina, Balanoglossus, Protopterus, Chimaera, Platypus and Archaeopteryx
9. Studyofimportantlivingfossils(Cyanobacteria,jellyfish,cockroach,sphenodon, opossum)
10. Study of materials/organisms of evolutionary significance;
11. Rocks(igneous,sedimentary,metamorphic)
12. Fossils(plants and animal parts)

Reference book:


- Kliman, R.M.(2016). Encyclopediaof evolutionarybiology.Academic Press.
- Pigliucci,M.,&Kaplan,J.(2010). Making sense of evolution: The conceptual foundations of evolutionary biology. University of Chicago Press.
- Rose,M.R.(1994).Evolutionary biology of ageing.Oxford University Press.


MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)
InternalExamination-10Marks
Internal Examination / Seminar Presentation -10 Marks
Group Discussion /Assignment- 5 Marks
Attendance & Others-5 Marks

Learning outcomes:

- Students get information about the inheritance of modern organisms from ancient ones.
- Evolution describes our origin and relations to other living things.
- Variations are produced through which offspring can adapt to a new environment. It produces species diversity.

Detailed syllabus of PG 2nd semester
Title of the paper: Aquatic Biology
Course code: PZOC 201
Nature of course: Major
Total credit: 4
(60Lectures, 52Marks)

Course Objectives: The Study of protection and restoration of water quality and the management of the freshwater environment.

Unit1:Aquatic biomes: Brief introduction of the aquatic biomes: freshwater ecosystems (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

( 15 lectures)

Unit2:Freshwater biology:Lakes: Origin and classification, lake as an ecosystem, lake morphometry, physico-chemical characteristics: light, temperature, thermal stratification, dissolved solids, carbonate, bicarbonates, phosphates and nitrates, turbidity; dissolved gases (oxygen, carbon dioxide); nutrient cycles in lakes-nitrogen, sulphur and phosphorus. Streams: Different stages of stream development, physico-chemical environment, adaptation of hill-stream fishes.

( 15 lectures)

Unit3: Marine biology: Salinity and density of seawater, continental shelf, adaptations of deep-sea organisms, coral reefs, sea weeds.

( 15 lectures)

Unit4:Management of aquatic resources: Causes of pollution: agricultural, industrial sewage, thermal and oil spills, eutrophication, management and conservation (legislations), Sewage treatment, water quality assessment- Biological, mechanical and chemical.

( 15 lectures)

PRACTICAL ( 18 Marks )

- Determine the area of a lake/pond using graph metric and gravimetric methods.
- Identification of important macrophytes, phytoplankton and zooplanktons present in a lake/pond ecosystem.
- Determine the amount of turbidity/ transparency, dissolved oxygen, free carbon dioxide, and alkalinity (carbonates and bicarbonates) in water collected from a nearby lake/pond/stream.
- Instruments used in limnology (Secchi disc, Van Dorn bottle, conductivity meter, turbidity meter, PONAR grab sampler) and their significance.
- A project report on a visit to a sewage treatment plant/fisheries institute.

Reference Book:


- Maitland, P.S. (2013). Biology of freshwaters. Springer Science &Business Media.

- Stanford, L. L., & Spacie, A. (1994).Biological monitoring of aquatic systems. CRC Press.
- Fay,R.R.,&Tavolga,W.N.(Eds.).(2012). Sensory biology of aquatic animals. Springer Science & Business Media.


MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)
InternalExamination-10Marks
Internal Examination / Seminar Presentation -10 Marks
Group Discussion /Assignment- 5 Marks
Attendance & Others-5 Marks

Learningoutcomes:
Upon completion of the course, students should be able to analyse and interpret different stages of stream development and the physicochemical environment

Detailed syllabus of PG 2nd semester
Title of the paper: Histology
Course code: PZOC 202
Nature of course: Major
Total credit: 4
(60Lectures, 52Marks)

Objectives: To know the microscopic structure and organisation of animal tissues, organs and their functions.

Unit 1: Introduction to Histology: Scope, Relevance in Biomedical sciences, pathology and experimental Zoology, Tissue processing.

( 15 lectures)

Unit 2: Epithelial Tissue & Connective tissues: Structural organisation, characteristics of Types, structure, location, and functions. Connective tissue Proper (extracellular matrix), Specialised Connective Tissue: Blood: Components and their functions. Blood as a buffer system; Blood groups: ABO, Rh factor, MN, Golden blood; structure types and functions of bones and cartilages

( 15 lectures)

Unit 3: Muscular Tissues: Types and functions of muscles; Ultrastructure of skeletal muscle; Molecular and chemical basis of skeletal muscle contraction; isotonic and isometric contraction. Characteristics of muscle twitch; treppe, summation and tetanus; Electromyography. Nervous Tissues, Neurons: Structure, types and functions; Neuron doctrine, Classification and properties of nerve fibres 3. Glia Cells: Structure, types and functions; Synapse: Structure and types; Neuromuscular junction

( 15 lectures)

Unit 4: Histology of Organs, Structural organization of the gastrointestinal tract and functions of associated glands, Structure of salivary glands, liver, pancreas and lungs, Structural organisation of the mammalian heart, histology of blood vessels, Structure of kidney and its functional unit.

( 15 lectures)

PRACTICAL ( 18 Marks )

1. Study of permanent slides/ photo-micrographs of Mammalian skin, Cartilage, Bone, Spinal cord and brain tissue.
2. Study of permanent slide/ photo-micrographs of important organs and glands (mammalian
3. Pituitary, Pancreas, Kidney, Adrenal, Thyroid and Parathyroid, Testis, Ovary, Uterus)
4. Microtomy Procedure: Preparation of permanent slides.

Reference Book:

- Pushpalatha K and Bhat D (2022). Inderbir Singh's Textbook of Human Histology Xth. Jaypee Brothers Medical Publishers.

- Kim E. Barrett KE, Barman SM, Yuan J X.-J., Brooks H (2019). Ganong's Review of Medical Physiology, McGraw-Hill Education / Medical; 26th Edition.

- Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company

- Eric R. Kandel ER, Koester JD, Mack, S.H. (2021). Principles of Neural Science. VI Edition, McGraw Hill Medical


MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)
InternalExamination-10Marks
Internal Examination / Seminar Presentation -10 Marks
Group Discussion /Assignment- 5 Marks
Attendance & Others-5 Marks

Course Outcome: Students will be able to analyse and classify animal tissues, comprehend their functions, and apply histological techniques for research and diagnostic purposes.

Detailed syllabus of PG 2nd semester
Title of the paper: Essentials of Biochemistry
Course code: PZOC 203
Nature of course: Major
Total credit: 4
(60Lectures,52Marks)

UNIT 1: Types and features of biochemical reactions. Bioenergetics: redox reaction, redox potential and free energy, oxidative and photophosphorylation and their mechanism. Structure of ATPase and Chemiosmotic theory of ATP synthesis.

( 15 lectures)

UNIT2: Metabolism of Carbohydrates: Regulation of Glycolysis, Krebs Cycle, HMP pathway, glycogenesis, glycogenolysis; Glyoxylate cycle.

