Name of the Programme:
M. Sc. Zoology with specialization in Integrative Biology
(Syllabus effective from 2024 Admission onwards)

UNIVERSITY OF KERALA

Inter-University Centre for Evolutionary and Integrative Biology (*i*CEIB)

2024

PREAMBLE

The role of higher education is vital in securing the gainful employment and providing further access to higher education comparable to the best available in the world-class institutions elsewhere. The improvement in the quality of higher education, therefore, deserves to be given tom-most priority to enable the young generation of students to acquire skill, training and knowledge to enhance their thinking, comprehension and application abilities and prepare them to compete, succeed and excel globally. Sustained initiatives are required to reform the present higher education system for improving and upgrading the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes across all undergraduate programs in science, humanities, commerce and professional streams of higher education.

One of the significant reforms in the undergraduate education is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome-oriented with well-defined aims, objectives and goals to achieve. The University Grants Commission (UGC) took the initiative of implementing the LOCF in the Colleges and the Universities of the country. Accordingly, the University of Kerala has decided to implement the LOCF in all its departments under the auspices of Internal Quality Assurance Cell (IQAC). A series of teacher training workshops were organised by IQAC and the office of the Credit and Semester System (CSS), and the departments have revised the syllabus accordingly, through workshops and in consultation with academic experts in the field.

GRADUATE ATTRIBUTES (GAs)

The Graduate Attributes (GAs) reflect particular qualities and abilities of an individual learner including knowledge, application of knowledge, professional and life skills, attitudes and human values that are required to be acquired by the graduates of University of Kerala. The graduate attributes include capabilities to strengthen one's professional abilities for widening current knowledge and industry-ready skills, undertaking future studies for global and local application, performing creatively and professionally, in a chosen career and ultimately playing a constructive role as a socially responsible global citizen. The Graduate Attributes define the characteristics of learners and describe a set of competencies that are beyond the study of a particular area and programme.

The GAs of University of Kerala

- Continue life-long learning as an autonomous learner
- Continuously strive for excellence in education
- Apply and nurture critical and creative thinking
- Promote sustainable development practices
- Promote co-operation over competition
- Balance rights with responsibilities
- Understand and respect diversity & difference
- Not be prejudiced by gender, age, caste, religion, or nationality.
- Use education as a tool for emancipation and empowerment of humanity

Brief History of the Centre

Inter-University Centre for Evolutionary and Integrative Biology (*i*CEIB) of the University of Kerala at North campus was established in 2013. The Centre explores Biological Sciences in an innovative way utilizing trans-disciplinary approaches to pursue teaching and research in various areas of modern Biology. As an ambitious centre, *i*CEIB started a master's degree course in Integrative Biology. Students are provided with research and training programs with a curriculum ranging from studies on the evolution of structure and function of life-forms to advance studies on molecular technologies.

This Centre intends to provide opportunity for students to interact with leading scientists and academicians of our country and abroad. We thus, frequently organize National and International seminars, workshops and conferences and encourage educational activities including Nature camps and visits to fields and National Institutes. We also organize interactive sessions regularly, in which students present and discuss common scientific topics and thus promote their scientific communication and management skills. The centre also serves as a platform for students to perform well in competitive exams and also equip them to pursue their scientific dreams in India and abroad.

UNIVERSITY OF KERALA

Syllabus for M. Sc. Zoology with specialization in Integrative Biology

Programme Specific Outcomes (PSO) for M. Sc. Zoology with specialization in Integrative Biology	
PSO 1	Opportunity to learn about trans-disciplinary approaches to explore Modern Biology
PSO 2	Learn the basic, fundamental and applied aspects of Biology
PSO 3	Pursue research in various fields of Applied Biology
PSO 4	Inculcate interest in teaching, managing and research in Science
PSO 5	Facilitate students to approach diverse scientific themes in a comprehensive way

Programme Structure of M. Sc. Zoology with specialization in Integrative Biology

Semester	Course Code	Name of the course	Credits
I	**Core Courses (CC)**		
	INB-CC-511	Advanced Animal and Plant Physiology	3
	INB-CC-512	Evolutionary Biology and Ethology	3
	INB-CC-513	Biochemistry	3
	INB-CC-514	Research Methodology, Biosafety and Biostatistics	3
	INB-CC-515	Practical I: Physiology, Biochemistry and Research Methodology	2
	Discipline Specific Elective (DE)		
	INB-DE-516	Stress Physiology and Adaptation Biology	2
	INB-DE-517	Animal Cell Culture Technique	2
II	**Core Courses (CC)**		
	INB-CC-521	Bioinstrumentation and Biophysics	4
	INB-CC-522	Environmental Biology	3
	INB-CC-523	Animal Systematics and Diversity	3
	INB-CC-524	Cell and Molecular Biology	3
	INB-CC-525	Practical II: Cell and Molecular Biology, Environmental Biology and Bioinstrumentation	2
	INB-CC-526	Mini Project / Internship	2
	Discipline Specific Elective (DE)		
	INB-DE-527	Applied Zoology	2
	INB-DE-528	Molecular Diagnostics	2
III	**Core Courses (CC)**		
	INB-CC-531	Genetics and Biotechnology	3
	INB-CC-532	Immunology and Microbiology	3
	INB-CC-533	Endocrinology and Reproductive Biology	4
	INB-CC-534	Developmental Biology and Neurobiology	3
	INB-CC-535	Practical III: Microbiology, Biotechnology, Endocrinology and Developmental Biology	2
	Discipline Specific Elective (DE)		
	INB-DE-536	Molecular techniques in Integrative Biology	2
	INB-DE-537	Vectors and Communicable Diseases	2
IV	**Core Courses (CC)**		
	INB-CC-541	Conservation Biology	4
	INB-CC-542	Integrative Biology	4
	INB-CC-543	Project Work and Viva	8

Any Semester (I-III)	**Generic Courses (GC)**		
	INB-GC-501	Introduction to Microbial Pathology	2
	INB-GC-502	Introduction to Animal Behavior	2
	INB-GC-503	Stress Physiology and Adaptation Biology	2
	INB-GC-504	Cancer: Causes, Prevention and Treatment	2
Any Semester (I-III)	**Skill Enhancement Courses (SEC)**		
	INB-SE-501	Biofertilizer production technology	2
	INB-SE-502	Histology and Histopathology	2
	INB-SE-503	Advanced Molecular Techniques	2

SEMESTER I	Course Code: INB-CC-511	Credits: 3

ADVANCED ANIMAL AND PLANT PHYSIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify basic knowledge of study and comparison of organ systems across the living world

CO2: Give an overview of the comparative functioning of different systems in animals

CO3: Gain knowledge on human physiology

CO4: Comprehend concepts related to various stress endured by plants and animals and how they adapt to these adverse conditions

CO5: Apply concepts and principles of homeostasis and its regulation including functioning of respiratory, cardiovascular and sensory systems

CO6: Understand Environmental and adaptive physiology and apply its concepts for the betterment of animals and plants in nature

COURSE CONTENT

Module I: Systemic and Cellular homeostasis: Concept and principles of homeostasis, mechanism of homeostasis, Homeostatic processes, Integrating factors of homeostasis. Gas transport, Acid-base, osmotic and metabolic homeostasis. Water and salts in cell environment, resistance of cells to changes in pH. Factors affecting homeostasis including oxygen availability and temperature. Transport of Oxygen. Cellular response to acidosis and ketosis, hypercapnia, Respiratory and renal control of acid-base balance, Gas transport, Neuronal and chemical regulation of respiration. Comparison of respiration in different species, anatomical considerations, transport and exchange of gases, waste elimination.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember concepts of homeostasis

M02: Understand principles of gas transport

M03: Evaluate transport of various biomolecules

M04: Analyse respiration in different life forms

M05: Apply techniques to measure and study osmotic changes in an organism

MODULE II: Cardiovascular and muscular physiology: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity, homeostasis. Cardiovascular and muscular system: Comparative anatomy of heart structure, myogenic heart, specialized tissue, Cardiac cycle, Heart as pump. ECG – its principle and significance, heart as a pump, blood pressure, neural and chemical regulation of the processes. Ultra structure of muscle fiber, molecular mechanism of muscle contraction, muscle metabolism.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember and understand the process of haemopoiesis

M02: Understand various components of cardiovascular and muscular system

M03: Evaluate working of heart of various animals

M04: Analyse the anatomy and cardiac cycle of humans
M05: Apply techniques to assess the working of heart and its related functions

MODULE III: Sensory and excretory physiology: Sense organs - Vision, hearing and tactile response. Sensory receptors. Mechanism of hearing. Physiology of vision. Nitrogen excretion, Kidney physiology and its role in osmoregulation and acid-base balance. Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, maturation, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. Urea cycle. Renin-Angiotensin system.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember principles of sensory perception
M02: Understand mechanisms of sensory and excretory physiology
M03: Evaluate functioning of sensory and excretory organs
M04: Analyse the processes of acid base balance
M05: Apply techniques to measure and study regulation of sensory and excretory organs

MODULE IV: Environmental Physiology: Environmental effects on ion regulation- Bioenergetics and energy partitioning. Environmental perturbations of growth and reproduction in fishes. Environmental influence on growth and metabolism - hormonal and biochemical aspects. Endocrine disruptors. Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember effects of surroundings on physiology of organisms and environment
M02: Understand concepts of environmental perturbations
M03: Evaluate environmental influence on growth and metabolism
M04: Analyse thermoregulation and acclimatization with regard to it
M05: Apply techniques to determine effects of environment on Bioenergetics

MODULE V: Adaptive Physiology: Physiological adaptations- Homeothermy and Poikilothermy. Salinity adaptation. Biochemical basis of physiological adaptation. Osmoregulation in fresh water and estuarine and marine and terrestrial animals. Hypoxia. Sodium pump.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember principles of adaptations
M02: Understand concepts of osmoregulation in various environments
M03: Evaluate biochemical parameters of adaptations
M04: Analyse the working of sodium potassium pump
M05: Apply techniques to determine hypoxia and its effects on the organisms

MODULE VI: Plant physiology: Photosynthesis - Light harvesting complexes. Mechanisms of electron transport. Photoprotective mechanisms. CO_2 fixation - C3, C4 and CAM pathways. Respiration and photorespiration – Citric acid cycle, plant mitochondrial electron transport and ATP synthesis, alternate oxidase, photorespiratory

pathway. Nitrogen metabolism - Nitrate and ammonium assimilation, amino acid biosynthesis. Plant hormones - Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks. Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration, mechanisms of loading and unloading of photoassimilates. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember the complete process of photosynthesis
M02: Understand carbon fixation, respiration and photorespiration in plants
M03: Evaluate nitrogen metabolism and regulation of plant hormones
M04: Analyse the solute transport in plants and its regulation
M05: Apply methods to study stress response in plants to various stressors

