Syllabus for
B.Sc. Zoology (UG)
Madhabdev University

Framed According to the National Education Policy (NEP 2020)

Implemented from the Academic Year 2022-2023

Preamble:

Institutional infrastructures of colleges and universities within the country are incomparable and uneven, and they function with an additional variation of adopting different road maps for the teaching and learning process. Thus, we have different syllabi, teaching methods, hands-on training, and different learning outcomes. Introducing uniformity, whenever and wherever tried, has obviously not worked with the desired outcome. Added to this, failure to keep pace with the advancing knowledge base, half-hearted engagement and integration with other disciplines, and poor transfer of skill sets to the students to negotiate efficiently with the changing needs have made it essential to graduate from incremental inputs to syllabi revisions alone, to the use of disruptive approaches to reshape the subject-specific course structures, with measurable learning outcomes. The approach, if adopted, is bound to generate opinions of teachers and students alike to resist the change. However, the intention is to understand the subject of Zoology in the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. The syllabi could be shaped with a customised approach depending on the institutional infrastructure and geographical location, yet it should cater, in principle, to the expected learning outcomes more or less uniformly. For example, in diverse geographical domains with diverse skill sets, examples illustrated in detail for teaching and hands-on exposure and fieldwork could differ by involving the study of available species across the ladder of evolution, yet the comparative biology taught should provide a uniform level of understanding of the subject. After all, the purpose is to understand the inner workings of living beings by comparing various systems within invertebrates and vertebrates, i.e., from a single- cell protozoan to multicellular humans, and develop a comprehensive understanding and appreciation of the differences through ICT tools and well-designed hands-on practical exposures along with fieldwork. Added to this, if the same principle is followed to understand different phyla through the ladder of evolution and compare cardinal features for classification involving both morphological and molecular tools, along with associated field and lab work, the final product would be better trained without rote learning. Diversity in the life forms needs to be understood by a Zoologist for its socio-economic capital, in case a student is interested in entrepreneurship, through applied aspects of Zoology; and by a career-

7 researcher as a ladder towards multiscale hierarchical systems, where chemical and physical principles would apply from molecules to self-assembled and organised organisms. The ability to synthesise out of the knowledge gained and come out with disruptive outcomes would define the learning outcomes of the future UG and PG students. Apart from the above mentioned attributes expected of a UG/PG student related to the subject area of Zoology to be studied in an integrated and cross-disciplinary manner with a comprehensive understanding of all living systems, their relationship with the eco-system, and unravelling of their application value; the scale, character and rigour of which may vary from one institution to the other, it would, however, be mandatory to bring in uniformity in the learning outcomes
with respect to the 'broad-range skill sets' related-to-the-discipline of the study and the 'Social skills'. Within the broad-range skill sets related to the discipline, what would be required is to impart and assess the quality of critical thinking, analytical and scientific reasoning, reflective thinking, information and digital literacy, and problem-solving capacity. These are part of the defined characteristic attributes to be demonstrated by a UG/PG in any discipline, as defined by the Core Committee on LOCF of UGC. On similar lines, what is expected of social skills is to imbibe values for cooperative teamwork, moral and ethical awareness and reasoning, multicultural competence, leadership readiness and qualities and a self-directed and lifelong learning attitude. Again, this has been a general guideline defined by the UGC Core Committee. It is obvious that all of us together need to meet the challenge to bring in these attributes within each subject area of study, in the present case the subject of Zoology. As regards the fine nuances of how to organise the course structure in Zoology and Aquaculture (the latter being a part of the subject of Applied Zoology, may not necessarily require separate emphasis) within the framework of expectations of the learning outcome, I provide a few steps of specific details for general debate and course corrections, wherever required.

Specific Details:

Background: Students should be equipped to identify the major groups of organisms, discuss the basis of their biodiversity and draw parallels with their phylogenetic relationship, using well-thought-out cardinal features of classification on the basis of morphology and molecular information wherever available. This principle of comparative biology should be followed in understanding comparative anatomy, physiology and other functions for all in the hierarchy of animal evolution, instead of dealing with each phylum/order/species and each system as a stand-alone. This shall allow the student to gain comprehensive knowledge about

different animal species in one go, appreciating the differences and similarities, thereby achieving proficiency in handling them experimentally or for research purposes. This would also reduce the burden of teaching on mentors, though initially a little hard work to shape the contents of the curriculum is required. Teachers would need to be trained for the same as well for a uniform approach to deliver and communicate. A comprehensive knowledge of structure-function relationships at the level of gene, genome, cell, tissue, organ, and systems, through development, would further add to the knowledge base and the learning outcome in terms of editing of genes and genomes for industrial application and research purposes. Short dissertations could be designed around these problems to give them hands-on training and equip them with skill sets of use in future, in the areas of applied aspects of Zoology, including Aquaculture. Details of the course content in an integrated fashion to cut down on some of the individual lectures would be designed by the members of the committee for further feedback to shape the syllabi better for both UG and PG students, to be monitored for the outcomes through the innovative processes of learning efficiently and effectively.

Introduction

Zoology deals with the study of the animal kingdom, especially the structural diversity, biology, embryology, evolution, habits and distribution of animals, both living and extinct. As it covers a fascinating range of topics, modern zoologists need to have insight into many disciplines. The learning outcomes-based curriculum framework for a B.Sc. degree in Zoology is designed to cater to the needs of students in view of the evolving nature of animal science as a subject. The framework is expected to assist in the maintenance of the standard of Zoology degrees/programmes across the country by reviewing and revising a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework, however, does not seek to bring about uniformity in syllabi for a programme of study in Zoology, or in the teaching-learning process and learning assessment procedures. Instead, the framework is intended to allow for flexibility and innovation in programme design and syllabi development, teaching-learning process, and assessment of student learning levels.

Learning Outcomes based approach to Curriculum Planning

The courses should be delivered in terms of concepts, mechanisms, biological designs & functions and evolutionary significance cutting across organisms at B.Sc. level. These courses should be studied by students of all branches of biology. Both chalk and board, and PowerPoint presentations can be used for teaching the course. The students should do the dissertation/ project work under practicals of different courses, wherever possible. The students are expected to learn the courses with excitement about biology along with the universal molecular mechanisms of biological designs and their functions. They should be able to appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realise how contributions from research and innovation have made the subjects modern, interdisciplinary and applied and laid the foundations of Zoology, Animal Sciences, Life Sciences, Molecular Biology and Biotechnology. These courses and their practical exercises will help the students to apply their knowledge in future courses of their career development in higher education and research. In addition, they may get interested in looking for engagements in industry and commercial activities employing Life Sciences, Molecular Biology and Biotechnology. They may also be interested in entrepreneurship and start some small business based on their interest and experience

Learning Outcomes in Bachelor's Degree programme in Zoology

Knowledge and Understanding

• Demonstrate

(i) in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying the academic field of Zoology and its different subfields (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases, apiculture, aquarium fish keeping, medical diagnostics, and sericulture)

(ii) Procedural knowledge that creates different types of professionals in the field of Zoology and related fields such as apiculture, aquarium fish keeping, medical diagnostics, and sericulture, etc.