(15 lectures)

UNIT3: Structure of proteins in relation to their biological functions, primary, secondary, tertiary, and quaternary structure, maintenance of secondary structure, Ramachandran Plot, protein folding, Metabolism of amino acids (Transamination, Deamination, Urea Cycle)

(15 lectures)

UNIT4: Lipids: β-oxidation of saturated and unsaturated fatty acids, biosynthesis of saturated fatty acids, its regulation; Enzymes: Enzyme-catalysed reaction. Single and bi-substrate reactions, mechanism of action, Allosteric enzymes, Enzyme induction and inhibition (competitive, noncompetitive, and uncompetitive), Enzymes: enzyme kinetics (Michaelis-Menten equation)

(15 lectures)

PRACTICAL ( 18 Marks )

1. Estimation of protein and carbohydrate in biological samples.
2. Estimation of ascorbic acid (Colourimetric).
3. Separation of amino acids by Paper/Thin Layer Chromatography
4. Assay of activity of an enzyme in biological samples

Reference Book:


- Lehninger's Principles of Biochemistry, Nelson and Cox, Sixth Edition or recent edition, Macmillan Press.
- Principles of Biochemistry, Voet, Voet and Pratt, 5th edition (2012) or recent edition, Wiley.
- Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.
- Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge[Latest edition].


MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)
InternalExamination-10Marks
Internal Examination / Seminar Presentation -10 Marks

Group Discussion /Assignment- 5 Marks
Attendance & Others-5 Marks

Learning outcomes:
After completion of the course, the students will have a deep knowledge of protein structures, their synthesis, functions and enzyme actions and their inhibitors.

Detailed syllabus of PG 2nd semester
Title of the paper: Aquatic Biology
Course code: PZOG 201
Nature of course: Major
Total credit: 4
(60Lectures, 52Marks)

Course Objectives: The study of protection and restoration of water quality and the management of freshwater environments.

Unit1: Aquatic biomes: Brief introduction to the aquatic biomes: freshwater ecosystems (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

( 15 lectures)

Unit2:Freshwater biology:Lakes: Origin and classification, lake as an ecosystem, lake morphometry, physico-chemical characteristics: light, temperature, thermal stratification, dissolved solids, carbonate, bicarbonates, phosphates and nitrates, turbidity; dissolved gases (oxygen, carbon dioxide); nutrient cycles in lakes-nitrogen, sulphur and phosphorus. Streams: Different stages of stream development, physico-chemical environment, adaptation of hill-stream fishes.

( 15 lectures)

Unit3:Marine biology: Salinity and density of seawater, continental shelf, adaptations of deep-sea organisms, coral reefs, sea weeds.

( 15 lectures)

Unit4:Management of aquatic resources: Causes of pollution: agricultural, industrial sewage, thermal and oil spills, eutrophication, management and conservation (legislations), Sewage treatment, Water quality assessment- Biological, mechanical and chemical.

( 15 lectures)

PRACTICAL ( 18 Marks )

1. Determine the area of a lake/pond using graphimetric and gravimetric methods.
2. Identification of important macrophytes, phytoplanktons and zooplanktons present in a lake/pond ecosystem.
3. Determine the amount of turbidity/ transparency, dissolved oxygen, free carbon dioxide, and alkalinity (carbonates and bicarbonates) in water collected from a nearby lake/pond/stream.

4. Instruments used in limnology (Secchi disc, Van Dorn bottle, conductivity meter, turbidity meter, PONAR grab sampler) and their significance.
5. A project report on a visit to a sewage treatment plant/fisheries institute.

Reference Book:


- Maitland, P.S. (2013). Biology of freshwaters. SpringerScience&Business Media.
- Stanford, L. L., & Spacie, A. (1994).Biological monitoring of aquatic systems. CRC Press.
- Fay,R.R.,&Tavolga,W.N.(Eds.).(2012). Sensory biology of aquatic animals. Springer Science & Business Media.


MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)
InternalExamination-10Marks
Internal Examination / Seminar Presentation -10 Marks
Group Discussion /Assignment- 5 Marks
Attendance & Others-5 Marks

Learning outcomes:
Upon completion of the course, students should be able to analyse and interpret different stages of stream development and the physicochemical environment

Detailed syllabus of PG 2nd semester
Title of the paper: Fundamentals of Bioinformatics
Course code: PZOC 204
Nature of course: Major
Total credit: 4
(60Lectures, 52Marks)

**Course Objectives**

The course aims to:

1. Introduce students to the fundamental concepts and scope of bioinformatics.
2. Familiarize and provide hands-on experience to students in using biological databases.
3. Develop skills in sequence analysis and sequence alignment.
4. Enable students to interpret biological information using computational approaches.
5. Introduce the relationship between protein sequence, structure, and biological function.
6. Familiarize students with protein structure prediction and visualization tools.

**Syllabus:**

**Unit I: Basics of Bioinformatics** **5**
**Lectures**
Introduction to bioinformatics, history and evolution, scope and applications, branches and interdisciplinary nature of bioinformatics.

**Unit II: Biological Databases** **20**
**Lectures**
Introduction to biological databases: primary, secondary and composite databases; nucleotide sequence databases (GenBank, ENA, DDBJ); protein sequence databases (UniProt, Swiss-Prot, TrEMBL); protein structural databases (PDB); specialized databases (ensemble, KEGG, BioCyc); literature databases (PubMed); Sequence data formats (FASTA, GenBank, PDBx/mmCIF); database searching and retrieval.

**Unit III: Sequence Alignment and Analysis** **15**
**Lectures**
Concept of biological sequences; pairwise and multiple sequence alignment, global and local alignment; Needleman-Wunsch and Smith-Waterman algorithms, sequence similarity, identity and homology; scoring matrices (PAM, BLOSUM). Basic Alignment tools (BLAST, EMBOSS Needle/Water).

**Unit IV: Protein Structure and visualization Tool** **20**
**Lectures**
Amino acids; peptide bonds**;** primary, secondary, tertiary and quaternary structures; Ramachandran plot; forces stabilizing protein structures; structural motifs and domains; methods of protein structure determination: X-ray crystallography, NMR spectroscopy and Cryo-EM; Protein Data Bank (PDB) and protein structure file formats (PDB and mmCIF); protein visualization, structural analysis and comparison using PyMOL, UCSF Chimera/ChimeraX, BIOVIA DSV and Mol* Viewer. Introduction to protein structure prediction; sequence–structure relationship; Protein modeling: homology modeling (SWISS-MODEL).

**Practical: Total credit: 1 (18 marks)**

1. Searching and retrieval of biological information from sequence databases.
2. Sequence similarity search using BLAST.
3. Accessing, downloading and retrieving information about protein structure from PDB Database.
4. Sequence alignment using alignment tool.
5. Protein structure visualization and analysis using PyMOL.
6. Protein structure prediction using SWISS-MODEL.
7. Evaluation of protein models using Ramachandran plot.

MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)
InternalExamination-10Marks
Internal Examination / Seminar Presentation -10 Marks
Group Discussion /Assignment- 5 Marks
Attendance & Others-5 Marks

**Course Outcome:**
On completion of the course the students will be able to
CO1: Explain the fundamental concepts of phylogenetics.
CO2: Construct and validate molecular phylogenetic trees using MSA tools and MEGA software.
CO3: Execute basic Linux command-line operations and write simple shell scripts
CO4: Retrieve, visualize, and analyze protein structures using bioinformatics resources.
CO5: Perform basic protein structure prediction and evaluate model quality.

**Suggested Reading:**

1. Ghosh, Z., & Mallick, B. (2008). *Bioinformatics: Principles and Applications*.
2. Ignacimuthu, S. (2005). *Basic Bioinformatics*.
3. Mount. D.W. (2nd Edition). *Sequence and genome analysis.*

## Semester wise distribution of credits

| **Semester** | **Core course** | **Elective Course (EC)** | **Research Project/Dissertation** | **Total** |
|---|---|---|---|---|
| III | 12 | 04 | 04 | 20 |
| IV | 12 | 04 | 04 | 20 |
| **Grand Total** | **24** | **08** | **08** | **40** |

## Curriculum structure

### Semester-III

| Course | Course Code | Course Name | Type | Internal Assessment marks | End semester marks | Credit |
|---|---|---|---|---|---|---|
| Core Course-I | PZOC 301 | Biological Techniques and Biostatistics | Theory | 30 | 70 | 4 |
| Core Course-II | PZOC 302 | Ecology and Environmental Biology | Theory | 30 | 70 | 4 |
| Core Course-III | PZOC 303 | Biotechnology and Bioinformatics | Theory | 30 | 70 | 4 |
| Elective Course-I | PZOE 301 | Biochemistry-I | Theory | 30 | 70 | 4 |
| | PZOE 302 | Fish & Fisheries-I | | | | |
| | PZOE 303 | Mammalian Reproductive Biology-I | | | | |
| Research Project | | | | ……. | ……. | **4** |
| | | **Total** | | **120** | **280** | **20** |

SEMESTER-III

## PZOC 301: Biological Technique and Biostatistics

**Total marks: 70+30 = 100**
**Credit=04 (70 lectures)**

### Course objective:

- Biological Technique is the development of technologies for the measurement and manipulation of parameters within biological systems, focusing on the application of engineering tools for scientific discovery and for the diagnosis and treatment of disease.
- The objective of Biostatistics is to advance statistical science and its application to problems of human health and disease, with the ultimate goal of advancing the public's health.

### Learning outcomes:

- Upon completion of the course the students will know about the use of bio instruments along with their principles and they will also know about different types of statistical analyses.

### Course content:

**Unit 1:** Separation technique: Principle of chromatography and its types, and practice of paper chromatography, thin layer chromatography and ion-exchange chromatography: concept centrifugation and sedimentation; types and applications of centrifuge; theory and types of electrophoresis; support media.

**Unit 2:** Microscope: Principle of microscopy ; theory, instrumentation and application of compound light microscope, phase contrast microscope, fluorescence microscope, transmission and scanning electron microscope ; advantage and disadvantage of different types of microscope

**Unit 3:** Photometry and histochemical techniques: Absorption laws and spectrophotometry; Principle, instrumentation and application of the colorimeter, techniques of histological preparation and microtomy; paraffin method tissue sectioning; fixation and staining; types and properties of dye(Stains); vital staining: principle, instrumentation and application of kymograph

**Unit 4:** Fundamentals of biostatistics : Scope and application of statistic in biological

sciences; sources, classification of data; sampling and sampling methods; organization and representation of data; frequency distribution and its graphical representation (Histogram, frequency curve and give)

**Unit 5:** Statistical measure and test of significance: Measure of central tendency (Arithmetic mean, medium and mode), for discrete and continuous series and their application; measure of dispersion (mean deviation, variance, standard deviation, coefficient of variation)

## Practicals

1. Separation chlorophylls/ any organic substance by paper/ thin layer chromatography
2. Separation of cellular extract by using centrifuge
3. Histological preparation of amphibians/ mammalian tissues by paraffin method, and submission of slides.
4. Demonstration of instrumentation of different types of chromatography, microscopy, microscopes, spectrophotometer s and kymograph.
5. Graphical representation of given set/sets of data (bar and pie diagrams, histogram, frequency polygon, frequency cure and ogive)
6. Statistical calculation of central tendencies and deviations of discrete and continuous data.

## Reference Book:


- Webster, J. G. (Ed.). (2003). Bioinstrumentation. John Wiley & Sons.
- Bisen, P. S., & Sharma, A. (2012). Introduction to instrumentation in life sciences. Crc Press.
- Antonisamy, B., Premkumar, P. S., & Christopher, S. (2017). Principles and Practice of Biostatistics-E-book: Principles and Practice of Biostatistics-E-book. Elsevier Health Sciences.
- Rao, P. S., & Richard, J. (2012). Introduction to biostatistics and research methods. PHI Learning Pvt. Ltd..

SEMESTER-III

**PZOC 302: Ecology & Environmental Biology**
**Total marks: 70+30 = 100**
**Credit=04 (70 lectures)**

## Course objective:

- The objective of this course to make awareness among the young students about the surrounding environment, the impact of climate change and its mitigation, and about pollution.

## Learning outcomes:

- Students will be exposed to the fundamental aspects of ecology. They will get idea about the impact of anthropogenic activities on the environment. They will also have an idea about pollution and the major terrestrial biomes.

## Course content:

**UNIT1:** Concept of Ecology. Autecology and synecology; Ecosystem: structure & types Trophic structure and function, Food chain, food web, ecological pyramids, ecological Energy flow and productivity in the ecosystem

**UNIT2:** Population ecology: Population structure, growth and fluctuation. Species interaction – interspecific and intra-specific competition, predation, parasitism, mutualism and commensalisms. Community structures and stability and community succession Ecological succession, Mechanism and causes of succession

**UNIT3:** Pollutants (Mercury, Arsenic, PAN, Lead, Organochlorine, CO2, Methane) and their effects on organism Environmental impact assessment Greenhouse effect and global warming Concept of habitat loss and ecological balance.

**UNIT4:** Major terrestrial Biomes: freshwater, forest- Vegetation types in Arunachal Pradesh, grassland and tundra Environmental Biotechnology: Definition, Scope and role in environmental protection Bioremediation and Eco-restoration: Definition and Scope Concept of habitat and ecological niches; Niche overlap and species coexistence.

## Practicals

1. To study the physical and chemical characteristics of soil -C, N content and pH of soil by rapid soil test method.
2. Determination of dissolve oxygen, carbon-di-oxide, alkalinity of the soil.
3. Estimation of the size of the population by capture-recapture method (any

vertebrate/invertebrate)

4. To determine the frequency, density and abundance of the primary producers of a grassland community by quadrat method.
5. To determine the abundance and density of soil fauna.
6. Study of trophic relation (food chain/ food web) in a grassland ecosystem.
7. Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro-, and macrofauna in decomposition.
8. Understandingecosystem succession by studying various stages of vegetation/community assemblages' development.