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

First Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-511: Advanced Animal and Plant Physiology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Is cotransport considered as an active transport ?
2) Annotate on the direct and indirect effects of physiological distress.
3) In your point of view, when does the chloride shift occur ? List the causes.
4) Hydrogen peroxide forms by the photosynthesis. What is this reaction ?
5) Compile the causes of systemic edema.
6) What happens to eye lens of people suffering from myopia?
7) 5-methylthioadenosine (MTA) is recycled to Methionine in plants. Clarify.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Blood has non living matrix, what is it made of ?
9) Hormonal functions get messed up when you are stressed. Account for this statement.
10) Acid base balance is properly maintained in the body. Discuss the role of kidney in it.
11) Steroid hormones influence cellular activities. Justify.
12) "Phytochromes and biological clock". Are they co-related ?
13) Present your views on what would happen if Henle's loop were absent from mammalian nephron.
14) Expound on the information processing mechanism in the human eye.
15) What are secondary metabolites ? Describe the synthesis and biological roles of Terpenes.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Do plants have chemical messengers that control and coordinate the cell functions ? Explain about their biosynthesis and mechanism of action.
17) Plants synthesize amino acids. How do they do it ? Explicate.
18) Once a signaling molecule from one cell has bound to a receptor on another cell, is the signaling process complete ? How do second messengers amplify the signal ?
19) Enumerate the various factors involved in the regulation of respiration in vertebrates.

(2x10=20 Marks)

SEMESTER I	Course Code: INB-CC-512	Credits: 3

EVOLUTIONARY BIOLOGY AND ETHOLOGY

Course Outcomes (CO)

CO1: Give an overview of the fundamentals of organic evolution and animal behaviour
CO2: Communicate and represent vital understanding of evolutionary processes and ethological principles
CO3: Expand knowledge on current trends in evolutionary and behavioural studies
CO4: Comprehend the major and minor processes regulating the process of evolution and ethological perceptions
CO5: Understand the role of genetics in evolution and sociobiology
CO6: Apply techniques to learn future course of evolution and measure behavior changes in animals using appropriate tools

COURSE CONTENT

MODULE I: Concepts in Evolution and Origin of Life: Pre-Darwanian, Lamarck, Darwin and Wallace and Post Darwanian. Concepts of variation, adaptation, struggle, fitness. Natural selection - spontaneity of mutation and the evolutionary synthesis. Neutral Evolution. Molecular Evolution. Neutralist versus Selectionist. Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould (Punctuated equilibrium), Rose Mary and Peter Grant (Molecuar evolution in Darwinian finches). Concept of Oparin - Haldane, Miller-Urey Experiment. The First Cell. Evolution of Prokaryotes, Origin of Eukaryotic cells. Anaerobic metabolism. Origin of photosynthesis and aerobic metabolism.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember concept of primary abiogenesis and experiments to prove it
M02: Understand principles variation and adaptation
M03: Evaluate theories relating to process of evolution
M04: Analyse the first derived living forms during evolution
M05: Create experiments to show initial processes of evolution in present times

MODULE II: Geological Timescale and Population Genetics: Major events in evolutionary timescale. Anthropocene. Mass extinction and its consequences. Fossils-fossilization and its significance. Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change in gene frequency through natural selection, migration and random genetic drift. Founder effect. Isolating mechanisms and speciation. Micro, Macro and Mega evolution. Co-evolution.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember the geological timescale and its importance
M02: Understand concepts of anthropocene
M03: Evaluate the process of fossilization and its significance
M04: Analyse the factors affecting changes in gene frequency and thereby the genetic equilibrium
M05: Apply Hardy-Weinberg law to determine gene and allele frequencies

MODULE III: Biochemical and Molecular Evolution: Gene evolution, Evolution of gene families, molecular drive, Amino acid sequence divergence in proteins, Nucleotide sequence divergence in DNA, Molecular clock, Ancient DNA. Biochemical and genomic evolution: The evolutionary history of proteins and the concept of molecular clock. Outline of organization of prokaryotic and eukaryotic genomes. The "C-Value paradox". Evolutionary history of neural integration. Evolution of the endocrine system – Hormones and Evolution. Role of environment in regulating evolution.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend the evolution of macromolecules leading to molecular evolution
M02: Understand the biochemistry behind evolution of biomolecules
M03: Evaluate the significance of ancient DNA leading to molecular clock hypothesis
M04: Analyse the importance of C-Value paradox.
M05: Understand and apply evolution of neural and endocrine systems thereby comprehending the regulation of evolution by the environment

MODULE IV: Ethological principles, Motivation and learning: Concepts in Ethology, Scope of Ethology. Goal-oriented drive, internal causal factor, Homeostatic and Non-homeostatic drives. Psycho-hydrologic model of motivation. Short and long term memory. Habituation - Classical conditioning (Pavlov's experiments), Instrumental conditioning, Latent learning, Trial and error learning, Instinct, Imprinting.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember the basic principles of ethology
M02: Understand the classic experiments in ethology
M03: Evaluate short and long term memory
M04: Analyse the various forms of learning
M05: Apply principle of habituation to determine types of conditioning and learning

MODULE V: Communication and Neurophysiological Aspects of Behaviour: Reflex action, Kinesis, Taxes, Fixed action patterns. Sherrington's neuro-physiological concepts in behavior. Evolution of communication. Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual. Dance language of honey bees. Pheromonal communication.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember various neurophysiological aspects of behaviour
M02: Understand diverse types of neuro-physiological concepts
M03: Evaluate and remember sensory mechanisms in an assortment of organisms
M04: Analyse the languages used by different organisms to communicate with each other
M05: Understand the mechanism of pheromonal communication in animals

MODULE VI: Hormones and behaviour, Social Behaviour and Biological rhythms: Sociobiology, Aggregations – schooling in fishes, herding in mammals. Group selection, Kin selection, altruism, reciprocal altruism, inclusive fitness, co-operation, territoriality,

alarm call. Biological rhythms – Circadian, Circannual, Lunar periodicity, Tidal rhythms. Genetics of biological rhythms. Clock genes.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Understand the basics of social behaviour and Biological rhythms
M02: Comprehend and be acquainted with the types of social behaviours
M03: Evaluate types of selection and altruism
M04: Understand biological rhythms and analyze its different types
M05: Apply concept of biological rhythms to understand the role of clock genes

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

First Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-512: Evolutionary Biology and Ethology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Newborn chicks follow the first moving object they see. Clarify.
2) How does the genome change its structure and size over time ?
3) Information retention in latent learning. Elucidate.
4) Shed light on the process of food production by primary producers.
5) Hormones outside the body. Expound.
6) Charles Darwin wrote a book which was later considered as a bible of Evolutionary Biology. The book talked about a process. What was the process ?
7) "Father of Biogeography". Note down his contributions.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Evolutionary arms race in evolutionary biology. Elaborate.
9) How does evolution occur based on Darwinian concepts ?
10) Why do animals use chemical communication?
11) Present an account of scope of ethology in your terms.
12) How can we account for the amount of DNA in terms of known function? Clarify briefly.
13) Signify in your view, how can the molecular clock model support evolution?
14) Hardy Weinberg principle of equilibrium. How can we apply the assumptions to determine gene and allele frequencies ?
15) The idea of primary abiogenensis lead to synthesis of first prokaryotes. Explain.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Explicate about the various processes involved in Learning and discuss in detail about the process of classical conditioning.
17) Apply Oparin and Haldane concept and add your views to produce an experiment to support their concept.
18) Signify the role of punctuated equilibrium in shaping the process of evolution.
19) Corroborate how molecular biology supports the course of evolution ?

(2x10=20 Marks)

SEMESTER I	Course Code: INB-CC-513	Credits: 3

BIOCHEMISTRY

Course Outcomes (CO)

CO1: Understand the structure and functions of various biomolecules
CO2: Learn about the metabolism of major biomolecules and how the processes are regulated and the diseases caused when the regulation is disrupted
CO3: Expand knowledge on diverse catalysts that trigger and regulate biochemical events in cells
CO4: Comprehend and differentiate fundamental divergence in biological molecules
CO5: Gain knowledge about various biochemical methods used to study diverse biomolecules at micro and macro levels
CO6: Apply knowledge perceived to generate new information and techniques using principles of biochemistry

COURSE CONTENT

MODULE I: Concept of biomolecules: Chemistry of life, Concept and scope. Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance. Buffers - biological importance. Vitamins.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember the concept of chemistry of life and life forms
M02: Understand the molecules at different physical realms
M03: Evaluate the importance of water as a universal solvent
M04: Analyse details of acid – base balance and its regulation
M05: Apply knowledge to formulate new buffers for diverse biological conditions

MODULE II: Carbohydrates and lipids: Monosaccharides - Classification and nomenclature**,** Biological importance. Structural representations of sugars – Isomerism: structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Reactions of monosaccharides: Oxidation, reduction, ester formation. Disaccharides: Sucrose, Lactose. Polysaccharides**:** Homopolysaccharides - Starch, Glycogen, Cellulose, Chitin. Heteropolysaccharides. Overview of Major metabolic pathways – Glycolysis: Fate of pyruvate. Citric acid cycle and its significance; Central role of citric acid cycle. Oxidative and substrate level phosphorylation. Gluconeogenesis, Cori cycle. Glycogen metabolism **-** Glycogenesis, Glycogenolysis, Adenylate cascade system, Regulation of glycogen synthesis. Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Glucuronic acid metabolism, Glycogen storage.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Understand and memorize the various classes of carbohydrates
M02: Comprehend the structural and functional aspects of different classes of carbohydrates
M03: Assess the functional regulation of carbohydrates
M04: Analyse the metabolic pathways of carbohydrates and how their regulation occurs

in various cells

M05: Learn how carbohydrates are used by different cells for various purposes and the diseases humans acquire if the metabolic regulation is interrupted

MODULE III: Classification of lipids: simple, compound and derived lipids. Biological importance of lipids. Fatty acids: classification, nomenclature. Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions: Hydrolysis, Saponification. Glycolipids, Sphingolipids. Prostaglandins- structure, types, synthesis and functions. Beta oxidation, alpha oxidation and omega oxidation of fatty acids. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Ketone bodies - Ketogenesis, Ketolysis, Ketosis. Lipid peroxidation.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Understand and memorize the various classes of lipids