(iii) Skills related to specialisation areas within Zoology as well as within subfields of Zoology, including broader interdisciplinary subfields (Chemistry, Physics and Mathematics).

(iv) Over the years, Zoologists were able to find many differences within the same breed of an animal species.

(v) As a Zoology professional, one can study extinct animals by specialising in Paleozoology, on the different types of birds in Ornithology; opt for studying.

(vi) Herpetology and Arachnology, the branches dealing with the study of snakes and spiders, respectively or appreciate the complexity of life processes, their molecular, cellular and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.

(vii) Study concepts, principles and theories related to animal behaviour and welfare.

(viii) Understand and interpret data to reach a conclusion

(ix) Design and conduct experiments to test a hypothesis.

(x) Understand scientific principles underlying animal health, management and welfare.

(xi) Accept the legal restrictions & ethical considerations placed on animal welfare.

(xii) Understand fundamental aspects of animal science relating to management of animals.

(xiii) Assess problems and identify constraints in management of livestock.

Subject Specific Intellectual and Practical Skills

The students will be able to understand how organisms are classified and fully identified

- Demonstrate knowledge of basic zoological principles
- Use appropriate information with a critical understanding
- Learn basic laboratory and analytical skills
- Use effective methods for modifying animal behaviour

- ❖ Participate in animal management programmes in an effective manner
- ❖ Work safely and effectively in the field, in laboratories and in animal facilities
- ❖ Demonstrate competence in handling and statistical analysis of data gained from practical
- ❖ Learn communication and IT skills, including the collation and statistical analysis of data, citing & referencing work appropriately, communicating using a range of formats in course learning outcomes.
- ❖ The student will attain subject knowledge in terms of individual course as well as holistically.

SYLLABUS

Department of Zoology

MADHABDEV UNIVERSITY

FYUGP 2024/2026

1. Aims of Four Year Under-Graduate Programme (FYUGP) in Department of Zoology, Madhabdev University:

- ➢ To introduce the students to the diverse animal kingdom.
- ➢ To enable the students to explore the biodiversity and help in conservation.
- ➢ To develop capabilities of students for critical evaluation of contemporary issues related to environment and sustainable development.
- ➢ To generate skilled human resource for biological entrepreneurship.

2. Graduate Attributes of the FYUGP in Zoology:

Disciplinary Knowledge:

The graduates should have the ability to demonstrate comprehensive knowledge and understanding of both the theoretical and applied components of animal science and allied areas of study in a multidisciplinary context. Students should have the ability to connect relevant disciplines and recent trends in biological and contemporary issues. **Communication Skills**

The graduates in Zoology should have the ability to present and express information, thoughts, experiments and results clearly and concisely for effective communication of any issues related to animals.

Moral and Ethical Awareness/Reasoning

Ability to recognise ethical issues that are pertinent to one's work and pledge not to engage in unethical behaviour such as plagiarism, copyright and infringement of intellectual property rights; ability to appreciate recent developments in various fields and one's research with honesty and integrity in all aspects.

Multicultural Competence

Ability to correlate and compare recent developments in various branches of plant science worldwide; ability to collaborate in research in various fields of biology with other researchers from allied organisations; acquisition of knowledge on traditional practices of different ethnic communities.

Information/Digital Literacy

The graduates of Zoology should have the ability to utilise Information and Communications Technology (ICT) tools, biological databases and computer software in solving biological problems.

Reflective Thinking and Problem Solving:

After completion of graduation in Zoology, the students will be able to understand the value of animal resources, the need for conservation, bio-prospecting and sustainable utilisation of resources for human welfare.

Critical thinking: Graduates of Zoology should be competent for critical analysis of problems related to biology, sustainable uses of biological resources and their conservation strategies.

3.0 **Programme Learning Outcome P.O.**

- Knowledge on diversity of animals, their importance and strategies for conservation.
- Scientific approach to address problems in biology and sustainable use of resources for human welfare.
- 3. Application of knowledge and skills in entrepreneurship.
- 4. Develop new techniques/methods for solving the problems of the allied disciplines.

4.0 Teaching Learning Process

The programme allows using varied pedagogical methods and techniques both within the classroom and beyond.

- Lecture
- Tutorial
- Power-point presentation

- Documentary film on related topic
- Project Work/Dissertation
- Group Discussion and debate
- Seminars/workshops/conferences
- Field visits and Report/Excursions
- Mentor/Mentee

5.0 Teaching Learning Tools

- White/ /Black Board
- Projector
- LCD Monitor

6.0 Assessment

- Home assignment
- Project Report
- Class Presentation: Oral/Poster/Power point
- Group Discussions
- In-semester examinations
- End Semester examinations

FYUGP Structure as per UGC guidelines of NEP-2020

Outline of UG Syllabus (NEP)

Total Credits to Complete During the Programme: 174

COURSES OFFERED IN UG (NEP) PROGRAMME OF ZOOLOGY

Semester	Course	Credit	Total Marks (TH+ PR+IA)
I	ZooM101: Animal diversity, Non-Chordates.	4	70 + 30 =100
	ZooN101: Animal Diversity, Non-Chordates	4	

			70 + 30 =100
II	ZooM201: Animal Diversity, Chordates.	4	70 + 30 =100
	ZooN201: Animal Diversity, Chordates	4	70 + 30 =100
III	ZooM301: Comparative Anatomy of Vertebrates.	4	70 + 30 =100
	ZooM302: Physiology: Controlling and Coordinating System.	4	70 + 30=100
	ZooN301: Comparative Anatomy of Vertebrates.	4	70 + 30=100
IV	ZooM401: Fundamentals of Biochemistry	4	70 + 30 =100
	ZooM402: Taxonomy and Biostatics.	4	70 + 30=100
	ZooM 403: Principles of Ecology	4	70 + 30=100
	ZooM404: Animal Physiology: Life Sustaining System.	4	70 + 30=100
	ZooN401: Fundamentals of Biochemistry	4	70 + 30 =100

V	ZooM501: Endocrinology. ZooM502: Cell Biology ZooM503: Molecular Biology ZooM504: Animal Behaviour. ZooN501: Endocrinology.	4 4 4 4 4	70 + 30 =100 70 + 30=100 70 + 30=100 70 + 30 =100 70 + 30 =100
VI	ZooM601: Principles of Genetics. ZooM602: Immunology ZooM 603: Developmental Biology ZooM604: Parasitology. ZooN605: Principles of Genetics.	4 4 4 4 4	70+30 =100 70 + 30 =100 70 +30 =100 70 +30 =100 70 +30 =100

Detailed syllabus of 1st semester

Title of the paper: DIVERSITY OF NON-CHORDATES

Course code: ZOOM101/ZOON101

Nature of course: Major/Minor

Total credit: 4

(60 Lectures, 52 Marks)

Course Objectives:

- To introduced the concept of various types of non chordates
- To explain the classification
- To analyzed the structural anatomy and physiology of different types

THEORY

Unit 1: (12 Lectures, 12 Marks)

Protista, Porifera and Metazoa : General characters and classification up to classes of Protista, Porifera and Metazoa Nutrition and Locomotion Protozoa. Canal system of Porifera. Symmetry and segmentation in Metazoa. Polymorphism in Cnidaria. Coral and Coral Reefs. General characters and evolutionary significance of Ctenophora.