## Reference Book:


- Field Sampling: Principles and Practices in Environmental Analysis. 2004. Conklin, A.R. Jr. CRC Press.
- Principles and Standards for Measuring Primary Production. 2007. Fahey, T.J. and Knapp, A.K. Oxford University Press, UK.
- Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
- Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford University Press, UK.
- Principles of Terrestrial Ecosystem Ecology. 2011. Chaplin, F.S., Matson, P.A. and Vitousek, P.M. Springer.
- Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
- Freshwater Ecology: A Scientific Introduction. 2004.Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.
- A.G.E Pearse: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill-Livingstones,1980-1993

SEMESTER-III

**PZOC 303: Biotechnology & Bioinformatics**
**Total marks: 70+30 = 100**
**Credit=04 (70 lectures)**

## Course objective:

- This course is designed so that students can practice the various important skills related to biological data that are important in the research and development sector. This course will teach the students will introduce to basics of bioinformatics and biotechnology.

## Learning outcomes:

Understand the principle and application of biotechnology and bioinformatics for the benefit of human being. Acquire the necessary knowledge to pursue jobs in biological data science, particularly in scientific academics, funding agencies, and educational institutions.

## Course content:

**UNIT1:** Introduction to animal tissue culture: Principle of animal cell culture: Primary culture, cell line, and cell clones; Basic techniques in mammalian cell culture Types of growth media, component Transgenic animal-its application; Stem cell culture, applications in medicine and Biotechnology Cloning vectors (Plasmid, Cosmid, Phasmid) Lytic and Lysogenic cycle, RAPD, RFLP, DNA fingerprinting and barcoding

**UNIT2:** Introduction to Genetic engineering & rDNA Technology: Definition, history and scope. Molecular Genetic Tools: Restriction enzymes and their types (I, II, III), mode of action, cohesive and blunt end restriction, isoschizomers, restriction mapping, modification of DNA ends, (terminal transferases, linkers and adaptors). Ligases, T4 kinase, alkaline phosphatase, klenow fragment, Dnase-I, single strand specific nucleases, RNase H, Transformation in bacteria, animal and plant cells.

**UNIT3:** Introduction to bioinformatics, history and scope, biological databases: primary, secondary and composite databases; nucleotide sequence databases (GenBank, EMBL-EBI, DDBJ); protein sequence databases (UniProt, Swiss-Prot, TrEMBL); protein structural databases (PDB); specialized databases (ensemble, KEGG, BioCyc); literature databases (PubMed); Sequence data formats (FASTA, GenBank, PDBx/mmCIF); database searching and retrieval.

**UNIT4:** Pairwise and multiple sequence alignment, global and local alignment; Needleman-Wunsch and Smith-Waterman algorithms. Basic Alignment tools (BLAST, EMBOSS Needle/Water, ClustalW/Omega). Phylogenetics and character states; phylogenetic trees and their topologies; rooted versus unrooted tree, clades; monophyletic, paraphyletic, and polyphyletic groups; cladograms, phenograms, and chronograms. Distance-based methods (UPGMA, Neighbor-Joining,); Character-based methods (Maximum Parsimony, Maximum Likelihood), tree construction MEGA.

## Practicals

1. Proximate Analysis of Edible fish- Protein, Carbohydrates, Fats, Moisture, Fiber.
2. Separation of substrates or amino acids by paper chromatography/TLC
3. Determination if in-vitro antioxidant activity using DPPH assay
4. Preparation of liquid culture medium and raise culture of *E. coli*
5. Case study on ethical issues of application of GMOs
6. Primer designing for gene amplification
7. Perform Sequence and Structure Retrieval and Analysis.
8. Perform Pairwise and Multiple Sequence Alignment
9. Construction of phylogenetic trees for DNA and proteins

## Reference Book:


- Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 2nd Edition, Oxford University Press, 2003
- Introduction to Plant Biotechnology. 2nd edition. By H. S. Chawla. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
- Plant Biotechnology and Genetics: Principles, Techniques and Applications, Edited by C. Neal Stewart JR. John Wiley and Sons Publications 2008.
- Marker Assisted Plant Breeding: Principles and practices, B.D Singh and A.K Singh, Springer 2015
- Ghosh, Z., & Mallick, B. (2008). Bioinformatics: Principles and Applications.
- Ignacimuthu, S. (2005). Basic Bioinformatics.
- Mount. D.W. (2nd Edition). Sequence and genome analysis.

SEMESTER-III ELECTIVE COURSE

# PZOE 301: BIOCHEMISTRY-I

**(Protein chemistry and Enzymology)**

**Total marks: 70+30 = 100**

**Credit=04 (70 lectures)**

## Course objective:

- The major learning objective of the course is to understand the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell. Proteins are biopolymeric structures composed of amino acids, of which there are 20 commons found in biological chemistry. Proteins serve as structural support, biochemical catalysts, hormones, enzymes, building blocks, and initiators of cellular death.

## Learning outcomes:

- After completion of the course the students will have a deep knowledge on the protein structures, their synthesis, functions and about the enzyme actions and their inhibitors.

## Course content:

**UNIT1:** Structure of protein in relation to their biological functions, primary, secondary, tertiary, and quaternary structure, maintenance of secondary structure, Ramachandran Plot, protein folding, determination of amino acid sequence.

**UNIT** 2: Biosynthesis of protein, direction of chain growth, Inhibitors of protein biosynthesis, Co-translational and Post translational modification of protein. Protein purification, Mechanism of protein and steroid hormone action, role of cAMP and G-protein in metabolism, prostaglandins

**UNIT3:** Enzymes: Enzyme catalyzed reaction. Single and bi-substrate reactions, mechanism of action, Allosteric enzymes, Enzyme induction and inhibition (competitive, non-competitive, and uncompetitive), purification of enzymes.

**UNIT4:** Enzyme kinetics; Michalis-Menten Equation., Line weaver Burk plot, Hill plot, Restriction enzymes, RNA as an enzyme, Isoenzyme and their significance. Regulation of metabolism of enzyme (Carbohydrate metabolism)

## Practical:

1. Estimation of protein by Bradford method.
2. Estimation of amino-acids
3. Determination of pK and IPH
4. Separation of amino acids by Paper/Thin Layer Chromatography
5. Assay of activity of an enzyme in biological samples
6. Electrophoretic separation of protein using PAGE

7. Purification of proteins using column chromatography.

**Reference Book:**

- Lehninger's Principles of Biochemistry, Nelson and Cox, Sixth Edition or recent edition, Macmillan Press.
- Principles of Biochemistry, Voet, Voet and Pratt, 5th edition (2012) or recent edition, Wiley.
- Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.
- Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge [Latest edition].