M02: Comprehend the structural and functional aspects of different classes of lipids

M03: Assess the functional regulation of lipids

M04: Analyse the metabolic pathways of lipids and how their regulation occurs in various cells

M05: Learn how lipids are used by different cells for various purposes and the diseases humans acquire if the metabolic regulation is interrupted

MODULE IV: Proteins and enzymes: Structure, classification and properties of amino acids. Amphoteric properties of amino acids, p*K* value and iso-electric point of amino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins. Structural organization of proteins, Ramchandran plot. Primary structure of protein (*e.g.* insulin). Classification and properties of proteins. Fibrous proteins - Keratin, Collagen, Chaperons. Tertiary structure - Myoglobin. Quaternary structure - Haemoglobin. Amino acid metabolism - Deamination, Transamination and Trans-deamination. Formation and disposal of ammonia. Urea cycle. Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember structure, classification and properties of aminoacids and proteins

M02: Understand structural organization of proteins from primary to tertiary forms with examples

M03: Evaluate the metabolism of aminoacids and proteins and how the process is regulated at different levels

M04: Analyse the structure and functions of various proteins and how they regulate various metabolic processes in humans

M05: Apply knowledge to analyse proteins and create new assays to measure protein activity and enhance its functionality

MODULE V: Enzyme Classification - (I. U. B. system), co-enzymes, iso-enzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Active site. Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors

influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition. Enzyme regulation: Allosteric regulations - Key enzymes, Covalent modification. Enzyme engineering**.**

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember classification and properties of enzymes
M02: Understand structural organization of enzymes
M03: Evaluate the functioning and metabolism of enzymes and how the process is regulated at different levels
M04: Analyse the structure and functions of various enzymes and how they regulate various metabolic processes in humans
M05: Apply knowledge to analyse enzyme kinetics and create new assays to measure enzyme activity and enhance catalytic activity of enzymes

MODULE VI: Nucleic Acids: Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson – Crick model). Characteristic features of A, B, C and Z DNA. Structural organization of tRNA, Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation. Catabolism of purines and pyrimidines.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember the basic structure of nucleic acids
M02: Understand the structural organization of DNA
M03: Evaluate different forms of DNA
M04: Analyse various protein nucleic acid interactions and their regulation
M05: Learn and assess the metabolism of nucleic acid in cells

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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- Alonso, A. and Arrondo, J. L. R. (2006). *Advanced Techniques in Biophysics*. Springer, UK
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- Varghese, T. and Balakrishna, K. M. (2012). *Nanotechnology-An Introduction to Synthesis, Properties and Applications of Nanomaterials*. Atlantic Publishers and Distributors. (P) Ltd. New Delhi, India.

On-line Sources

http://employees.csbsju.edu/hjakubowski/classes/ch331/bcintro/olbcmenuoldA.html
http://biochem-vivek.tripod.com/
http://private.nmr.ru/manuals/biophys/OLTB/Textbook.html
http://www.mednotes.net/notes/biophysics/

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Second Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-513: Biochemistry

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) DNA and Protein isolation are normally done in buffers. Why ?
2) Adolf Fick is eminent in the field of biophysics. What is his contribution ?
3) Some lipids are formed of amine alcohol sphingosine and which are mostly found on the cell membranes of the brain and nervous tissue. Which are they ? Elaborate its structure.
4) How the fatty acids, a component of lipids are metabolised to generate acetyl-CoA which is the intermediate of TCA cycle ?
5) "Isomerism and chirality". Comment.
6) When RBCs are placed in hypertonic solution they shrink. What can we infer from it ?
7) If the Isoelectric point of a protein is 6.8 and if the protein is placed in a buffer of pH 8.0. What will be the charge on the protein ? Why ?

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) DNA exists in different polymorphic forms. Elaborate.
9) Transport of various nutrients into the cell takes place across the membrane. How ?
10) Glycolysis takes place in the cytoplasm. How many net ATPs and NADH are formed by this process and how ?
11) All chemical reactions occur spontaneously if (Free energy change) ΔG= -ve. But certain substances can accelerate the rate of this spontaneous reaction. What are those substances ? How they are significant ?
12) Cori cycle occurs through muscles and liver. Elaborate and what is its significance ?
13) The presence of impermeant charged ions on either side of a semipermeable membrane causes an unequal distribution of the charged ions. Discuss it.
14) Role of transamination aminoacid metabolism. Elaborate.
15) "Eicosanoids and Arachidonic acid". How are they related ? Role of Eicosanoids ?

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Ramachandran plot predicts the allowed conformation of proteins. Elaborate its Significance. How are the proteins organized ?
17) Deoxy nucleotides are the monomers of DNA. Discuss its structure and how this is organized according to Watson and Crick double helix model ?
18) Catabolism and anabolism are the main pathways of carbohydrate metabolism.
19) Fatty acids are one of the main energy sources and it liberates energy by metabolism. Discuss it.

(2x10=20 Marks)

SEMESTER I	Course Code: INB-CC-514	Credits: 3

RESEARCH METHODOLOGY, BIOSAFETY AND BIOSTATISTICS

Course Outcomes (CO)

CO1: Understand and memorize basic principles and tools used in biological research
CO2: Learn about new concepts and methodologies to assess critical thinking and problem solving
CO3: Expand knowledge on how to formulate and design a research, performing research and data collection
CO4: Comprehend and get trained in scientific documentation and communication which helps in presentation of data in scientific format
CO5: Gain knowledge in techniques and softwares to analyze data obtained during research analysis
CO6: Apply the knowledge gained to utilize information technology in research
CO7: Create new processes and products using research related to biological sciences information and process it and interpret data

COURSE CONTENT

MODULE I: Science and Life Sciences, Scientific Documentation and Information Sciences: Basic concepts - Knowledge, Information and Data - Science, Pseudoscience. Life Science - Definition, Laws, Characteristics. Scientific temper, Empiricism, Rationalism and Units of measurements. Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications). Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference. Sources of Information - Primary and secondary sources. Library - books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents. Internet - Search engines and software, Online libraries, e-Books, e-Encyclopedia, TED Talk, Institutional Websites.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Comprehend and understand principles of research
M02: Learn to differentiate between Science and pseudoscience
M03: Evaluate the documentation process involved in research
M04: Analyse the various methods of scientific temper and its use in research
M05: Apply knowledge of proposal writing and report presentation in research communication

MODULE II: Research plan and Analysis: Basic concepts of research - Meaning, Objectives, Motivation and Approaches. Types of Research (Descriptive/Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/Empirical. Research methods versus Methodology, Research and scientific method. Research Process. Research Formulation: Research formulation - Observation and Facts, Prediction and explanation, Deduction. Defining and formulating the research problem, Selecting the problem and necessity of defining the problem. Literature review - Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Know the basics of research methodology
M02: Understand the fundamentals of research formulation
M03: Evaluate the process of literature review
M04: Analyse the necessity of defining a research problem
M05: Apply the knowledge gained in performing literature review for a definite problem

MODULE III: Hypothesis -Null and alternate hypothesis and testing of hypothesis - Theory, Principle and Laws. Research Designs: Research Design - Basic principles, Meaning, Need and features of good design, Important concepts. Types of research designs. Development of a research plan-Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs. Data collection techniques. Tests of significance (For large and small samples – Critical Ratio and P value). Z Test (Problem for small samples), Chi- Square Test. Student's 't' test (Problem for small samples comparing mean of two variable). F-test and Analysis of Variance (ANOVA - One way) (Brief account only).

Module Outcome:

After Completion of this module, the student should be able to:

M01: Be trained and remember fundamentals in designing research plans
M02: Understand various types of research designs
M03: Evaluate about research process and research formulation
M04: Analyse the procedure involved formulating a research design
M05: Apply the knowledge gained about different types of research designs to create new protocols for carrying out research

MODULE IV: Biosafety and Bioethics: Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications. Safety measures in the laboratory research, Good laboratory practices, Precautions for Handling of chemicals and radionuclide, Waste disposal. Ethics in research, ethics of GMO, ethics committee and evaluation. Ethics in scientific communications. Bioethics: Principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity. Ethics in post genomic era-genetic testing and genetic screening.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember about intellectual property rights
M02: Understand different types of intellectual property rights
M03: Evaluate safety and precaution in research practices and bioethics
M04: Analyse the various types of lab protocols for biosafety
M05: Apply the knowledge gained to create lab protocols and structuring labs

MODULE V: Biostatistical Analysis: Steps in Statistical Investigation, Data and Variable (Collection, Types, Sources). Population, Sample, Sampling Methods (Random, Cluster, Stratified and Geographical) and Sampling Errors/Bias. Organization of Data - Editing, Classification, Tabulation (forming a frequency distribution from raw data and types and characteristics of a Frequency table). Presentation of Data - Types and Characteristics of Tables and Visual aids – Graphs, Charts, Diagrams, Flow charts, Cartographs.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Be trained and remember tools used for biostatistical analysis
M02: Understand the principles in sampling methods and sampling errors
M03: Evaluate the organization of data and its types
M04: Analyse and apply various statistical presentation tools to represent data
M05: Apply the knowledge about various techniques to perform and create new tools for efficient analysis of information obtained during research

MODULE VI: Measures of Central Tendency: Introduction, Characteristics, Merits and Demerits of Mean, Median and Mode. Calculations/Problems for different data (raw, frequency table). Harmonic and Geometric Mean (Brief account only). Measures of Dispersion: Introduction, Characteristics, Merits and Demerits of Range, Quartile Deviation, Mean Deviation and Standard Deviation. Standard Error and Relative Measures of Dispersion, Skewness and Kurtosis (Brief account only). Correlation - types and methods of correlation analysis, Regression and Line of Best Fit, Types and methods of regression analysis.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Ahuja, V. K. (2010). *Law of Copy Rights and Neighbouring Rights: National and International Perspectives*. Lexis Nexis- Butterworths Wadhwa, Nagpur, India.
- Kothari, C.R. (2009). *Research Methodology: Methods and Techniques*. (2nd edn.). NewAge International Publishers, New Delhi, India.
- McGee, G. (2003). *Pragmatic Bioethics*. The MIT Press, MA, USA.
- Rao, P. S. S. and Richard, J. (2006). *Introduction to Biostatistics and Research Methods*. (4th edn). Prentice Hall, New Delhi, India.