Unit 2: (12 Lectures, 10 Marks)

Helminthes: General characters of Platyhelminthes and Nematohelminthes. Life cycle of *Taenia solium.* Parasitic adaptation in Helminthes. Annelida: General characters and classification up to classes. Excretion in Annelids.

Unit 3: (12 Lectures, 10 Marks)

Arthropoda: General characters and classification up to classes. Metamorphosis, Mouth parts and social life in insects (Bee and Termite).

Unit 4: (12 Lectures, 10 Marks)

Mollusca: General characters and classification up to classes. Respiration in Mollusca. Pearl formation. Evolutionary significance of trochophore larva.

Unit 5: (12 Lectures, 10 Marks)

Echinodermata: General characters and classification up to classes. Water vascular system and larval forms of Echionoderms. Affinities with chordates.

Practical: (18 Marks)

1. Identification and study the following specimens: Euglena, Paramecium, Sycon, Obelia, Physalia, Tubipora, Gorgonia, Madrepora, Fasciola, Taenia, Ascaris, Nereis,

Heteronereis, Chaetopterus, Hirudinaria, Limulus, Palaemon, Daphnia, Balanus, Julus, Honey bee, Bombyx, Peripatus, Chiton, Dentalium, Pila, Unio, Asterias.

2. Study of excretory system of earthworm.
3. Study the mouth parts of Insects.
4. Dissection of digestive system of Cockroach.
5. To submit a life cycle any invertebrate species

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 the completion of this course, the learner will be able to:
- Understand the different groups of animals under non-chordates and their importance.
- Understand the zoogeographical distribution of animals
- Analyze and examine the structural differences between different groups of animals.

Reference book

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
- 3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press. 5. Pough H. Vertebrate life, VIII Edition, Pearson International

Detailed syllabus of 2nd semester

Title of the paper: **ANIMAL DIVERSITY: CHORDATEs**

Course code: ZOOM 201/ZOON201
Nature of course: Major/Minor
Total credit: 4
(60 lectures 52 Marks)

COURSE OBJECTIVES: -

- To introduce the concept of various forms of chordates and non-chordates –
- To explain their classification -
- To analyze their structural anatomy and physiology

THEORY

Unit 1: (12 Lectures, 12 Marks)

Proto chordate and Chordate: General characteristics of Proto chordate and chordates Study the larval forms in protchordates. Retrogressive metamorphosis in urochordate. Affinities of protochordate. Ammocoete larva and its significance.

Unit 2: (12 Lectures, 10 Marks)

Pisces and Amphibia: General character and classification fishes and Amphibia. Migration Accessory respiratory organs and parental care in fishes. Metamorphosis, Neoteny and parental care in Amphibia

Unit 3: (12 Lectures, 10 Marks)

Reptilia: General characteristics and classification up to orders. Poison apparatus and biting mechanism of snakes. Distinctive features of poisonous and non poisonous snakes. Affinities of sphenodon .

Unit 4: (12 Lectures, 10 Marks)

Aves: General characteristics and classification up to orders. Flight adaptation. Perching mechanism and migration in birds.

Unit 5: (12 Lectures, 10 Marks)

Mammalia: : General characteristics and classification up to orders. Affinities of Prototheria (Monotremata). Adaptive radiation with reference to the locomotory appendages. Adaptation in aquatic mammals.

Practical: (18 Marks)

1. Identify the following Vertebrate species: Balanoglossus, Salpa, Petromyzon, Myxine, Scoliodon, Pristis, Torpedo, Mystus, Heteropneustues, Lebeo, Exocoetus, Hippocampus, Cryptobranchus, Axolotol larva, Ambyostoma, Necturus, Hyla, Chelone, Trionyx, Draco, Viper, Naja, Hydrophis, Columba, Chiroptera.
2. Dissected and display the following Vertebrate species: Internal ear of scoliodon and Weberian ossicles in carps.
3. Power Point presentation of two animals of the locality.
4. Submission of report on the adaptation of aquatic mammals

Reference book

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.

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 the completion of this course, the learner will be able to:
- Understand the different groups of animals under chordates and non-chordates and their importance.
- Understand the zoogeographical distribution of animals
- Analyze and examine the structural differences between different groups of animals.

Detailed syllabus of 3nd semester

Title of the paper: **COMPARATIVE ANATOMY OF VERTEBRATES**

Course code: ZOOM 301/ZOON301
Nature of course: Major/Minor
Total credit: 4
(60 Lectures, 52 Marks)

COURSE OBJECTIVES:

- To introduce and explain the anatomy of different systems in Vertebrates
- To analyze the structural modifications in anatomy of different groups

THEORY

Unit 1: (12 Lectures, 10 Marks)

Integumentary System: Structure, functions and derivatives of integument in different classes of vertebrates.

Unit 2: (12 Lectures, 10 Marks)

Skeletal System: Over view of skeleton in different classes of vertebrates.

Unit 3: (12 Lectures, 10 Marks)

Digestive system: Alimentary canal and associated glands, dentition in vertebrates.

Unit 4: (12 Lectures, 12 Marks)

Respiratory system: Skin, Gills, Lungs, and Air sac.

Unit 5: (12 Lectures, 10 Marks)

Circulatory system: General plane of circulation and structure of heart in vertebrates

PRACTICAL (18 Marks)

1. Study of cycloid, placoid and ctenoid scales of fish through permanent slides.
2. Temporary preparation of fish scales.
3. Identification of skeleton of frog, fowl and rabbit.Study the skull of different vertebrates.
4. Study the structure of stomach, heart, lungs, kidney through permanent slides or digital 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:

After the completion of this course, the learner will be able to: Analyze the modifications and anatomical relationship among the vertebrates.

Reference Book: -

- Comparative Anatomy of Vertebrates by RK Saxena - Anatomy of the Vertebrates by George C Kent
- Modern Textbook of Zoology by RL Kotpal

Detailed syllabus of 3nd semester

Title of the paper: A**NIMAL PHYSIOLOGY: CONTROLLIG AND COORDINATING SYSTEM**

Course code: **ZOOM302**
Nature of course: Major/Minor
Total credit: 4
(60 Lectures, 52 Marks)

Course objective:
Animal physiology examines how biological process function, how they operate under different environmental conditions and how these processes are regulated and integrated

THEORY

Unit 1: (12 Lectures, 10 Marks)

Histology: Structure and functions of epithelial and connective tissue. Histological structure of lungs, liver, stomach, intestine and kidney in mammals. Structure and types bone and cartilage.