SEMESTER-III ELECTIVE COURSE

**PZOE 302: FISH & FISHERIES-I**

**Total marks: 70+30 = 100**

**Credit=04 (70 lectures)**

## Course objective:

- To understand the classification of fishes, their basic Biology and Factors of influence.
- To understand Fish as resources and their commercialization and laws for their Conservation.

## Learning outcomes:

- After completion of the course Students can identify different types of fishes and will have a deep knowledge on the basic body processes along with their food habit. Students understand the importance of Commercialization of fish as resources and their Conservational importance.

## Course content:

**UNIT1:** Classification of fishes: Various trends in the classification of fishes; Classification of major groups of living fishes; classification of water bodies on the basis of their productivity; General anatomy of fish: Comparative anatomy of skin, scales and fins,digestive system, circulatory system, respiratory system including accessory respiratory organs, urinogenital system and immune system

**UNIT2:**. Fish Behaviour in relation to feeding, schooling, migration, courtship, mating and parental care. Adaptations and Symbiotic associations. Reproductive strategies, Environmental factors regulating reproductive cycles, Stress Physiology: Effect of abiotic, biotic and xenobiotic stresses on fishimmune system, Adaptation to extreme temperature, Hypoxia. Symptoms of different fish diseases and their aetiology; prophylactic measures, control and therapeutics; Fish quarantine.

**UNIT3:** Determination of age in fishes; Absolute and relative growth, growth curve, length-weight relationship, condition factor and their significance; Sexual dimorphism; Maturity cycle and gonadal development; Reproductive strategies and parental care; Types, causes and mode of migration in anadromous and catadromous fishes.

**UNIT**4: Fish preservation and by-product: Causes of fish spoilage: biochemical changes during fish spoilage; Principle and practice of fish preservation; By-products of fishes; Present

status and scope of development of fishing technology in India; Types of fishing crafts and gears in marine and inland waters, their maintenance and operation; Modern transportation system; Management and conservation of inland fisheries resources; , Impact of exotic fish species and GMOs on aquatic biodiversity, Fisheries legislation. International trade and export promotion; Existing system of fish marketing; Use of modern marketing and transportation for aqua products.

## Practicals

1. Identification of locally available fishes / Study of museum specimens.
2. Dissection: (a) Cranial nerves (5th, 7th, 9th& 10th) of cat fishes or carps. (b) Urino-genital system of male and female fishes. (c) Weberian ossicles (d) Afferent and efferent vessels of carps and catfishes.
3. Study of Accessory respiratory organ of the following fishes: (i) *Clarias*, (ii) *Heteropneustes*, (iii*) Anabas*, (vi) *Channa*.
4. Studies of gastrosomatic index, gonadosomatic index, K-factor, length-weight relationship of fecundity and other body parameters.
5. Biological survey of pond / water body and Analysis of pH, texture and porosity of soil. Analysis of physico-chemical parameters of pond water. (a) turbidity, (b) dissolved oxygen, (c) alkalinity, (d) hardness, (e) TDS, (f) TSS, (g) Nitrate-nitrite (h) Phosphate.
6. Study of bucco-pharyngeal region of following fishes: (i) *Labeo*, (ii) *Punitus*, (iii) *Channa*, (iv) *Heteropneustes;*Gut content analysis of *Labeo, Punitus*, Channa and *Heteropneustes.*

## Reference Book:


- Fish and fisheries in North East India Editors R. N. Bhuyan, D. Ghose and D. Sharma
- The Biology of Fishes H. M. Kyle
- The illustrated encyclopaedia of Fish. Biodiversity of Assam Edited by A. K. Bhagabati, M. C. Kalita and S. Baruah
- An introduction to fish Biology and fisheries by Dr. S. S. Khanna & Dr. Neeraj Kapoor

- Biology of Fishes. 2008. Bone, Q. and Moore, R., Talyor and Francis Group, CRC Press, U.K.
- The Diversity of Fishes. 1994. G.S. Helfman, B.B. Collette & D.E. Facey (Eds) BlackwellSceince, USA.
- Readings in Ichthyology. 1979. M.S. Love and G.M. Cailliet (eds). Prentice-Hall of India.
- The Senses of Fish Adaptations for the Reception of Natural Stimuli. 2004. von der Emde, R.,Mogdans, J. and Kapoor, B. G., Narosa Publishing House, New Delhi, India

SEMESTER-III
ELECTIVE COURSE

**PZOE 303: Mammalian Reproductive Biology-I**

**Total marks: 70+30 = 100**

**Credit=04 (70 lectures)**

## Course Objective:

Specifically, the course seeks to:

- Analyze mammalian mating systems, reproductive strategies, and the detailed structure and functional regulation of the human male and female reproductive systems.
- Examine the embryonic differentiation of genital ducts (Wolffian and Müllerian), the onset of puberty, reproductive maturation, and the physiological transitions of reproductive aging and menopause.
- Assess the impact of physiological stress, nutritional deficiencies (such as anorexia), and environmental endocrine-disrupting chemicals (EDCs) on the stability of the ovulatory cycle.
- Introduce the clinical causes and diagnoses of human infertility, and survey contemporary Assisted Reproductive Technologies (ART) alongside their medical and ethical applications.

## Learning Outcomes

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

- Detail the precise biochemical and cellular stages of spermatogenesis (including sperm maturation, transport, capacitation, and activation) and oogenesis (including folliculogenesis, ovulation, and luteal dynamics).
- Differentiate between the hormonal profiles, physiological changes, and anatomical variations characterizing the estrous and menstrual cycles in mammals.
- Explain the developmental trajectories of the Wolffian and Müllerian ducts during embryonic sexual differentiation and identify how these systems transition during puberty and reproductive senescence.
- Evaluate how systemic stressors, metabolic imbalances, and exogenous environmental steroids disrupt neuroendocrine control of ovulation.
- Critically discuss the mechanics, clinical indications, and success metrics of various ART protocols, including IVF, ET, GIFT, ZIFT, ICSI, cryopreservation, and surrogacy.

## Course content:

**Unit I:** Introduction to reproductive strategies in mammals: Reproductive strategies, Mating System, Male and female reproductive system: Outline of Structure and function of human reproductive system, Spermatogenesis, Sperm transportation in male tract, Capacitation, Activation. Oogenesis, Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; secretion of ovarian hormones, Reproductive cycles (Estrous and Menstrual)

**Unit 2:** Development of Genital ducts: Wolffian duct, Mullerian duct, Puberty and reproductive maturation, Reproductive ageing, Menopause, Reproductive issues: Stress, anorexia, Nutrition and stress influences on the ovulatory cycle. steroids in the environment; Endocrine disrupting chemicals.