On-line Sources:

http://quizlet.com/8794604/research-methodology-study-guide-final-ndnu-flash-cards/
http://pinkmonkey.com/studyguides/subjects/stats/contents.asp
http://www.medpagetoday.com/lib/content/Medpage-Guide-to-Biostatistics.pdf
http://serc.carleton.edu/introgeo/teachingwdata/Stats.html
http://www.vu.nl/en/study-guide/2012-2013/master/a-b/bioinformatics/index.asp

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Third Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-514: Research Methodology, Biosafety and Biostatistics

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Elucidate on IPR.
2) Explicate on Induction in terms of research methodology.
3) Present your views on the role of Fundamental research in present scenario.
4) Hypothesis forms the basic structure of research. Validate the statement.
5) Expound about the role of research design in biological research.
6) Present your views on the role of probability in present scenario.
7) Signify the role of biological databases as source of literature.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Present your view on the role of information technology in research.
9) List out the classifications of research types.
10) Construe about the process of research methodology in biological research.
11) What is a scientific hypothesis? Formulate the various steps in hypothesis formation.
12) Briefly put in plain words the significance of presentation methods in research.
13) Parse about the features of hypothesis testing.
14) Parse about the features of good research design ?
15) Analyze the various steps involved during the preparation of research design.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) "Documentation is one of the most important steps of a scientific research proposal". Articulate.
17) Why is significance testing important in research ? Elucidate various tests used for testing significance of information after analysis of research data.
18) Explicate the steps involved in collection, sampling and organization of data ?
19) "The future of research in life science is not in novelty but in innovation." Present your thoughts on the statement.

(2x10=20 Marks)

SEMESTER I	Course Code: INB-CC-515	Credits: 2

PRACTICAL I: PHYSIOLOGY, BIOCHEMISTRY AND RESEARCH METHODOLOGY

Course Outcomes (CO)

CO1: Understand the normal and aberrant physiological processes of vertebrate and invertebrate animals

CO2: Learn about functioning of basic human physiological activities

CO3: Develop knowledge on osmoregulatory mechanisms using fish as model organism and human blood constituents

CO4: Comprehend processes of thermoregulation and motility using *Paramecium* as model organism

CO5: Study identification and characterization of microbes using staining and biochemical tests

CO6: Apply assays to check antimicrobial activity of various samples

COURSE CONTENT

1. Preparation and staining of blood smear
2. Differential count of WBC
3. Quantitative determination of plasma Urea Concentration
4. Quantitative determination of plasma Glucose concentration
5. Measure Packed Cell Volume of Whole Blood using Microhematocrit
6. Effect of Tonicity on Human Blood Cells
7. Identification of ABO blood groups
8. Determination of Iodine number of fats
9. Estimation of protein by Lowry's method
10. Preparation of osazones and identification of carbohydrates
11. Colour reactions of proteins
12. Thin Layer Chromatography
13. Preparation of buffer
14. Writing a project proposal
15. Preparation of original research article and review article
16. Analysis of mean and standard deviation using statistical tools and softwares
17. Presentation of data and results using various representation tools including graphs, pie chart and bar diagrams

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Preparation and analysis of experimental data
- Practical skill development
- Develop expertise in handling lab equipments

LEARNING RESOURCES

References

- Goldman, E. and Green L. H. (2015). *Practical handbook of Physiology*. 3rd edn. CRC Press. Taylor and Francis Group. USA.
- Khan, S. M. (2016). *Practical Physiology: A New Approach*. Jayppee publications.
- Mali, R. P. and Afsar, S. K. (2015). *A Practical Manual on Innovative Animal Physiology.* Science, Technology and Medicine.
- Pal, G. K and Pal, P. (2010). *Textbook of Practical Physiology*. Higher Education Text books.
- Varshney, V. P. and Mona, B. (2018). *Ghai's Textbook of Practical Physiology*. 9th edn. Higher Education Text books.
- Kothari, C.R. (2009). *Research Methodology: Methods and Techniques*. (2nd edn.). NewAge International Publishers, New Delhi, India.

On-line Sources

https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
https://faculty.washington.edu/korshin/Class-486/MicrobiolTechniques.pdf
https://www.researchgate.net/publication/303820251_PHYSIOLOGY_PRACTICALS
https://www.knauer.net/en/Systems-Solutions/Osmometry
http://www.phys.szote.u-szeged.hu/edu/angla/labprac1+2.pdf
https://sites.google.com/a/koyauniversity.org/anp6119/practical
https://www.slideshare.net/vidhyakalaivani29/animal-physiology-and-biochemistry-lab-manual-64718095
https://www.worldscientific.com/worldscibooks/10.1142/1337
https://www.youtube.com/channel/UCX8IBPjimE3iZH7MpviZc6Q

ASSESSMENT

100% End-semester/Summative Assessment: 4 hour Practical and Viva Voce examination.

SEMESTER I	Course Code: INB-DE-516	Credits: 2

STRESS PHYSIOLOGY AND ADAPTATION BIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify basic knowledge of study of stress in the animal world
CO2: Give an overview of the comparative functioning of different adaptive systems in animals.
CO3: Gain knowledge on physiological stress
CO4: Comprehend concepts related to various stress endured by the organisms and how they adapt to these adverse conditions
CO5: Apply concepts and principles of adaptive functioning of respiratory, cardiovascular and sensory systems
CO6: Understand Environmental and adaptive physiology and apply its concepts for the betterment of animals in nature

COURSE CONTENT

Module I: Stress Physiology and Ease Physiology: Concepts of stress and ease, stressors, integrated stress response, ease response, eustress, distress.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of stress and ease physiology
M02: Understand mechanisms of hormonal regulation of stress adaptation
M03: Evaluate stress response, ease response
M04: Analyse ease response in various organisms
M05: Apply techniques to determine levels of stress and ease in different organisms

Module II: Stress adaptation and tolerance. Mechanism of stress tolerance, stress acclimation, stress proteins. Endocrinology of stress and ease, endocrine stress axis. Hormonal regulation of stress adaptation. Hormonal control of ease response in fish and mammals.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of stress tolerance
M02: Understand mechanisms of hormonal regulation of stress adaptation
M03: Evaluate stress tolerance and acclimation
M04: Analyse ease response in various organisms
M05: Apply various methods to evaluate stress in animals from stress protein/hormone analyses.

Module III: Definition, Types of adaptations-Physical and behavioural, Environmental conditions of aquatic, terrestrial, xeric and aerial habitats. Nature of interaction with the environment-Tolerance, resistance, acclimation and acclimatization, Physiological Effects of temperature change in animals-Q 10 effect; Lethal temperature, causes of thermal death (high and low temperature). Light conditions - eclosion in insects.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of physical and behavioural adaptation
M02: Understand the nature of interaction of animals with the environment
M03: Evaluate physiological effects of temperature change in animals
M04: Analyse different types of physical and behavioural adaptations
M05: Apply strategies to evaluate tolerances to environmental and physical conditions in animals.

Module IV: Aquatic life: Adaptations of marine, intertidal, estuarine and fresh water animals (Lentic and lotic) with emphasis on morphological and physiological adaptations. Terrestrial and aerial life: Adaptations for life in forest, grass land and desert. Flight adaptations-morphological and physiological in insects and birds.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember diverse aquatic, terrestrial and ariel adaptations
M02: Understand morphological and physiological adaptations of aquatic animals
M03: Evaluate distinctive adaptations in marine, estuarine and freshwater fishes
M04: Analyse various terrestrial adaptations to live in forest, grassland and desert.
M05: Apply and develop new methods to study flight adaptation differences and similarities in insects and birds.

Module V: Life in extreme environments: Adaptations for life in Deep -sea and caves; Effects of depleted oxygen availability; adaptations for deep-sea diving and high altitude conditions.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the life forms in extreme environments
M02: Understand the divergent adaptations for deep-sea and caves
M03: Evaluate the effects of Oxygen in the life in extreme environments
M04: Analyse the differences between deep-sea and cave adaptations
M05: Apply techniques to explore deep-sea and high altitudes to study more about life in extreme conditions

Module VI: Biological rhythms: Rhythms as adaptive feature, Types of rhythms, Circadian rhythms – Examples in man, jet lag, health Impacts of disruption in sleep-wake rhythm, Entrainment, Phase shift, Phase response curves (PRC) and phase transition curves (PTC).

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the various types of biological rhythms
M02: Understand principles of rhythms in animals
M03: Evaluate the adaptive feature of biological rhythms.
M04: Analyse health impacts of disruption in circadian rhythms
M05: Apply new approaches to understand circadian rhythms in animals

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Iwama GK, Pickering AD, Sumpter JP (2011) Fish Stress and Health in Aquaculture. Cambridge University Press, Cambridge, UK
- Jay, C. D., Jennifer. J. Loros, Patricia J. DeCoursey (ed.), (2004) ChronobiologyBiological Timekeeping: Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
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- Moberg GP, Mench JA (2000) The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare. CABI Publishing, Wallingford, UK
- Nesse RM, Young EA (2007) Evolutionary origins and functions of the stress response. In Encyclopaedia of Stress, Ed 2. Academic Press, San Diego, USA, pp 965–970.
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- Steel C.G.H. and Afopoulou X., (2002) Insect Clocks (ed.) R.D. Lewis.(3rd Ed) Barens and Noble Inc. New York, USA.
- Weibel, E.R., Taylor C.R., Bolis L. (1998) Principles of Animal Design, Cambridge –University Press.

On-line Sources

https://www.ncbi.nlm.nih.gov/books/NBK541120/#:~:text=Physical%20stress%20stimulates%20the%20HPA,response%2C%20and%20delayed%20wound%20healing.
https://www.ncbi.nlm.nih.gov/books/NBK278995/
https://www.health.harvard.edu/staying-healthy/understanding-the-stress-response
https://education.nationalgeographic.org/resource/adaptation/

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

First Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. M. Sc. Zoology with specialization in Integrative Biology
INB-DE-516: Stress Physiology and Adaptation Biology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Annotate on the direct and indirect effects of physiological distress.
2) Explain lethal temperature.
3) Write a note on stress indicators.
4) Distinguish between physical and behavioural adaptations.
5) Expound the incidence of jetlag.
6) Evaluate physiological effects of temperature change in animals.
7) Elaborate the idea of tolerance and resistance in adaptation.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Give an account of various stress hormones.
9) Describe pre – adaptation.
10) Hormonal functions get messed up when you are stressed. Account for this statement.
11) All animals do not show the same adaptations for terrestrial habitats. Evaluate with examples.
12) Annotate the differences between flight adaptations of birds and insects.
13) Give an account of the role of stress leading to evolution.
14) Explain the different types of biological rhythms.
15) Expound on the role of ease response in stress management.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) When animal is exposed to various stressors, which all stress hormones will be analyzed to confirm the animal is stressed ? How hormones mediate the body's response to stress ?
17) How do bony fishes adapt to different osmoregulatory strategies in fresh water, estuarine and marine environments.
18) Illustrate how life is possible in extreme conditions with suitable examples.
19) Adaptation occurs when the organism undergoes stress. Substantiate the statement with example.