Unit 2: (12 Lectures, 12 Marks)

Nervous system: Structure of neuron. Resting membrane potential. Origin of action potential and its propagation across the myelinated and non myelinated nerve fibers. Synapse, its type and synaptic transmission. Neuromuscular junctions.

Unit 3: (10Lectures, 10 Marks)

Muscular system: Ultra structure of skeletal muscles. Mechanism of muscle contraction ((molecular and chemical) Isometric and isotonic contraction.

Unit 4: (6 Lectures, 5 Marks) Reproductive system: histology of testis and ovary. Sexual cycle in human. Method of contraception in male and female.

Unit 5: (18 Lectures, 17 Marks)

Endocrine system: Histology of endocrine glands. Characters and classification of hormones. Regulation of hormone secretion. Mechanism of hormone action (steroid and non steroid hormone). Hypothalamus (neuroendocrine gland); neuroendocrine control of pituitary gland. Placentral hormone.

PRACTICAL (18 Marks)

1. Study of the permanent slides of vertebrate: skin, cartilage, bone, nerve cell, pituitary, pancrease, adrenal, thyroid, parathyroid, testis and ovary.
2. Microtomy: preparation of permanent slide of any (five) vertebrate tissues.
3. Preparation of temporary slide of squamous epithelium.
4. Recording of muscle twitch in frog with kymograph.
5. Demonstration of the unconditioned reflex action (knee jerk reflex).

Reference book:

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 the completion of this course, Students gain fundamental knowledge of animal physiology
- Seeks to understand the mechanisms that work to keep the animal body alive and functioning.
  - Interactions and interdependence of physiological and biochemical processes.
- Students are taught the detailed concepts of digestion, respiration, excretion, the functioning of nerves and muscles, cardiovascular system, endocrine system and reproductive system.

Detailed syllabus of 4rth semester
Title of the paper: **Fundamentals Biochemistry**

Course code: **ZOOM401/ZOON401**
Nature of course: Major/Minor
Total credit: 4
(60 Lectures, 52 Marks)

Course objective:

- To familiarize the students with major biomolecules namely carbohydrates, lipids, proteins and nucleic acids which are important for the structural organization and functions of the cells.
- Understand how the chemical properties of molecules determine the ways in which they interact and react with each other.
- Understand different types of chemical reactions and how they are used by living organisms

THEORY

Unit 1: (9 Lectures, 8 Marks) Fundamental Biochemistry: Principle and properties of Water, Acid, Base, pH and Buffer. Physiological buffer and redox system.

Unit 2: (10 Lectures, 10 Marks) Biomolecules: Composition, structure, classification and functions of Carbohydrates, Amino acids, Proteins, Lipids and Nucleic acid. Level of organization of protein and denaturation of proteins. Watson and Crick's model of DNA structure.

Unit 3: (10 Lectures, 10 Marks) Bioenergetics: Principles of Thermodynamics and their applications in Biological sciences. Free energy and free energy changes in biological systems. High energy compounds. ATP as energy currency of the cell.

Unit 4: (16 Lectures, 15 Marks)

Metabolic pathways: Glycolysis, Krebs cycle, Gluconeogensis, Cori Cycle, β-Oxidation, Amino acids catabolism (Transamination and Oxidative Deamination), Urea Cycle. Electron Transport Chain (ETC), ATP synthesis, Substrate level on Oxidative Phosphorylation

Unit 5: (15 Lectures, 9 Marks)

Enzymes: Biochemical properties protein and non- protein parts, classifications and nomenclature of enzymes. Mechanism of enzyme action, factor affecting enzyme activity Enzyme inhibition (Competitive and non-competitive)

PRACTICALS (18 Marks)

1. Preparation of molar, normal and buffer solution.
2. Qualitative test of carbohydrates, proteins and lipids.
3. Separation of amino acids by paper chromatography.
4. Estimation of protein by Lowry's Method.
5. To study the activity of enzyme urease by titrimatric method.
6. To study the activity of enzyme Trypsin and Lipase
7. Effect of pH and temperature on the action of Salivary amylase

Reference book:

- Satyanarayana, U. (2013). *Biochemistry*. Elsevier Health Sciences.
- Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.

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:

- Understanding of Biochemistry as a discipline and milestone discoveries in life sciences that led to establishment of Biochemistry as separate discipline.
- Fundamental properties of elements, their role in formation of biomolecules and in chemical reactions within living organisms.
- Understanding of the concepts of mole, mole fraction, molarity, etc. and to apply them in preparations of solutions of desired strengths.
- Unique property of water as a universal solvent and its importance in biological system

Detailed syllabus of 4rth semester
Title of the paper: **Taxonomy and Biostatics**

Course code: **ZOOM402**
Nature of course: Major
Total credit: 4
(60 Lectures, 52 Marks)

Course objective:

The goal of taxonomy is to classify species based on their shared traits and lineage. The primary goal of taxonomy is to recognise, characterise, classify, and name all living species based on their properties and 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

Theory

Unit 1: (12 Lectures, 10 Marks)

Introduction to animal taxonomy: Taxonomy and systematic. Hierarchy and system of classification. International Code of Zoological Nomenclature. Principles of zoological nomenclature. Concept of major and minor phyla in non-chordates.

Unit 2: (10 Lectures, 8 Marks)

Species: Concept of species. Types of species.

Unit 3: (12 Lectures, 10 Marks)

Fundamentals of biostatistics: Scope and application of statistics in biological sciences. Sources and classification of data. Sampling and sampling methods.

Unit. 4. **(12** Lectures, 10 Marks)

Organization and representation of data. Frequency distribution and its graphical representation(Histogram, Frequency Polygon, Pie Diagram, Frequency curve and ogive). Discrete and continuous frequency distribution. Concept and laws of probability.

Unit 5: (14 Lectures, 14 Marks)

Statistical measures and test of significance: Measures of central tendency(mean median and mode) and their applications. Measure of dispersion (mean deviation, standard deviation and coefficient of variation.) Correlation, test of hypothesis, standard error and test of significance.

PRACTICAL (18 Marks)

1. Study the morpho-taxonomic characters of locality available animals.
2. Graphical representation of given set of data.
3. Statistical calculation of central tendencies and deviation of discrete and continuous data.
4. Submission an assignment on graphical representation of central tendency/deviation/correlation of any set of data collected by student on field.

Reference Book

- Rosner, Bernard A. Fundamentals of biostatistics. Vol. 6. Belmont, CA: Thomson-Brooks/Cole, 2006.
- Bebchuk, J., & Wittes, J. (2012). Fundamentals of biostatistics (pp. 28-41). Cambridge University Press
- Lawrence, G. H. (1955). An introduction to plant taxonomy. Central Book Depot
- Manktelow, M. (2010). History of taxonomy. Lecture from Dept. of Systematic Biology, Uppsala University, 29..