**Unit 3:** Reproductive technologies: Infertility in human: causes, diagnosis and management, Assistant Reproductive Technologies: In vitro fertilization and embryo transfer, cryopreservation of embryos hormone replacement therapy, GIFT, ZIFT, ICSI, TET, oocyte and embryo donation, semen collection and storage, artificial insemination and surrogacy,

## Practical

1. Study of estrous cycle in rat/mice.
2. Study of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems.
3. Study of histological sections from photomicrographs/ permanent slides of Rat/human :ovary, fallopian tube, uterus and cervix.
4. Study on IVF and embryo transfer (demonstration/video-assisted)

## Reference Book:


- Gary C.S.; Steven B.B.; Philip R.B. and Philippa H.F. (2014) Larsen's Human Embryology (5 th edition) Elsevier.
- Gilbert, S.F. (2016) Developmental Biology (11 th edition) Sinauer.
- Knobil, E. et al.(eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.
- Johnson, M.H. (2018). Essential Reproduction, Wiley-Blackwell, 8th Edition.

## Curriculum structure

### Semester-IV

| Course | Course Code | Course Name | Type | Internal Assessment marks | End semester marks | Credit |
|---|---|---|---|---|---|---|
| Core Course-I | PZOC 401 | Molecular Biology | Theory | 30 | 70 | 4 |
| Core Course-II | PZOC 402 | Cell Biology and Inheritance Biology | Theory | 30 | 70 | 4 |
| Core Course-III | PZOC 403 | Physiology and Immunology | Theory | 30 | 70 | 4 |
| Elective Course-I | PZOE 401 | Biochemistry-II | Theory | 30 | 70 | 4 |
| | PZOE 402 | Fish & Fisheries-II | | | | |
| | PZOE 403 | Mammalian Reproductive Biology-II | | | | |
| Research Project | | | | ……. | ……. | **4** |
| | | **Total** | | **120** | **280** | **20** |

SEMESTER-IV

**PZOC 401: Molecular Biology**
**Total marks: 70+30 = 100**
**Credit=04 (70 lectures)**

## Course objective:

- The discipline particularly seeks to understand the gnome organisation of the organisms and other molecular processes through which it could be understand how the different traits are carried to the next generations and how they are regulated.
- The main motive of this discipline is to understand about the different properties of the biomolecules and anabolic processes. Moreover, to have a deep idea about the natural catalyst.

## Learning outcomes:

- By studying the course, the students will have a clear idea about different metabolic events along with their regulation and also will have the knowledge on the genetic material and the role of different molecular processes inside the body.

## Course content:

**UNIT 1:** DNA and RNA as the genetic material, Physico-chemical properties of DNA. Organization of genome in prokaryotes and eukaryotes. Structure and forms of eukaryotic DNA, Chromatin structure & nucleosomes, DNA supercoiling,

**UNIT 2:** DNA replication: mechanism of replication in prokaryotes & eukaryotes, Enzymes in replication. DNA Recombination: Molecular basis of recombination and genetic exchange, Chimeric DNA; Enzyme in recombination, homologous and site -specific recombination; DNA methylation.

**UNIT 3:** Transcription: RNA Polymerases in eukaryotes and prokaryotes; Types of RNA; Transcription in prokaryotes and eukaryotes, RNA processing and splicing; Catalytic RNA. Reverse transcription and its significance

**UNIT 4:** Translation: Genetic code, Role of Ribosome and tRNA; Elongation and Termination in Prokaryote and Eukaryote. Genetics of Virus: Double and single standard DNA and RNA virus Gene mutation and type. Mutagenesis: Type of mutation, molecular basis of mutation DNA damage and repair site directed mutagenesis. Regulation of gene expression in prokaryotes: Operon concept, Attenuation and antitermination

## Practical:

1. Isolation of Human Genomic DNA from Blood.
2. Genomic DNA isolation using phenol extraction method
3. Detection of DNA and RNA from histochemical slides
4. Demonstration of PCR / ELISA
5. SDS PAGE, Western blot

## Reference Book:


- Alberts et al: Molecular Biology of the Cell (4th Ed.),
- Garland, 2002 8. A. Paul: Cell and Molecular Biology, Books and Allied(P) 2nd Ed. (2009)
- Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
- DeRobertis & DeRobertis: Cell & Molecular Biology, Lea &Febriger,1987
- Friefielder: Molecular Biology
- Darnell, Lodish and Baltimore: Molecular cell biology (Scientific AmericanBooks)
- H.D. Kumar: Molecular biology
- W.H. Elliot and D. C. Elliot: Biochemistry and molecular biology by (OU Press)
- Lehninger's Principles of Biochemistry, Nelson and Cox, Sixth Edition or recent edition, Macmillan Press.
- Principles of Biochemistry, Voet, Voet and Pratt, 5th edition (2012) or recent edition, Wiley.
- Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.
- Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge [Latest edition].

SEMESTER-IV

**PZOC 402: Cell Biology and Inheritance Biology**
**Total marks: 70+30 = 100**
**Credit=04 (70 lectures)**

## Course objective:

- This course aims to provide a detailed understanding of cell biology covering about the dynamicity of cell, cell communications, cell signalling, cell cycle and details about cancer cell and apoptosis.
- Genetics is offered as a core course that provides fundamental knowledge of how organisms, populations and species evolve. Apart from Mendel's laws and basic genetics, at Master's level, this course will provide some of the most incisive analytical approaches that are now being used across the spectrum of the biological disciplines. Overall, this course will highlight extension of Mendelian Genetics, dosage compensation, evolution of the concept of gene and its amalgamation with molecular biology and study of genetic diseases.

## Learning outcome:

- Upon completion of this course students should be able to understand and interpret the dynamicity of cell. They will also have a clear knowledge about the cell communication and signalling, protein sorting and transport and also have a profound knowledge on cancer and apoptosis.
- Genetics will open several avenues for students in terms of research and employability.
- Genetics has made extensive use of model organisms, many of which will be used to teach this course. By observing genetic mutations in Drosophila, students can correlate phenotype with genotype, understand genetic interaction and their molecular basis.

## Course content:

**UNIT I**: cell-cell communications and Cellular processes: Role of different adhesion molecules: Desmosomes, Hemi-desmosomes, Gap junctions, Tight Junctions, Plasmodesmata. Organelle Interconnectivity and communications: cell division: mitosis, meiosis and cytokinesis, cell differentiation: Introduction to stem cells, Molecular mechanisms of membrane transport active, passive, facilitated Cell signaling: Hormones and their receptors, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, Tyrosine kinase; MAP kinase cascade, STAT.