(2x10=20 Marks)

SEMESTER I	Course Code: INB-DE-517	Credits: 2

ANIMAL CELL CULTURE TECHNIQUE

Course Outcomes (CO)
CO1: Understand the basics of animal cell culture
CO2: Evaluate the role of cell culture in biomedical research
CO3: Attain the skills for setting up tissue culture lab for their research
CO4: Comprehend the cell culture application for research purpose
CO5: Apply the knowledge on cell culture techniques to culture cell lines
CO6: Create new media composition and techniques to culture and maintain animal cells

COURSE CONTENT

Module I: Animal cell culture: Historical background. Advantages and limitations. Laboratory design and layout. Equipments. Aseptic techniques.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember historical background of animal cell culture
M02: Understand the layout of laboratory design
M03: Comprehend about equipments in cell culture lab
M04: Analyse aseptic conditions for laboratory
M05: Apply the knowledge gained to devise novel aseptic techniques and prepare laboratory layout

Module II: Culture Vessels and substrates. Defined media and supplements. Preparation and sterilization of media.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Understand the vessels used in cell culture
M02: Gain knowledge on various substrates used in cell culture
M03: Differentiate between defined media and supplements in media
M04: Analyse sterilization of media and its preparation
M05: Create novel media for use in cell culture

Module III: Primary culture. Subcultures and cell lines. Cell separation techniques. Characterization. Differentiation. Tranformation and immortalization.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn the principles of primary culture
M02: Understand the maintenance of cell lines
M03: Differentiate cell separation techniques
M04: Analyse the immortalization process in cell culture
M05: Apply the techniques to create new cell lines by immortalization

Module IV: Contamination in cell culture. Sources, types, Monitoring, Disposal and eradication of contaminated cultures.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Understand the contaminations affecting cell culture
M02: Learn methods to prevent contamination of media
M03: Comprehend about sources of contamination and its monitoring
M04: Differentiate the types of contamination and its eradication methods
M05: Apply knowledge learnt to prevent contamination and its disposal

Module V: Cryopreservation and Quantification. Principles of cryopreservation. Methods in cryopreservation. Quantification of cells in culture using cell counting methods. FACS.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn and remember about cryopreservation
M02: Understand the principles in cryopreservation
M03: Evaluate methods in cryopreservation of cell culture
M04: Analyse quantification of cells in cell culture
M05: Apply principles learnt to create novel techniques in flow cytometry

Module VI: Culture of tumor cells. Sampling and primary culture. Development of cell line. Development of cell lines. Specific tumor types. Scale up.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn about tumor cells
M02: Understand about sampling and primary culture of tumor cells
M03: Comprehend about development of cell line
M04: Evaluate and differentiate between specific tumor types in cell culture
M05: Create novel scale up methods for culturing tumor cells for research purpose

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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- R. Ian Freshney, Seventh Edition, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, (2017).

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https://link.springer.com/book/10.1007/978-3-642-80412-0

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

First Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. M. Sc. Zoology with specialization in Integrative Biology
INB-DE-517: Animal Cell Culture Technique

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:
1) Annotate on the history of cell culture.
2) Explain the limitations of cell culture.
3) Write a note on defined media.
4) Distinguish between physical and chemical sterilization techniques.
5) Give reasons for immortalizing cells.
6) Evaluate the sources of contamination in cell culture.
7) Elaborate the process of quantification of cells.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:
8) Give an account on laboratory design.
9) Describe aseptic techniques.
10) Evaluate the process of sterilization of media.
11) Differentiate subcultures and cell lines.
12) Annotate the differences between transformation and differentiation.
13) Analyze the types and eradication strategies for contamination in cell culture.
14) Expound on the process of development of cell line.
15) Cell culture as an indispensible step in drug development. Validate.

(6x5=30 Marks)

III. Answer **any two** of the following:
16) Delineate the process of creating a cell line from a biopsy tissue sample.
17) Cryopreservation is the tool with which we can manipulate the future of humans. Substantiate with example.
18) A researcher finds his cells in the culture not growing but the medium turning yellow. What can he infer and how will he overcome the problem without losing the cells ?
19) Formulate a media which will help in culturing both cancer cells and normal cells so that the toxicity of a novel drug can be tested for its efficacy.

(2x10=20 Marks)

SEMESTER II	Course Code: INB-CC-521	Credits: 4

BIONINSTRUMENTATION AND BIOPHYSICS

Course Outcomes (CO)

CO1: Understand the major tools and techniques used for studying biochemical and biophysical nature of life

CO2: Learn about analytical methods used for measuring biomolecules and pharmacologically active substances

CO3: Develop knowledge on safety concerns which arise during and after any biological assay is performed

CO4: Comprehend protocols better and create new procedures by improvising existing assays to measure various biomolecules

CO5: Gain awareness about the principles and various applications used in Biophysics for studying Biochemical processes

CO6: Apply knowledge achieved to create new assessments tools for measuring levels of biomolecules

COURSE CONTENT

MODULE I: Microscopy: History. Parts of simple and compound microscopes. Differential Interference contrast (Nomarsky) microscopy, Confocal microscope, Electron microscope –TEM, SEM, Scanning Tunnelling and Atomic Force Microscopes.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember history of microscopy

M02: Understand different parts of various microscopes

M03: Evaluate pros and cons of various microscopes

M04: Analyse functioning of electron microscopes

M05: Apply knowledge to design novel microscopes with improvements over existing designs

MODULE II: Chromatography: Paper chromatography, Thin layer chromatography, Ion exchange chromatography, Gel permeation chromatography, Affinity chromatography, Gas chromatography, High pressure liquid chromatography (HPLC). Electrophoresis: Paper electrophoresis, Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and non SDS, Agarose gel electrophoresis, Disc electrophoresis, High voltage electrophoresis, immunoelectrophoresis, isoelectric focusing. Colorimetry, Spectrophotometry and Spectroscopy: Principle and applications of colorimetry and spectrophotometry. Spectroscopy: Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic Resonance spectroscopy (NMR), Circular Dichroism spectroscopy, ESR spectroscopy, Mass spectroscopy. pH meters. Principle and working of IR, Raman spectroscopy. Centrifugation: Basic principles of sedimentation, Types of centrifuges. Analytical and Preparative centrifugation. Differential and density gradient centrifugation.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and remember techniques in chromatography, electrophoresis, spectroscopy

and centrifugation
M02: Understand principles of different types of chromatography, electrophoresis, spectroscopy and centrifugation methods
M03: Evaluate functioning of different types of chromatography, electrophoresis, spectroscopy and centrifugation methods
M04: Analyse the instruments used to assess levels of biomolecules using chromatography, electrophoresis, spectroscopy and centrifugation methods
M05: Apply the principles to create novel processes and instruments using principles in chromatography, electrophoresis, spectroscopy and centrifugation

MODULE III: Radioisotope Detection and Measurement: Dosimetry: Ionization chamber, GM counter, Solid and liquid scintillation counters, Autoradiography, Radio ImmunoAssay, Enzyme Linked Immuno Sorbant Assay (ELISA). Nanotechnology**:** Nanosensors and Nanomedicines.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Comprehend and remember basics of radioactivity
M02: Understand principles in radioisotope detection and its measurements
M03: Evaluate types of devices to measure radioactivity
M04: Analyse diverse radioactive biomolecules using principle of ELISA
M05: Apply knowledge to design novel methods and instruments to measure radioactivity

MODULE IV: Histological Techniques: Fixation, preparation of temporary and permanent slides, whole mounts, smears, squashes and sections. Specimen preparation for TEM, SEM, shadow casting, freeze fracturing, freeze etching, negative staining. Cytochemical and histological methods - Microtome techniques, fixation, staining. Flow Cytometry.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn and remember principle behind histological techniques
M02: Understand the methods of preparation of samples for histological examination
M03: Evaluate the types of electron microscopy
M04: Analyse the representations gained after performing histological techniques
M05: Apply knowledge added to create innovative techniques for histological examination of biological samples

MODULE V: Concepts in Biophysics: Diffusion and Osmosis Diffusion - Kinetics of diffusion, Fick's law of diffusion and diffusion coefficient, Biological significance in animals and plants. Electrochemical gradient, Stokes-Einstein equation and Graham's law, Facilitated diffusion, Gibbs-Donnan equillibrium. Osmosis - osmotic concentration and osmotic pressure, Biological significance of osmosis in animals and plants. Biophysics of Cell Membrane: Physico-chemical properties of cell membrane, conformational properties of cell membranes, Membrane Transport – endocytosis, exocytosis, Nutrient transport across membranes, porins facilitated diffusion, porter molecules. Facilitated transport: symport, antiport, uniport, anion porter, glucose porter. Active transport: proton pumps, $Na^{+}K^{+}$ pumps and Ca^{++} pumps, ionic channels. Functions of cell membrane. Artificial membranes.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember basic biophysical principles

M02: Understand significance of processes like osmosis and diffusion and how they occur in cells

M03: Evaluate different forms of osmosis and diffusion and active transport

M04: Analyse transfer of various biomolecules and solutes across cellular membranes

M05: Apply knowledge to create novel artificial membranes which can replace the current cellular membranes with higher efficiency

MODULE VI: Bioenergetics: Thermodynamics- Laws of thermodynamics, Entropy, Enthalpy, Free energy. Reversible thermodynamics and irreversible thermodynamic. Systems – open, closed and isolated. Photo bioenergetics. Photosynthesis – light and dark reactions, Redox couple and redox potential. Chemo-bioenergetics: electron transport and oxidative phosphorylation. Chemiosmotic theory and binding change mechanism of ATP synthesis. Radiation Biophysics: Interaction of radiation with matter – Photoelectric effect, ion pair production, absorption and scattering of electrons. Biological effects of radiation: effect on nucleic acids, proteins, enzymes and carbohydrates. Cellular effects of radiation: somatic and genetic. Nuclear medicine: Internally administered radioisotopes. Radioiodine in thyroid function analysis. Renal, liver and lung function analysis. Application of radioactive tracers. Radiation protection and therapy.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and memorize basic laws of thermodynamics

M02: Understand diverse energy dependent cellular processes and its bioenergetics

M03: Evaluate the interaction of radioactivity in cellular models and its uses

M04: Analyse the beneficial and detrimental effects of radioactive substances in biological samples

M05: Apply knowledge to create new radioactive tracers which can be used for prognostic and therapeutic practices

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Baker, E.J. and Silverton R. E. (1978). *Introduction to Medical Laboratory Technology*. ELBS. London, UK.