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 complete the course the student to be an expert in a group is as much to know the topography of this information landscape as it is to be able to identify different organisms, At a fundamental level, students design robust studies, collect relevant data, perform statistical analyses and interpret the results

Detailed syllabus of 4rth semester
Title of the paper: **Principle of ecology**

Course code: **ZOOM403**

Nature of course: Major
Total credit: 4
(60 Lectures, 52 Marks)

Objective of course: The main aim of ecology is to understand the distribution of biotic and abiotic factors of living things in the environment. The biotic and abiotic factors include the living and non-living factors and their interaction with the environment.

THEORY

Unit 1: (12 Lectures, 10 Marks) **Ecosystem Structure:** Levels of organization in biosphere, concept of species, autecology and synecology, concept of ecosystem; biotic components of ecosystem; study of abiotic components (Physical and chemical factors) and their affect on living organisms; Liebig – Blackman law of limiting factors; Sheford's law of tolerance; major types of ecosystems and biomes of the world.

Unit 2: (12 Lectures, 10 Marks) **Ecosystem function:** productivity, flow of energy through ecosystems, food chain (detritus and gazing), food web and ecological pyramids, nutrient and biogeochemical cycles (carbon and nitrogen cycle); biotic interactions (intraspecific and interspecific), concept of habitat; niche and its types; Gause's principle

Unit 3: (12 Lectures, 10 Marks) **Population ecology:** Unitary and modular populations, population density, natality and mortality, life tables, survivorship curves, age distribution and age pyramids, dispersion; growth forms of population (exponential and logistic growth); biotic potential and carrying capacity, r and k strategies; Lotka-Voltera equation.

Unit 4: (10 Lectures, 8 Marks) **Community characteristics**: (species richness, dominance, diversity, abundance, vertical stratification); ecotone and edge effect; ecological succession; general process and types of succession (with examples)

Unit 5: **(14** Lectures, 14 Marks)
Applied Ecology and Biodiversity: Biomagnifications, eutrophication and BOD, bioindicators, type's levels and service of biodiversity; threats to biodiversity; biodiversity hot spots, wildlife conservation (in-situ and ex-situ), and concept of protected areas (national parks, species (animal) of North –East India under special conservation status; important protected animals and protected areas of Assam

PRACTICAL (18 Marks)

1. Estimation of the size of the population by capture–recapture method (any vertebrate/ invertebrate)
2. Determination of population density in a natural /hypothetical community by quadrate method
3. Calculation of Shanon-Wiener index for hypothetical communities
4. Study of composition and organization of biotic communities in a lentic aquatic ecosystem (lake/pond)
5. Study of physical properties of any aquatic ecosystem: measurement of area, temperature, turbidity, suspended and dissolved solid, water current
6. Submission of assignment on biology, past and present status, threats and conservation strategies of any protected animal species of Assam
7. Field study visit to a protected area (National park/ wildlife sanctuary /reserved forest) and submission of report

Reference Book:

- Levin, S. A., Carpenter, S. R., Godfray, H. C. J., Kinzig, A. P., Loreau, M., Losos, J. B., ... & Wilcove, D. S. (Eds.). (2009). The Princeton guide to ecology. Princeton University Press.
- Remmert, H. (2012). Ecology: a textbook. Springer Science & Business Media.
- Monson, R. K. (Ed.). (2014). Ecology and the Environment. New York, NY: Springer.

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 the successful completion of program students will:

1. Effectively apply basic principles of the natural and social sciences to current issues of natural resources and the environment;
2. Understand and appropriately use the vocabularies of the natural and social sciences relevant to issues of natural resources and the environment;
3. Write and speak clearly about technical issues related to their concentration of study in the ecology program;
4. Work collaboratively with other professionals in the disciplines of the major to address significant policy issues in natural resources and the environment.
5. Identify significant ethical issues in natural resources and the environment and be able to address these issues in an informed and thoughtful manner.

Detailed syllabus of 4rth semester
Title of the paper: **ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS**

Course code: **ZOOM404**
Nature of course: Major
Total credit: 4
(60 Lectures, 52 Marks)

Objective of course:

Animal physiology is the scientific study of the life-supporting properties, functions and processes of animals or their parts. The discipline covers key homeostatic processes, such as the regulation of temperature, blood flow and hormones

THEORY

Unit 1: **(12** Lectures, 12 Marks) Physiology of Digestion: Structure and function of gastrointestinal tract and associated glands. Mechanism of digestion of food. Absorption of carbohydrates, proteins, lipids, water,minerals and vitamins. Gastrointestinal hormones. Hormonal control of secretion of enzymes in gastrointestinal tract.

Unit 2: (12 Lectures, 10 Marks) Physiology of Respiration: Structure of respiratory system. Mechanism of respiration. Transport of respiratory gases in blood. Chloride shift. Respiratory pigments. Carbon monoxide poisoning. Regulation of respiration. Pulmonary diseases.

Unit 3: (10 Lectures, 8 Marks) Blood: Components of blood and their functions. Structure and function of haemoglobin. Coagulation of blood. Blood groups- ABO and Rh factor.

Unit 4: (12 Lectures, 10 Marks) Physiology of Heart: Structure of mammalian heart. Origin and conduction of cardiac impulse. Cardiac cycle. Cardiac output and its regulation. Neural and chemical regulation of heart rate. Blood pressure and its regulation. Electrocardiogram.

Unit 5: (14 Lectures, 12 Marks) Renal Physiology: Structure of kidney and its functional unit (Nephron) Renal blood supply. Mechanism of urine formation and its regulation. Regulation of water and acid base balance. Renal failure and dialysis.

PRACTICAL (18 Marks)

1. Identification of permanent slides of mammalian oesophagus, stomach, duodenum, ileum, rectum, liver, trachea, lungs and kidney.
2. Recording of heart beat by kymograph.
3. Preparation of blood smear to study various components of blood.
4. Estimation of RBC and WBC using Haemocytometer.
5. Preparation of haemin crystals.
6. Estimation of haemoglobin using Sahli's Haemoglobinometer

Reference book:

- Schmidt-Nielsen, K. (1997). *Animal physiology: adaptation and environment*. Cambridge university press.
- Srivastava, A. K. (1986). Animal Physiology and Biochemistry. S. Chand Publishing.

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 would be able to know basic fundamentals and understand advanced concepts related to systems in the body, their feedback loop controls.
- They would be able to understand the connections between knowledge of Physiologyin relation to real world situations, including healthy lifestyle decisions, diseases and disorders and homeostatic imbalances.
- They would be able to know the role of self-sustaining systems like circulatory, digestive, respiratory and excretory systems and how all of these work in unison to maintain a balance in the body.