**UNIT 2**: Regulation of cell cycle: Discovery of MPF, cyclins and cyclin dependent kinases, Check points- role of Rb and p53, apoptosis. Neurotrophic factors, caspases, pathways of apoptosis. Cell Cycle misregulation and cancer: Cancer. Types and stages, Tumor suppressor genes and protooncogenes. Molecular basis of cancer, cell senescence

**UNIT 3:** Mandelian Laws: Gene interaction; Extension of Mendelism -Dominance relationship, epistasis, pleiotropy. Expressivity and penetrance. Sex determination and Sexlinked inheritance; Studies on metaphase chromosomes; linkage, crossing over and recombination Multiple allelism, pseudoallelism, polygenic inheritance/ interaction

Extranuclear inheritance; mutations in mitochordial DNA

**UNIT 4:** Numerical & structural Changes in chromosomes (aneuploidy, euploidy, auto and allo polyploidy); chromosome anomalies & diseases; Human genome project: History, Organisation, Goal & characterization of chromosomes Drosophila embryogenesis & development; Zygotic genes and segment formation in drosophila Development of *Caenorabditis elegans*: genetic analysis of vulva formation

## Practical:

1. Preparation of meiotic/ mitotic chromosomes from grasshopper /tadpole /rat /onion root tip
2. Microtome: Preparation of permanent slide
3. Vital staining of mitochondria
4. Chromosomal aberration in human buccal epithelium of smokers
5. Study of sex chromatin from buccal epithelium
6. Study of polytene chromosome in drosophila larva

## Reference Book:


- Lodish et al: Molecular Cell Biology (Freeman, 2000)
- Pollard & Earnshaw: Cell Biology (Saunders, 2002).
- Alberts et al: Molecular Biology of the Cell (4thEd.), Garland, 2002
- A. Paul: Cell and Molecular Biology, Books and Allied (P) 2nd Edn. (2009)
- Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
- De Robertis & De Robertis: Cell & Molecular Biology, Lea &Febriger,1987
- Principles of Genetics, Snustad and Simmons, John Wiley & Sons, USA [Latest edition].
- Modern Genetic Analysis: Integrating Genes and Genomes, Griffiths, J.F., Gilbert, M., Lewontin, C. and Miller, W. H. Freeman and Company, New York, USA [Latest edition].
- Genetics, J. Russell, Benjamin-Cummings Publishing Company, San Francisco, California, USA [Latest edition].

SEMESTER-IV

**PZOC 403: Physiology and Immunology**
**Total marks: 70+30 = 100**
**Credit=4 (70 lectures)**

## Course objective:

- The main objective of this study is to know about the different biological processes and how they perform their functions and their regulations. It will also provide a better understanding on cellular immunology i.e. how the body fight against different pathogens.

## Learning outcomes:

- The students at the completion of the course will learn to develop a better understanding of various physiological processes of human body and how these processes are corelated with each other.
- They will also gain a better knowledge on Immunology. How the body react with the pathogens and what are the mechanisms through which the body can mitigate the pathogenicity.

## Course content:

**UNIT 1:** Physiology of digestion and absorption of Macronutrients, balance diet structure of GI tract: Gastro intestinal hormones and functions, Pattern of nitrogen excretion, Urea synthesis and formation of urine, Counter current mechanism and hormonal regulation of excretion. Thermoregulation, hibernation in vertebrates, Physiology of Bioluminescence in invertebrates (Firefly) & vertebrates.

**UNIT 2:** Physiology of Reproduction in insects, sexual dimorphism, parthenogenesis, Physiology of Reproduction in vertebrates: seasonal and nonseasonal breeders, Reproductive cycles, spermatogenesis & Oogenesis Physiology of respiration: Transportation of Oxygen and CO2, acid base balance, Nerve impulse conduction through neurons and synapse, neuromuscular junctions.

**UNIT 3:** Antigen: chemical nature, and antigenic determinants Antigen-antibody binding sites and reaction Immunoglobulin heterogeneity-Allotype, idiotype Antigen and Immunogen, Hapten, Adjuvant- properties and mechanism of action Complement system activation: classical and alternate pathways.

**UNIT 4:** Cellular immunity: origin and maturation of T & B lymphocytes & their functions T-cell activation- molecular mechanism Allograft reaction, prevention of graft rejection Hybridoma and monoclonal antibodies-applications and therapeutic uses Hypersensitivity and autoimmunity-factors responsible for autoimmunity Histocompatibility antigen (MHC)-structure, Biological significance of HLA antigens.

## Practical:

1. Identification of histological slides of liver, pancreas, lung, stomach, kidney
2. Haemocyte count and estimation of protein in hemolymph.
3. Haemoglobin estimation of human blood.
4. Total RBC and WBC count in human blood.
5. Study of haemin crystal
6. Identification of histological slides of lymphoid tissue: a) Spleen b) Thymus c) Lymph node d) Bone marrow
7. Demonstration of ELISA and RIA.
8. Haemagglutination

## Reference Book:


- Guyton A, C & Hall, J. E. Textbook of Medical Physiology, XI Ed. W. B. Saunders Co.
- Tortora G. J. & Grabowski S. Principles of Anatomy & Physiology, XI Ed. John Wiley & Sons
- Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology, 3rd Ed. Pearson Education.
- Hill Richard W., et al., Animal Physiology, Vol. 2 Sunderland, M A: Sinauer Associates
- Chatterjee C C, Human Physiology Vol. 1 &2 CBS publication
- Kuby, W. F. Freeman, Immunology, U.S.A
- W. Paul, Fundamentals of Immunology

SEMESTER-IV

**ELECTIVE COURSE**
**PZOE 401: BIOCHEMISTRY-II**
**(Molecular Biochemistry)**
**Total marks: 70+30 = 100**
**Credit=4 (70 lectures)**

## Course objective:

- The discipline particularly seeks to understand the molecular basis of genetic processes; molecular biologists map the location of genes on specific chromosomes, associate these genes with particular characters of an organism.

## Learning outcomes:

- Students will Recognize and interpret the structural and functional aspects of molecules and their interactions that give rise to the supramolecular complexes such as organelles and cells and how those complexes function within organisms.

## Course content:

**UNIT 1:** Metabolism of Purines and Pyrimidines, its regulation, Organisation of DNA in chromosomes, Molecular structure, physico-chemical properties of DNA, DNA-replication, DNA polymerase in Prokaryotes and Eukaryotes, DNA sequencing, satellite DNA, Palindrome sequences, repetitive DNA.

**UNIT 2:** Types of genes: Split genes, Overlapping genes, pseudogenes, transposable genes and transposons, plasmids, Regulation of prokaryotic gene expression - inducible and repressible operon systems; Regulation of gene expression at transcription and translation level in eukaryotes, gene silencing and gene imprinting

**UNIT 3:** Transcription of RNA, sense and antisense strand, RNA polymerase in Prokaryotes and Eukaryotes, types and functions of RNA, RNA processing, spliceosome, catalyzed RNA splicing, Ribozyme, RNA editing, RNA sequencing. Reverse transcriptase and its significance

**UNIT 4:** DNA damage and repair; Alterations in DNA molecule, repair of incorrect bases, repair of thymine dimmers, recombination repair, SOS repair.