- Das, D. (1991). *Biophysics and Biophysical Chemistry*. Academic Publishers, Calcutta.
- Edward, A.L. (1997). *Radiation Biophysics.* Academic Press, NY, USA.
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- Gupta, A. (2009). *Instrumentation and Bio-Analytical Techniques*. Pragati Prakashan, Meerut.
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- Pradeep, T. (2007). *NANO: The Essentials. Understanding Nanoscience and Nanotechnology*. Tata Mc.Graw Hill Publications, India.
- Sandhu, G.S. (1990). *Research Techniques in Biological Sciences*. Anmol Publications, New Delhi, India.

On-line Sources

http://www.rsc.org/globalassets/09-careers/personal-professional-development/professional-scientists/qp-study-guide.pdf
https://moodle.kent.ac.uk/external/mod/book/view.php?id=2604&chapterid=163
http://www.purdue.edu/ehps/rem/home/booklets/bioman.pdf

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Second Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-521: Bioinstrumentation and Biophysics

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Radio labelled antibodies are widely used in immunoassays for high sensitivity tests. Specify.
2) There are analytical techniques which measure the mass-to-charge ratio and present the result as a mass spectrum. Identify this spectroscopy and explain the principle.
3) There are techniques which employs the sublimation of ice to reveal internal structures. Clarify.
4) Which microscopy technique will you use to to study the surface of nano materials ?
5) There is a spectroscopy which is commonly used to study the secondary structure of proteins on the basis of chirality. What is your take on this ?
6) "Nuclear spin and spectroscopy". Discuss the concept.
7) How sucrose and cesium chloride are important in centrifugation. Comment.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Radiolabelling is important in the isolation of macromolecules such as DNA or protein. Name the technique which employs this principle and discuss the protocol.
9) What are the steps will you adopt for the disposal of bio-hazardous wastes ?
10) How will you analyse the serum of a patient with suspected food poisoning for botulinum toxin employing Immunoelectrophoresis ?
11) Can we modify the genome of an organism ? If yes how ? Discuss its application.
12) "Nanoparticles as sensors". Elaborate.
13) Beer lambert's contribution in the field of spectrophotometry. Comment.
14) How acetylcholine receptors can be purified from a mixture of proteins employing chromatography ?
15) Most advanced chromatographic techniques are used for the isolation and purification of bioactive compounds. Specify.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) What are the strategies that you will adopt to separate DNA and proteins employing electrophoresis ?
17) Discuss about the protocol to detect a specific protein from a cellular protein extract.
18) What safety measures will you adopt to work in a laboratory ?
19) Radioactive isotopes have immense application in biomedical research. How will you detect and measure it ?

(2x10=20 Marks)

SEMESTER II	Course Code: INB-CC-522	Credits: 3

ENVIRONMENTAL BIOLOGY

Course Outcomes (CO)

CO1: Eloquent understanding of the fundamentals in ecological studies and exemplifies the basic concepts of ecology

CO2: Facilitate to remember and analyze the way of interaction between organisms, species and communities

CO3: Gain knowledge on the impact of natural and human altered ecosystems on environment

CO4: Comprehend the concept of adaptation of biotic elements with the abiotic factors

CO5: Apply concepts and principles of ecology to evaluate the causes and consequences of pollution in the environment

CO6: Understand to create new ideas based on resource ecology and applied ecology

COURSE CONTENT

MODULE I: Ecology and Environment: Physical Environment- biotic and abiotic interactions. Concept of Homeostasis; Concepts of habitats: host as habitat, niche, niche width and overlap, fundamental and realized niche, resource partitioning, Cybernetic nature of ecosystem, resistance and resilience stability. Gaia hypothesis. Concept of limiting factors- Liebig's law, Shelford's law. Ecological indicators. Ecology Vs Environmental science

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember concepts of ecosystem homeostasis

M02: Understand the concept of niche

M03: Evaluate the cybernetic nature of ecosystem along with biotic and abiotic interactions

M04: Analyse the concept of limiting factors

M05: Apply ecological indicators to detect signals of environmental change

MODULE II: Ecosystem: Structure and Function, Ecosystem and Landscapes, pathways in ecosystem, energy in the environment-Laws of thermodynamics, energy flow in the ecosystem. Primary productivity, Biomass and productivity measurement. Food chain, food web, trophic levels. Ecological efficiencies, Ecological pyramids, Biogeochemical cycles- patterns Tropical versus Temperate Ecology. Weater and Climate. Atmosphere – Structure and composition. Local winds, trade winds. Indian and African monsoons. Inversion: Tempreature or thermal inversion – causes, consequences, subsidence inversion. Clouds: their formation and types. Element and factors of climate: external and internal. Global climate changes: causes and consequences. Human population: Exponential growth, geometric growth or decay. Malthusian growth model. Current trends in global population with reference to developed and developing countries. Population explosion.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember and understand the structure and function of ecosystem

M02: Understand the energy as well as laws of thermodynamics
M03: Evaluate working of biogeochemical cycles
M04: Analyse the various types of ecological efficiencies
M05: Apply techniques to measure biomass and productivity

MODULE III: Population Ecology: Population group properties, density and indices of relative abundance, Concept of rate. Natality and mortality. Population age structure, Growth forms and concept of carrying capacity. Population fluctuations, density dependent and density independent controls. Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality. Population interactions- types, positive and negative, interspecific and intraspecific interactions. Ecological and evolutionary effects of competition. Concept of metapopulation. Levin's model of metapopulation. Comparison of Metapopulation and Logistic population model. Metapopulation structure.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the concept and properties of population ecology
M02: Understand mechanisms of population fluctuation
M03: Evaluate functioning of models of metapopulation
M04: Analyse the ecological effects of competition
M05: Apply various models to study metapopulation structure

MODULE IV: Community Ecology: Concept of community - community structure and attributes, ecotone and edge effect. Development and evolution of the ecosystem, concept of climax. Species diversity in community and it's measurement- Alpha diversity, Simpson's diversity index, Shannon index, Fisher's alpha, rarefaction. Beta diversity- Sorensen's similarity index, Whittaker's index, Evenness, Gamma diversity, Guild and its functioning.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concept of community
M02: Understand mechanisms of expansion of ecosystem
M03: Evaluate species assortment in community
M04: Analyse various indices of species diversity measurement
M05: Apply different methods to calculate species diversity

MODULE V: Resource Ecology: Natural Resources: Soil-soil formation, physical and chemical properties of soil. significance of soil fertility. Mineral resources with reference to India. Impact of mining on environment; Forest resources deforestation, forest scenario of India. Aquatic resources - Freshwater and water scarcity, water conservation measures - case studies from India; Wetlands and its importance, international initiatives for wetland conservation - Ramsar sites. Wetland reclamation- causes and consequences. Depletion of resources and impacts on quality of life. Energy Resources- solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear. Energy use pattern in different parts of the world, recent issues in energy production and utilization; Energy audit, Green technology and sustainable development. Ecosystem monitoring- GIS, Physics of remote sensing, role of remote sensing in ecology, GPS and its application; EIA- tools and techniques, Ecosystem Modeling (Brief account only).

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the natural resources and its properties
M02: Understand concepts of environmental perturbations
M03: Evaluate human influence on environment
M04: Analyse various ecosystem monitoring programmes
M05: Apply ecosystem models to understand complex ecological processes

MODULE VI: Applied Ecology: Environmental Pollution-types, causes and consequences. Concept of waste, types and sources of solid wastes including e-waste; Environmental biotechnology and solid waste management- aerobic and anaerobic systems. Concept of bioreactors in waste management. Liquid wastes and sewage. Bioremediation- need and scope of bioremediation in cleaning up of environment. Phytoremediation, bio-augmentation, biofilms, biofilters, bioscrubbers and trickling filters. Radiation Biology - natural and man-made sources of radioactive pollution; radioisotopes of ecological importance; effects of radioactive pollution; nuclear disasters (two case studies), Disposal of radioactive wastes. Toxicology- Principles, toxicants-types, dose and effects, toxicity of heavy metals.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember causes and consequences of pollution
M02: Understand concepts of solid wastes together with e-waste
M03: Evaluate various waste management systems
M04: Analyse the causes and effects of radioactive pollution
M05: Apply techniques to detect xenobiotics in biological specimens

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

- Abbasi, S. A and Ramasami, E.V. (1998). *Biotechnological Methods of Pollution Control*. Oxford University Press, Hyderabad.
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- Tietenberg, T. (2004). *Environmental and Natural Resource Economics*. 6th edn. Pearson, New Delhi.

On-line Sources

http://www.marietta.edu/~biol/102/102.html
http://quizlet.com/5573974/ecology-study-guide-flash-cards/
http://www.course-notes.org/Environmental_Science
https://learn.careers360.com/biology/ecology-and-environment-chapter/
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https://link.springer.com/book/10.1007/978-1-4020-6850-8

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Second Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-522: Environmental Biology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Indicator species in ecology and their importance. Annotate.
2) List the role of Food web in stabilizing energy management in the environment.
3) Beta-Diversity as a measure of Biodiversity Conservation. Expound.
4) Natality and mortality affect population. Present your views.
5) The role of greenhouse effect on Earth. Speculate.
6) Give reasons for why limiting factor decides the energy flow in food chain.
7) Signify the importance of Gaia hypothesis in sustaining the biosphere.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Elaborate on how Global Positioning System helps the environment.
9) Put in your words, how the impact of ozone depleting factors can be minimized.
10) Compile the steps used to characterize species diversity in a community using Shannon index.
11) Articulate on the different ways in which populations interact with each other.
12) Discuss about the process of soil formation and properties of diverse soil types.
13) Metapopulations contribute to the preservation of biodiversity. Enumerate points to support the statement.
14) How can we graphically represent the relationship between different organisms in an ecosystem ?
15) Explicate on the different community structures that influence species abundance along environmental gradients.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Elaborate on the different biogeochemical cycles with their importance in maintaining the ecosystem homeostasis?
17) Account for cell and tissue radio sensitivity with respect to practical impacts of radiation biology.
18) Have you ever wondered how many species live on Earth ? How can you account for the importance of diversity of species ?
19) The effects of pollution on the environment can be seen in the form of severe health conditions. What are the main causes of environmental pollution and how can we stop environmental pollution ?