Detailed syllabus of 5th semester
Title of the paper: Endocrinology

Course code: **ZOOM 501/ZOON501**
Nature of course: Major/Minor
Total credit: 4
(60 Lectures, 52 Marks)

Course Objective:

To explain the roles of the endocrine system in maintaining homeostasis, integrating growth and development, responding to environmental insults and promoting successful reproduction

THEORY

Unit 1: Introduction in endocrinology: Characteristics classification and transport of hormones; neurosecretions and neurohomones; neuroendocrine system in insects and role of insect hormones.(10 Lectures 10 marks)

Unit 2: Hypothalamus, adenohypohsis and epiphysis: Structure of hypothalamus and hypothalamo-hypophysial system in mammals; hypothalamic nuclei and their functions; hormones secreted by mammalian pituitary gland and their functions; regulation of neuroendocrine glands; disorders associated with hypo and hyper-secretion of pituitary hormones; pineal gland; secretions of pineal gland and their functions in biological rhythms and reproduction.(15 Lectures and 10 marks)

Unit 3: Peripheral endocrine gland : Hormones, functions and regulation of thyroid, parathyroid, adrenal, islets of Langerhans, ovary and testis in mammals; disorder associate with hypo and hypersecretion of endocrine hormones; hormones in homeostasis; placenta as endocrine gland. (17 Lectures and 12 marks).

Unit4: Reproductive endocrinology: Roles of hormones in reproductive cycles, pregnancy, parturition and lactation; and in-vitro fertilization. (6 Lectures and 8 marks).

Unit 5: Mechanism and regulation of hormone action: Hormone action at cellular level: hormones receptors; transduction and regulation; hormones action at molecular level: molecular mediators, genetic control of hormone action. (12 Lectures and 12 marks).

PRACTICAL (18 Marks)

1. Study of permanent histological slides of mammalian pituitary, thyroid, parathyroid, adrenal, pancreas, testis and ovary.
2. Dissection of following endocrine glands in fish/fowl/rat:
   a. Pituitary gland in fish /fowl/rat
   b. Thyroid gland in fish /fowl/rat
   c. Adrenal gland in fish /fowl/rat
3. Submission of charts on disease of hypo and hypersecrection of endocrine glands
4. Demonstration of mechanism of action of hormone (peptide, amino and steroid hormones) through digital media.

Reference book:

- Melmed, S., Polonsky, K. S., Larsen, P. R., & Kronenberg, H. M. (2015). *Williams textbook of endocrinology E-Book*. Elsevier Health Sciences.
- Turner, H. E., Eastell, R., & Grossman, A. (Eds.). (2018). *Oxford Desk Reference: Endocrinology*. 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:

1. Students learn how to demonstrate/illustrate how the homeostatic model applies to every endocrine system in normal physiology and disease.
2. Students learn how to demonstrate/illustrate how every aspect of our physiology and behavior is directly controlled or modified by hormones using reproduction, growth, development, stress, and metabolism as examples

Detailed syllabus of 5th semester
Title of the paper: Cell Biology

Course code: **ZOOM502**
Nature of course: Major
Total credit: 4
(60 Lectures, 52 Marks)

Course Objectives:

Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.

Theory

Unit 1: (10 Lectures, 8 Marks)

Overview of cells: Prokaryotic and eukaryotic cells and their distinctions. Structure and function of microtubules, microfilaments and intermediate filaments.

Unit 2: (14 Lectures, 12 Marks)

Plasma membrane: various models of pasma membrane structure; transport across the membrane (permeability, passive and active transport, membrane pumps), cell junctions (tight junctions, desmosomes, gap junctions).

Unit 3: **(12** Lectures, 12 Marks)

Intracellular organelles: structural organization and function of the endomembrane system (endoplasmic reticulum, golgi complex, endosomes, lysosomes, ribosomes), structure and functions of mitochondria; semi-autonomous nature of mitochondria; endosymbiotic hypothesis; peroxisomes.

Unit 4: **(12** Lectures, 10 Marks)

Nucleus: structure of nucleus; nuclear envelop and nuclear pore complex; nucleolus; chromatin packaging (nucleosome); euchromatin and heterochromatin; polytene and lampbrush chromosomes.

Unit 5: **(12** Lectures, 10 Marks)

Cell cycle and division: cell cycle and its regulation, mitosis and meiosis; malignant cell growth and biology of cancer. Cell signaling: basic elements and types of cell signaling;).

PRACTICAL:(18 Marks)

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1. Demonstrations of chromatin (DNA) packaging through digital recording/ animation.
2. Preparations of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
3. Preparation of temporary slide to observe polytene chromosomes in Chironomous/ Drosophila larvae.
4. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
5. Study of stages of meiosis through permanent slides.
6. Demonstration of autocrine, paracrine and endocrine signaling through digital media.
7. Study of distinctions between the virus, prokaryotic and eukaryotic cells (plant and animal) through digital media

Reference book:

- Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. (2022). Cell Biology E-Book: Cell Biology E-Book. Elsevier Health Sciences.
- Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., ... & Walter, P. (2015). Essential cell biology. Garland Science.
- Plopper, G. (2011). Principles of cell biology. Jones & Bartlett Publishers.

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:

- Describe the evolution, diversity and replication of cells;
- Explain the role of compartmentalization and signaling in cellular biology;
- Interpret and explain key experiments in the history of cell biology;
- Evaluate and apply knowledge of modern techniques in cellular biology.

Detailed syllabus of 5th semester
Title of the paper: Molecular Biology

Course code: **ZOOM503**

Nature of course: Major
Total credit: 4
(60 Lectures, 52 Marks)

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, and use genetic engineering (recombinant DNA technology) to isolate, sequence, and modify.

THEORY

Unit 1: **(12** Lectures, 10 Marks)

The nucleic acids and gene: salient features and forms of DNA and RNA; chemical nature of the gene, structure and stability of the genome, extranuclear (mitochondrial and chloroplast) genome, distinction between prokaryotic and eukaryotic genome.

Unit 2: **(12** Lectures, 10 Marks)

DNA replication: nature of DNA replication (semi-conservative, bidirectional and semi-discontinous): DNA polymerases; mechanisms of replication; DNA replication in prokaryotes and eukaryotes; replication of telomeres.

Unit 3: **(12** Lectures, 10 Marks)

Expression of the gene I- Transcription: transcription unit and RNA polymerases, mechanism of transcription in prokaryotes and eukaryotes, transcription factors; the genetic code and its properties.

Unit 4: **(12** Lectures, 10 Marks)

Regulation of gene expression: regulation of transcription in prokaryotes: the operon; principles of regulation with examples from *lac* operon and *trp* operon; regulation of tnascription in eukaryotes; bacterial and eukaryotic genes; gene silencing and gene imprinting.

Unit 5: **(12** Lectures, 12 Marks)

DNA repair and recombination: DNA damage and repair mechanisms, homologous and site-specific DNA recombination; recombination; concept of transposable genetic element and transposons, plasmids.

PRACTICAL : (18 Marks)

1. Histological staining of DNA and RNA in prepared slides.
2. Agarose gel electrophoresis for DNA.
3. Quantitative estimation of RNA using Orcinol reaction.
4. Study and interpretation of electron micrographs/photograph showing:
   a. DNA replication
   b. Transcription
5. Study of transcription in polytene chromosomes prepared from *Chironomous/Drosophila* larvae.
6. Demonstration of translation by means of digital media.