## Practical:

1. Estimation of RNA
2. Estimation of DNA
3. Estimation of protein
4. Separation of proteins using SDS-PAGE.
5. Isolation of DNA from biological samples.
6. Restriction digestion analysis of DNA using agarose gel electrophoresis

**Reference Book:**


- G. M. Cooper and R. E. Hausman: The Cell, A Molecular Approach. 5th Ed. ASM Press (2009)
- Bostock & Sumner: Eukaryotic Chromosome (North-Holland,1987)
- Karp: Cell and Molecular Biology (John Wiley & Sons, 2002)
- Lewin, Genes VIII (Wiley, 2004)
- Lodish et al: Molecular Cell Biology (Freeman, 2000)
- Pollard & Earnshaw: Cell Biology (Saunders, 2002).
- Alberts et al: Molecular Biology of the Cell (4thEd.), Garland,2002
- A. Paul: Cell and Molecular Biology, Books and Allied (P) 2nd Edn. (2009)
- Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
- DeRobertis & DeRobertis: Cell & Molecular Biology, Lea &Febriger,1987
- Friefielder: Molecular Biology
- Darnell, Lodish and Baltimore: Molecular cell biology (Scientific American Books)
- H.D. Kumar: Molecular biology
- W.H. Elliot and D. C. Elliot: Biochemistry and molecular biology by (OU Press)

SEMESTER-IV

**ELECTIVE COURSE**
**PZOE 402: FISH & FISHERIES-II**
**Total marks: 70+30 = 100**
**Credit=4 (70 lectures)**

## Course objective:

- To understand the ecology of the pond and have a better knowledge on fish culture and management of the fish culture.
- To Understand Modern technologies application if pisciculture.

## Learning outcomes:

- Students will have a deep knowledge on the culture and management of fish culture.
- Students will also understand about modern technologies used in pisciculture and can persue the application of the same.

## Course content:

**UNIT 1:** Induced breeding: Purpose, technique of induced breeding, influence of abiotic factors, Recent advances in induced breeding; Concept of hatchery, designing of Chinese and cemented hatchery, management of hatcheries.

**UNIT 2:** Construction and layout of fish ponds: Classification of ponds, choice of ground – topographical conditions, quality of water requirement, installation planning; Layout of the pond bottom, the dyke, draining installation bypass channel, water inlet. Reclamation of swamps. Ecology of fish pond: Abiotic and biotic components; Food chain; Concept of productivity, methods of measuring productivity.

**UNIT 3:** Predatory and weed fishes and their control; Fertilization, aquatic insects and their control; principle of fish feed formulation, preparation and mode of fish feed storage, use of unconventional feed as source of nutrients Supplementary feeding.

**UNIT 4:** Culture of air-breathing and other predatory fish (*Clarias Heteropneustes, Anabas, Monopterus, Pangasius* and *Ompok*), Integrated aquaculture (paddy cum fish culture; duck-cum and pig-cum fish culture); Culture of pearl and frog; sewage fed fisheries;; Rearing techniques and production in sewage ponds.

**UNIT 5:** Fish stock improvement through selective hybridization; Androgenesis and gynogenesis; polyploidy; Sex reversal and sterility; Transgenesis; Cryopreservation of gametes and embryos, Principles of economics as applied to aqua products;

## Practical

1. Induced breeding experiment in fish.
2. Histological study of guts/gonads
3. Preparation of fish weed using locally available feeding redients
4. Mounting of the following materials: Cypris, Daphnia, Diatoms, Ctenoid, Cycloid, Placoid and Rhomboid scales, Spirogyra, Nostoc, Navicularia.
5. Collection of fish parasites, their mounting, and identification.
6. Study of commonly used fishing gears.
7. Determination of age in fishes.
8. Identification of permanent slides.

## Reference Book:


- Freshwater fish pond culture and management Marilyn Chakroff
- Fish ponds in Farming Systems. 2007. Zijpp, V. D., Verreth, J. A. J., Tri, L. Q., van Mensvoort, M. E. F., Bosma, R. H., and Beveridge, M. C. M. Wageningen AcademicPublishers, Netherlands.
- Aquaculture Principles and Practices. 2005. Pillay, T. V. R. Second edition, Blackwell Publishing, USA.
- Aquaculture and Fisheries Biotechnology Genetic Approaches. 2011. Dunham, R. A. CABI Publishing, USA.

SEMESTER-IV

**ELECTIVE COURSE**
**PZOE 403: Mammalian Reproductive Biology-II**
**Total marks: 70+30 = 100**
**Credit=4 (70 lectures)**

## Course Objective:

The primary objectives of this course are to enable postgraduate students to:

- Develop a comprehensive, mechanistic understanding of the neuroendocrine regulation of reproduction, from the molecular pathways of steroidogenesis to the complex physiology of implantation, gestation, and parturition across human and domestic animal models.
- Critically assess the physiological principles, efficacy, and risks of fertility control methods, alongside the etiology, diagnostic parameters, and clinical implications of major structural, infectious, and oncological disorders of the reproductive tract.
- Explore, critique, and synthesize traditional Indian knowledge systems (IKS) regarding reproductive health, identifying the pharmacological potential of ethnomedical plants and validating traditional maternal-neonatal dietary and care frameworks through a contemporary scientific lens.

## Learning outcomes:

- By the end of this course, students will be able to learn the **Mechanisms &** Explaination of the neuroendocrine control of the HPG axis, steroidogenesis, and comparative gestational/parturition physiology across mammalian species., **Pathologies:** Differentiate the clinical presentation, etiology, and oncological progression of major reproductive tract disorders and fertility control methods, **Integration:** Synthesize traditional Indian Knowledge System (IKS) protocols regarding maternal-neonatal care and ethnopharmacology with modern obstetrical science.

## Course content:

**Unit 1**: Reproductive Endocrinology: Hypothalamo-pituitary-Gonadal axis, Gonadotropins and steroid hormones: Regulation of Goadotropin secretion in female and Male, Steroidogenesis, regulation of tissue receptors of steroids, Implantation: Peri-implantation

period, Uterine control of implantation, Pregnancy: Maternal Endocrine support of Pregnancy in human and other species (Horse, Sheep, Cow, Pig), amniocentosis, Parturation: Uterine Cervix, Prostaglandins, Oxytocin, Relaxin, Labour, Fetal monitoring and Caesarian section, Birth and lactation.

**Unit 2**:Artificial Control of fertility: Contraception, Steroidal Contraception risks versus effectiveness. Disorders of female tract: Adenomyosis, Endometriosis, fibroids, Anovulation, chronic infection of uterus, congenital uterine anomalies; Ovarian cysts, pelvic varicosities, Cancers of the reproductive system,

**Unit 3:** Foundations of Reproductive Health in Indian Knowledge System: Medicinal plants traditionally associated with reproductive health and fertility, Maternal and neonatal care described in traditional literature, Dietary recommendations during Pregnancy and lactating mother.

## Practical

1. Study of Uterine histological sections from photomicrographs/ permanent slides of Mouse/Rat during Periimplantation period.
2. Study of modern contraceptive devices.
3. Histological tissue processing of mouse Uterus and Ovary.
4. Study the Sperm vitality using Eosin Nigrosin Stain.
5. Report Submission on ethnobiological practices / literature on traditional medicinal plants used in reproduction regulation.

## Reference Book:


- Gary C.S.; Steven B.B.; Philip R.B. and Philippa H.F. (2014) Larsen's Human Embryology (5 th edition) Elsevier.
- Gilbert, S.F. (2016) Developmental Biology (11 th edition) Sinauer.
- Knobil, E. et al.(eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.
- Johnson, M.H. (2018). Essential Reproduction, Wiley-Blackwell, 8th Edition.