(2x10=20 Marks)

SEMESTER II	Course Code: INB-CC-523	Credits: 3

ANIMAL SYSTEMATICS AND DIVERSITY

Course Outcomes (CO)

CO1: Articulate and exemplify the principles and practices of systematics and diversity
CO2: Give an overview of the assessment and protection of biodiversity
CO3: Acquire an in-depth knowledge on the diversity and relationships among organisms in the environment
CO4: Understand the concept of conservation biology that would comprise the threats with regard to biodiversity
CO5: Apply molecular phylogeny and cladistic studies in the field of systematics
CO6: Understand various conservation strategies to overcome the biodiversity threats

COURSE CONTENT

Module I: Concepts and Techniques in Systematics: Three Domain Concept in Systematics, two, five and six kingdom classification. Concept of species taxonomic diversity within species. Molecular Phylogeny-use of Proteins, DNA and RNA. Phylogenetic trees. Taxonomic collections- types of collections, value of collections. Curation- preservation of collection in field and laboratory. Recording of field data, storage of collection, labelling and cataloguing of collections. Identification- methods of identification. Use of keys- kinds of keys, their merits and demerits. Taxonomic descriptions: presentation of findings. Kinds of taxonomic publications. Taxonomic and ecological publication and their difference.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of systematics
M02: Understand the three domain model in systematics
M03: Evaluate the uses of molecular phylogeny
M04: Analyse the concept of taxonomic diversity within species
M05: Apply techniques to construct phylogenetic trees

MODULE II: Biological Classification: Principles and methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical and quantititative methods of taxonomy of plants, animals and microorganisms. Classical and modern methods-Typological, Phenetics, Evolutionary, Phylogenetic, Cladistics and Molecular Taxonomy. Phylocode, Tree of Life and Bar-coding of Life. Species category – different species concept: typological, nominalistic, biological, evolutionary, recognition, ontological and operational. Classification and salient features of Insect Orders. Biology, habits and important features of harmful insects. External Morphology: Segmentation and division of the body – Insects. Mouth parts of Insects. Aquatic insects. Gall forming insects. Leaf mining insects. Social insects. Adaptations of parasitic and predatory insects.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember the methods of taxonomy
M02: Understand various components of biological classification
M03: Evaluate classical and quantititative methods of taxonomy
M04: Analyse the classical and modern methods of taxonomy
M05: Apply techniques to create barcoding of life

MODULE III: Structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs and systems. Comparative anatomy, adaptive radiation, adaptive modifications. Origin of Protists. Prokaryotes and Eukaryotes. Levels of organization in animal kingdom. theories of metazoan origin, Symmetry, Coelom and Metamerism. International code of Zoological nomenclature. Principle of priority, homonymy and synonymy. Type metod and its significance.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember various cellular forms of life
M02: Understand the biological levels of organization
M03: Evaluate the concept of adaptive radiation
M04: Analyse the processes of origin of different life forms
M05: Apply techniques to observe live cells to study various Levels of organization in animal kingdom

MODULE IV: Classification: Classification of plants, animals and microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa. Chemo and serotaxonomy. Cytotaxonomy. Numerical taxonomy. Cladistics. Molecular systematic. DNA bar coding vs traditional taxonomy. Ethics related to taxonomic publications. Impediments to build up taxonomic collections and maintenance. Development of Taxonomic centres. Need for efficient international networking.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concepts of classification
M02: Understand the criteria used for classification
M03: Evaluate the arrangement organisms in taxonomic groups
M04: Analyse the evolutionary relationships among taxa
M05: Apply techniques to determine the phylogeny of each taxon

MODULE V: Biodiversity: Concepts and Organisms of conservation concern: Rare, endangered species. Extant and Extinct species, Causes of diversity, Genetic diversity, Species diversity and ecosystem diversity. Biodiversity hot spots, Analyzing biodiversity, endangered animals, endemism and red data book, degradation and global climate change. Over exploitation, invasive species and diseases.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the concept of biodiversity
M02: Understand the different types of biodiversity
M03: Evaluate environmental influence on species diversity
M04: Analyse biodiversity across levels of biological organization

M05: Apply methods to monitor and measure biodiversity

MODULE VI: Conservation Biology: Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species, common Indian mammals, birds. Seasonality and phenology of the subcontinent, Organisms of health & agricultural importance: ex-situ conservation strategies, Restoration ecology. Evaluation of priorities for species and habitats**:** Conservation strategies, conservation indices, Hotspots for conservation. World heritage sites and biosphere reserves. Restoration ecology, climate change and biodiversity.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the various strategies of conservation biology
M02: Understand different aspects of Indian subcontinent
M03: Evaluate the various biological conservation strategy methods
M04: Analyse the conservation strategies applied to temporary conservation
M05: Apply techniques to assess the impacts of climate change on biodiversity

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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5eSn6Cm6gIVxH0rCh3HmgA2EAAYAyAAEgL6OfD_BwE
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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

First Semester M. Sc (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-523: Animal Systematics and Diversity

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Genetic diversity in a population. How can we identify it ?
2) Endemism supports diversity. Justify.
3) Why do invasive species out compete native species ?
4) List out the contributions of R. H. Whittaker.
5) Phylogenetic Code is essential for the naming of any organism. Validate.
6) Present your views on overexploitation and its affect on the environment.
7) Adaptive radiation and environment. Elaborate on their connection.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Cladistics and taxonomy. Are they the same or different ? Give reasons.
9) List out the criteria for classification of taxon.
10) Expound on Hotspots in biodiversity and their importance.
11) Compile the three types of molecular data that can be used to build phylogenies?
12) Give further details about the role of comparative anatomy in systematic.
13) How does random fertilization contribute to genetic diversity ?
14) What are the different types of phylogenetic trees ?
15) Importance of metamerism in classifying an organism. Present your views.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Annotate the causes of decline in biodiversity and how does it affects humans.
17) Carbon tax as a powerful way to combat global climate change. Do you agree ? If so, give reasons.
18) Explicate on the evolution of Three Domain concept and the main characteristics that separate the three domains ?
19) Speculate on importance of species diversity in an ecosystem and how is it measured with relevance to conservation.

(2x10=20 Marks)

SEMESTER II	Course Code: INB-CC-524	Credits: 3

CELL AND MOLECULAR BIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify the structural and functional details of the basic unit of life at the molecular level

CO2: Give an overview of the structures and purposes of basic components of prokaryotic and eukaryotic cells

CO3: Gain knowledge on cellular macromolecules, membranes and organelles

CO4: Figure out the major cell signaling events and its regulatory mechanisms

CO5: Apply the mechanisms of inheritance to analyze the factors influencing gene expression and its regulation

CO6: Understand the major cellular events like cell cycle, checkpoints in cell cycle and control of cell division

COURSE CONTENT

MODULE I: Cell organization: cell membrane - Ultrastructure. Cell Organelles - Endoplasmic reticulum, Golgi complex, Ribosome, Mitochondria. Cytoskeleton and Cell Motility - Microtubules, Microfilaments, Intermediate filaments, Molecular motors. Cell cycle - Steps in cell cycle, Control of cell cycle, Checkpoints in cell cycle. Control of cell division and cell growth. Apoptosis - extrinsic and intrinsic pathways, significance of apoptotic pathways. Basic properties of a cancer cell, Types of cancer, Causes of cancer, Genetics of cancer, Tumour suppressor gene, Oncogene. New strategies for combating cancer - Immunotherapy, Gene therapy, inhibiting cancer promoting proteins, Inhibiting formation of new blood vessels. Cancer as a lifestyle disease.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember ultrastructure of cell

M02: Understand cytoskeleton and cell motility

M03: Evaluate checkpoints in cell cycle

M04: Analyse control of cell division and cell growth

M05: Apply techniques to differentiate normal cell from cancer cell

MODULE II: Cell Signaling: Basic principles of cell communication, Extracellular messengers (signaling molecules), role of Calcium and Nitric oxide (NO) as intracellular and intercellular messengers. Receptors: G- Protein coupled receptors, Receptor tyrosine kinases (RTK), Ion channel receptors, Cytokine receptors (Tyrosine kinase linked receptors). Second messengers: Cyclic-AMP, Cyclic-GMP, Inositol 1,4,5-trisphosphate (IP3), Di-acyl glycerol (DAG). Signaling pathways: G-protein coupled receptor (GPCR) and cyclic AMP pathway – role of protein kinase A (PKA), GPCR pathway in rod cells, Receptor protein tyrosine kinase and Ras-MAP kinase pathway, JAK-STAT pathway, Calcium phosphatidyl- inositol pathway, Phospho Inositide 3-kinase (PI- 3 kinase), Transforming growth factor (TGF) signaling pathway. Regulation of signaling pathways. Convergence, divergence and crosstalk among different pathways.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember and understand the basic principles of cell communication
M02: Understand various components of signaling pathways
M03: Evaluate working of GPCR pathway
M04: Analyse the regulation of signaling pathways
M05: Apply techniques to differentiate various cellular receptors

MODULE III: Gene Expression: Relationship between genes and proteins. Transcription in prokaryotes and eukaryotes-rRNA, tRNA and mRNA, RNA processing in prokaryotes and eukaryotes. Post transcriptional modifications. Translation in prokaryotes and eukaryotes, initiation, elongation and termination, protein sorting, signal sequences and signal hypothesis. Gene Regulation: Regulation of gene expression in *E. coli:* Catabolite repression, *Trp* operon in *E. coli* - repression and attenuation, *Ara* operon in *E. coli* - positive and negative controls. General introduction to gene regulation in eukaryotes at transcriptional, post transcriptional and translational levels, transcription factors, enhancers and silencers, Chromatin-remodelling complexes, RNA interference (RNAi).