Reference book:

- Allison, L. A. (2021). Fundamental molecular biology. John Wiley & Sons.
- Clark, D. P., & Pazdernik, N. J. (2012). Molecular biology. Elsevier.
- Davis, L. (2012). Basic methods in molecular biology. Elsevier.

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:

- The field of molecular biology includes techniques which enable scientists to learn about molecular processes.
- These techniques are used to efficiently target new drugs, diagnose disease, and better understand cell physiology

Detailed syllabus of 5th semester
Title of the paper: Animal Behaviour

Course code: **ZOOM504**
Nature of course: Major
Total credit: 4
(60 Lectures, 52Marks)

Course Objective:

- Students get some knowledge about sexual and reproductive behaviour of animals.
- Recognizes social and play behaviours of animals.
- Learns behavioural disorders of some farm and pet animals

THEORY

Unit 1: (12 Lectures, 10 Marks)

Introduction to animal behavior: Origin and history of Ethology; approaches to study animal behavior; brief profiles of Karl Von Frish, Ivan Pavlok, Konrad Lorenz, Niko T inbergen; proximate and ultimate causes of behavior; methods and recording of a behavior. (6 Lectures)

Unit 2: (12 Lectures, 10 Marks)

Patterns of behavior: Patterns of behavior: fixed action patterns (FAP); stereotyped behavior (orientation, reflex, instincts and motivation); acquired behavior or learning (types of flexible and restricted learning).

Unit 3: (12 Lectures, 10 Marks)

Communication in animals: communication in animals; aggression; types and causes of aggression; defensive or anti-predator behaviors; concept, dominance and territoriality.

Unit 4: (12 Lectures, 12 Marks)

Social and sexual behavior: concept of society in animals; social organization in ants and honey bees; foraging in honey bee and the waggle dance; sexual behavior: asymmetry of sex and sexual dimorphism, sexual selection (intersexual and intrasexual), mating systems and courtship behaviour.

Unit 5: (12 Lectures, 10 Marks)

Biological rhythm: Types and characteristics of biological rhythm: short and long term rhythms: circadian rhythms; tidal rhythms and lunar rhythms; concept of synchronization and masking; circannual rhythms, photoperiod and regulation seasonal reproduction of vertebrates; role of melatonin.

PRACTICAL : (18 Marks)

1. Study of behavioural responses of wood lice to dry and humid conditions.
2. Study of habituation in mosquito larvae/ spider
3. To study taxis behaviour in animals
   a) Geotaxis in earthworms
   b) Phototaxix in insect larvae/cockroach/fish
4. Demonstration of social organization in honey bee
5. Visit to a forest/ zoological park to study behavioural activities of animals and prepare a short report[Can be carried out simultaneously with field study with regard to practical of core course XI: Principles of ecology]

Reference book:

- Mandal, F. B. (2015). Textbook of animal behaviour. PHI Learning Pvt. Ltd.
- Manning, A., & Dawkins, M. S. (2012). An introduction to animal behaviour. Cambridge University Press.
- Huntingford, F. (Ed.). (2012). the study of animal behaviour. 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:

- Studying animal behaviour will provide you with a deeper understanding of how animals interact with each other and their environment.
- Students learn about the biological and psychological mechanisms that influence behaviour, including genetics, hormones, and learning

Detailed syllabus of 6th semester
Title of the paper: Principles of Genetics

Course code:
ZOOM601/ZOON601

Nature of course: Major/Minor
Total credit: 4
(60 Lectures, 52 Marks)

Course Objective:

In this course, students learn genetic phenomena at many levels of biological complexity, from single molecules to populations of free-living organisms.

Theory

Unit 1: (14 Lectures, 12 Marks) **Mendelian Genetics and its Extensions**: Mendelian principles of inheritance, concept of factors and alleles; back cross and test cross; inter allelic and inter genic interactions(co dominance, incomplete dominance, lethality, epistasis, supplementary and complementary genes) multiple alleles, pleotropy.

Unit 2: (10 Lectures, 10 Marks) **Physical basis of heredity**: Chromosomal basis of inheritance, linkage and crossing over, cytological and molecular basis of crossing over. Sex influenced and sex limited characters, chromosomal mechanism of sex determination in *Drosophila* and man. Basic concept of gene (linkage) mapping, recombination frequency as a measure of linkage intensity, two and three factor crosses.

Unit 3: (12 Lectures, 10 Marks) **Mutation and Human genetics:** Types of chromosomal and gene mutation. Molecular basis of mutation; mutation in relation to UV light and chemical mutagens. Human chromosomes and karyotype. Genetic disorders and inborn error of metabolism.

Unit 4: (12 Lectures, 10 Marks) **Extra- chromosomal Polygenic inheritance**: Extra-chromosomal(cytoplasmic) inheritance and maternal effect(exemplified by inheritance of shell coiling in snail and ineffective heredity in paramecium); polygenic inheritance and quantitative genetics.

Unit 5: (12 Lectures, 10 Marks) **Applied genetics**: Pedigree analysis; concept of inbreeding, outbreeding and hybrid vigour and their practical applications, concept of population, gene pool and gene frequencies. Hardy-Weinberg equilibrium and its derivatives.

Practical : (18 Marks)

1. Simple calculation based on Mendelian monohybrid, dihybrid and test cross.
2. Demonstration of crossing over through digital media.
3. Linkage maps based on data from *Drosophila.*
4. Simple numerical calculations on genetic/linkage maps (based on principles of recombinant frequency)
5. Study of human karyotype.

Reference Book:

- Snustad, D. P., & Simmons, M. J. (2015). *Principles of genetics*. John Wiley & Sons.
- Gardner, E. J. (1960). Principles of genetics.
- Sinnott, E. W., Dunn, L. C., & Dobzhansky, T. (1950). Principles of genetics.

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 explores topics in eukaryotic molecular and classical genetics, focusing on current biotechnology techniques and their applications to humans.
- Human genetics is a branch of biology that studies how human traits are determined and passed down among generations. Explore this exciting field to better understand how your genes help shape your traits and health
- The course is problems-based with a strong emphasis on applying information and skills in real-life situat

Detailed syllabus of 6th semester
Title of the paper: Immunology

Course code: **ZOOM602**
Nature of course: Major
Total credit: 4
(60 Lectures, 52 Marks)

Objectives:

To better understand how the immune system functions.

THEORY

Unit 1: **(12** Lectures, 10 Marks)
Overview of the immune system: concept of immunity and immune response; cells and organs of the immune system; antigens and antigenicity; immunogens and immunogenicity; factors influencing immunogenicity; haptens and adjuvants.

Unit 2: **(12** Lectures, 10 Marks)
Types of immune responses; elements and principles of innate immunity and acquired immunity (cell mediated and humoral); active and passive immunity.

Unit 3: **(12** Lectures, 10 Marks)
Presentation of antigens and cell mediated immunity: structure and functions of major histocompatibility complex; antigen presenting cells; B cell and T cell epitopes; pathways of antigen processing and presentation; diversity, functions and response of T cells.

Unit 4: **(10** Lectures, 8 Marks)
Antigen antibody interactions: basic structure, functions and classes of immunoglobulins; clonal selection theory; affinity and avidity; antigen-antibody reactions; monoclonal and polyclonal antibodies and their therapeutic applications; components and pathways of complement system.

Unit 5: (12 Lectures, 14 Marks)
Immunodiagnostic techniques and immune dysfunctions: basic principles of immunodiffusion, RIA and ELISA; hypersensitivity; various types of hypersensitivities; concept of autoimmune diseases; HIV-AIDS; vaccination; various types of vaccines and their principles.

PRACTICAL (18 Marks)

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through permanent slides.
3. Preparation of stained blood film to study various types of blood cells involved in immunity.
4. Determination of AB blood group.
5. Ouchterlony's double immunodiffusion method.
6. Demonstration of RIA and ELISA

Reference book:

- Owen, J. A., Punt, J., Stranford, S. A., & Jones, P. P. (2013). *Kuby immunology* (Vol. 27, p. 109). New York: WH Freeman.
- Shots, C. (2001). Basic Immunology.
- Kapila, K. (2004). Kuby Immunology, year 2000. Medical Journal, Armed Forces India, 60(1), 91.

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:

- Student learn to understand how the immune system develops
- Student learns how the body defends itself against disease, and what happens when it all goes wrong.

Detailed syllabus of 6th semester
Title of the paper: Developmental Biology

Course code: **ZOOM603**
Nature of course: Major
Total credit: 4
(60 Lectures, 52 Marks)

Course Objectives:

Developmental biology aims to understand how an organism develops how ~~a~~ single cell becomes an organized grouping of cells that is then programmed at specific times to become specialized for certain tasks

THEORY

Unit I : (12 Lectures, 10 Marks)**Introduction:** Branches of embryology and their utility; phases of development; differentiation and growth; cytoplasmic determination and asymmetric cell division.

Unit 2: (12 Lectures, 10 Marks)**Early embryonic development** I: Gametogenesis (spermatogenesis and oogenesis); structure, maturation and growth of sperm and ovum; vitellogenesis; types of eggs and egg membranes; fertilization (external and internal); mechanism and significance of fertilization; changes in gametes; monospermy and polyspermy; parthenogenesis

Unit 3: (12 Lectures, 10 Marks)**Early embryonic development II:** characteristics, planes, patterns and types of cleavage; influence of yolk on cleavage; morula; blastula and its types; fate map of frog; general process of gastrulation; early development of frog and chick up to grastrulation; neurlation; embryonic induction and organizers.

Unit 4: (10 Lectures, 8 Marks)**late embryonic development:** fate of germ layers; extra-embryonic membranes in birds; structure and function of placenta; classification of placenta; development of vertebrate eye and ear.

Unit 5: (14 Lectures, 12 Marks)**Post embryonic development:** Metamorphosis in amphibians and insect; changes of organization during metamorphosis in amphibians; physiological (hormonal) regulation of metamorphosis; Regeneration and types; mechanisms of regeneration in vertebrates exemplified by regeneration in amphibians (Salamander)

PRACTICAL (18 Marks)

1. Study of whole mounts of developmental stages of chick through permanent slides through permanent slides: Primitive streak(13, and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation
2. Study of whole mounts and sections of developmental stages of frog through permanent slides. Cleavage, blastula, gastrula, neurula, tail –bud stage, tadpole.
3. Preparation of permanent stained slides of chick embryo (any three stages from 24 hours up to 72 hours development stage)
4. Demonstration of gemetogenesis , fertilization, and development of vertebrate eye through digital presentation/ recording
5. Study of development and metamorphosis by observing life cycle of nay species of ant/mosquito/ butterfly/moth.

Reference Book:

- Slack, J. M., & Dale, L. (2021). Essential developmental biology. John Wiley & Sons.
- Hall, B. K. (2012). Evolutionary developmental biology. Springer Science & Business Media.
- Dye, F. J. (2012). Dictionary of developmental biology and embryology. John Wiley & Sons.

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 knowledge molecular and genetic background of animal and plant development;
- Describe evolutionary history of complex multicellular life forms;
- Compare environmental influence on development and homeostasis of animals and plants;

Detailed syllabus of 6th semester
Title of the paper: Parasitology

Course code: **ZOOM604**
Nature of course: Major
Total credit: 4
(60 Lectures, 52 Marks)

Course Objectives:
Aims to provide understanding of parasitism and tropical infectious diseases. It covers the history and taxonomy of major human parasites, their life cycles and diseases

THEORY

Unit 1: (12 Lectures, 10 Marks)

Introduction to Parasitology: Brief introduction of parasitism, parasite, parasitoid and vectors (mechanical and biological vector), host parasite relationship; parasitic adaptations and effects on hosts.

Unit 2: **(12** Lectures, 10 Marks)

Parasitic protozoans: Study of morphology, life cycle, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of *Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani, Trichomonas vaginalis* and *Plasmodium vivax*.

Unit 3: **(14** Lectures, 14 Marks)

Parasitic bacteria and vectors of viral diseases: General organizations and pathogenicity of parasitic bacteria (*Rickettsia, Borellia, Treponema* and *Leptospira)*; causative virus and vectors of dengue, Japanese encephalitis, yellow fever and haemorrhagic fever; biology and measures of control of vectors.

Unit 4: **(12** Lectures, 10 Marks)

Parasitic helminthes: Study of morphology, life cycle, prevelance, epidemiology, pathogenicity, diagnosis, prophylaxis and treatment of *Fasciola hepatica*, *Taenia solium,Ascaris lumbricoides* and *Wuchereria bancrofti*

Unit 5: **(10** Lectures, 8Marks)
Parasitic arthropods: Biology, importance and control of ticks, mites, head and body lice.

PRACTICAL (18 Marks)

1. Identification of:
   a. Protozoan parasites (*Entamoeba, Giardia, Trypanosoma, Leishmania, Trichomonas, Plasmodium*).
   b. Adult stages of helminthes (*Fasciola, Taenia, Ascaris, Ancyclostoma, Wuchereria*).
2. Identification of mosquito species (vectors) causing malaria, encephalitis and dengue fever.
3. Study of life stages of *Entamoeba histolytica, Plasmodium vivax, Fasciola hepatica, Taenia solium, Ascaris lumbricoides*.
4. Collection identification and submission of parasitic arthropods in permanent whole mount slides.

Reference Book:

- Cox, F. E. (Ed.). (2009). Modern parasitology: a textbook of parasitology. John Wiley & Sons.
- Kelkar, S. S., & Kelkar, R. S. (1990). A textbook of parasitology.
- Cheng, T. C. (2012). General parasitology. Elsevier.

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:

- They will be able to recognize of parasites which are important for human health and caused disease.
- They recognize specific and nonspecific parasites to human.
- They comprehension biological characteristic of human parasites.
- They will be able to define human parasites after identify of them