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember central dogma of molecular biology
M02: Understand mechanisms of RNA processing in prokaryotes and eukaryotes
M03: Evaluate post transcriptional modifications and signal hypothesis
M04: Analyse the processes of regulation of gene expression
M05: Apply techniques to assess the working of chromatin-remodeling complexes

MODULE IV: Introduction to Molecular Biology: Concept of genes, genetic architecture. DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons). DNA damage and repair mechanisms. Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation. Control of gene expression at transcription and translation level. Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination. Translational proof-reading, translational inhibitors. Post - translational modification of proteins.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn and remember basic concepts of molecular biology
M02: Understand the method of DNA replication, repair and recombination
M03: Evaluate the process of transcription and post transcriptional modification
M04: Analyse the events during translation and post translational modifications
M05: Apply the knowledge to assess various steps during the central dogma of molecular biology and create new assays to evaluate the efficiency of these processes

MODULE V: Molecular methods: Molecular Biology and Recombinant DNA methods: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels. Gene knock out in bacterial and eukaryotic organisms. Protein sequencing methods, detection of post translation modification of proteins. Methods for analysis of gene expression at RNA and protein level, large scale

expression, such as micro array based techniques. Metagenomics. Histochemical and Immunotechniques: Detection of molecules using ELISA, RIA, western blot immunoprecipitation, flowcytometry and immunofluorescence microscopy, *in situ* localization by techniques such as FISH and GISH.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and memorize various molecular methods used to assess macromolecules
M02: Understand the principles used in evaluating various biomolecules
M03: Evaluate the expression of diverse macromolecules inside a cell using molecular techniques
M04: Analyse the functioning of modern methods used to study biomolecules and critically scrutinize their advantages and disadvantages
M05: Apply the knowledge about various techniques used in molecular biology and create novel assays to measure the expression and levels of biomolecules with higher efficiency

MODULE VI: Bionanotechnology: Introduction, Principles, Application. Role of nanoparticles as prophylactic and therapeutic agents. Nanoparticles, Nanosensors and Nanotubes. Carbon nanotubes. Future of nanotechnology.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Understand the basic principles of nanotechnology
M02: Comprehend the techniques in bionanotechnology
M03: Evaluate the role of nanoparticles in Biological Sciences
M04: Analyse the functions of nanostructures used in Biosciences
M05: Apply techniques learnt to create new nanoscale devices to study and solve biological problems

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/gene-expression
https://www2.palomar.edu/anthro/mendel/mendel_1.htm
https://www.ncbi.nlm.nih.gov/books/NBK9944/
https://www.slideshare.net/IbrahimMohammed15/basic-principles-of-genetics
http://www.sparknotes.com/biology/
http://www.biology101.org/biologystudyguides/cellparts.php
http://www.mednotes.net/notes/biology/
http://www.cod.edu/people/faculty/fancher/genetics/
http://quizlet.com/177035/genetics-study-guide-vocab-flash-cards/

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Second Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-524: Cell and Molecular Biology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Organelle which is referred to as cellular power house. Support your choice.
2) The receptor which is a target for almost 50% of drugs in current use.
3) The most common model used to represent repressible operon concept
4) Is "C-value paradox" a factual paradox ?
5) The mechanism by which a gene gets converted to another.
6) You are more of your mother than your father. Do you think the statement is true ?
7) Where and how do the proteins move after they get translated ?

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) What apparatus makes the skeleton of a cell ? Do they have other functions as well ?
9) Secondary messengers regulate the cell signaling. Yes or No. Assert your answer with substantial evidence.
10) "A protein functions only if it is modified". What are the modifications and how do they occur ?
11) "Daughter comes from a single strand". Explicate.
12) The future of research in Biology and medicine depends on nanotechnology. Validate the statement with your points.
13. Discuss the role of non coding RNAs in gene regulation.
14) DNA Polymorphism causes the diversity in a single species. Expound how.
15) Elucidate the steps in cell cycle.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Does the modification of histones play a role in the regulation of gene expression? Discuss.
17) The evolution of hallmarks of a cancer cell from simple to complex over the years. Depict the mechanisms involved.
18) Elucidate the role of nanoparticles as prophylactic and therapeutic agents. Create a nanoparticle for the treatment of cancer with the concepts learnt.
19) "Is the Cell death programmed?" Explicate in detail.

(2x10=10 Marks)

SEMESTER II	Course Code: INB-CC-525	Credits: 2

PRACTICAL II: CELL AND MOLECULAR BIOLOGY, ENVIRONMENTAL BIOLOGY AND BIOINSTRUMENTATION

Course Outcomes (CO)

CO1: Understand the genetic and biochemical mechanisms in living organisms and quantification of macromolecules

CO2: Learn about squash preparation of salivary gland chromosomes and grasshopper testes

CO3: Develop knowledge on mitotic and meiotic cell divisions in different models

CO4: Comprehend to evaluate the effect of various drugs or inhibitors on cell division

CO5: Study genetic analysis using PCR and gene sequencing

CO6: Apply techniques to separate and purify proteins

COURSE CONTENT

1. Analysis of meiotic stages in grasshopper testis employing Squash preparation.
2. Study of meiotic stages in the salivary gland chromosomes in *Drosophila* / *Chironomus* larva using squash preparation.
3. Evaluation of mitotic index in the cells of onion root tip using squash preparation.
4. Study the effect of drugs on cell division (Colchicine or any other inhibitor)
5. To study tissue sectioning using microtome, spreading and histochemical staining
6. Determination of barr body from buccal smears
7. Estimation of Carbon dioxide and dissolved oxygen in water samples
8. Estimation of BOD in polluted water sample
9. Estimation of COD in water sample
10. Collection of water samples and study of physico-chemical parameters: Colour, pH, Temperature, conductivity and turbidity
11. Field study: A study tour to observe the ecology and behaviour of animals should be under taken. The places of visit include inter tidal region, fresh water bodies, lakes, rivers, hill streams, wetlands, mangroves, forests grasslands, drinking water treatment plants and sewage treatment plants. A report of the field study is to be included in the practical record to be submitted at the time of examination.
12. Identification of bacteria using PCR amplification of partial DNA encoding 16S rRNA and automated sequencing.
13. Evaluation of the Electrophoretic separation of DNA using Agarose gel electrophoresis
14. To study the separation of proteins using SDS- PAGE electrophoresis
15. Purification of proteins by affinity chromatography.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Preparation and analysis of experimental data
- Practical skill development
- Develop expertise in handling lab equipments

LEARNING RESOURCES
References

- Rajan, K. (2011). *Analytical Techniques in Biochemistry*.
- Okotore, R. O. (1998). *Basic Separation Techniques in Biochemistry*.
- Wilson, K and Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology.*
- Rickwood, D and Harris, R. (2015). *Cell Biology: Essential Techniques.*
- Robin, D. J. (1997). *Biophysical Methods in Cell Biology*.

On-line Sources

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https://di.uq.edu.au/files/3522/MolBiolWS08Immunofluorescence.pdf
https://currentprotocols.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)1934-2616.CommonlyUsedTechniques
https://www.slideshare.net/evevoltech/cell-biology-techniques
https://www.britannica.com/science/bioinformatics/Goals-of-bioinformatics

ASSESSMENT

100% End-semester/Summative Assessment: 4 hour Practical and Viva Voce examination.

SEMESTER II	Course Code: INB-CC-526	Credits: 2

MINI PROJECT / INTERNSHIP

Course Outcomes (CO)
CO1: Able to identify a specific research area of interest
CO2: Conduct literature survey and review in the research area selected
CO3: Identify a research problem and formulate hypothesis and prepare research plan
CO4: Create the research methodology for conducting the research
CO5: Systematize a research proposal based on the survey and hypothesis
CO6: Prepare the report and presentation

COURSE CONTENT

The student will prepare an independent time bound research project proposal under the supervision of a faculty in the Department. The periodic progress of the proposal preparation will be monitored. The planning for the proposal may be initiated from the first semester onwards. The proposal has to be submitted by the end of Second semester.

The students can also undergo internship at any central, national or state institutes or universities for a period of one month. The detailed report of the work performed by the student along with the attendance certificate should be submitted by the end of second semester. The internship has to be undertaken during the months of April and May coinciding with the vacation.

ASSESSMENT
The evaluation will be based on the assessment of the proposal / internship report, presentation and viva voce.

SEMESTER II	Course Code: INB-DE-527	Credits: 2

APPLIED ZOOLOGY

Course Outcomes (CO)

CO1: Understand the concept of applied zoology
CO2: Analyse the scope and potentialities of using beneficial insects as resources
CO3: Give an outline of various traditional practices of apiculture, sericulture and lac culture
CO4: Acquire an in-depth knowledge on fisheries resources of India
CO5: Comprehend concepts related to animal farming, their management and disease control
CO6: Apply concepts and principles of laboratory animal breeding and maintenance.

COURSE CONTENT

Module I: Meaning and scope of Applied Zoology; beneficial and harmful insects; insects as tools in forensic science.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of applied Zoology
M02: Understand the scope of learning applied Zoology
M03: Evaluate the role of insects
M04: Analyse costs and benefits of applied sciences
M05: Apply the knowledge about animals to explore and maintain available resources.

Module II: Apiculture: Honeybee species, bee forage, beekeeping, bee hive products, honeybee diseases. Lac culture: lac insects, host plants, lac culture and by-products. Sericulture: silkworm races, life cycle of *Bombyx mori*, silkworm rearing, silkworm diseases, pests and predators of silkworms.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember the concept of useful insects
M02: Understand principles of insect rearing
M03: Evaluate the scope of insect rearing in our country
M04: Analyse life cycles of different useful insects
M05: Apply techniques to successfully rear and breed economically useful insects

Module III: Harmful insects; insect pests, pest control and IPM; pests of cereals and pulses; pests of millets and commercial crops; venomous insects and chemical composition of venom and its applications.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember different types of insect-pests.
M02: Understand venom and its composition
M03: Evaluate pest control methods used for different insect-pests
M04: Analyse various pest-management techniques

M05: Apply the strategies based on each pest to manage and control insect-pests

Module IV: Animal Farming; Poultry: Poultry breeds, rearing, poultry diseases and poultry by products; dairy: dairy breeds, dairy farming, management and by-products, piggery: pig species, rearing and byproducts.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concepts of animal farming
M02: Understand various types of commonly practiced animal farming
M03: Evaluate diseases associated with animal farming
M04: Analyse different by-products associated with animal farming
M05: Apply modern and sustainable methods to rear animals in farm

Module V Fisheries: Fisheries resources of India: coastal, deep sea and inland fisheries; fresh water and marine aquaculture; culturable organisms: prawn, pearl and oyster culture, fish culture, ornamental fish culture and sea weeds.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember various species used for aquaculture
M02: Understand fresh and marine aquaculture techniques used in India
M03: Evaluate the scope and challenges of ornamental fish breeding in India
M04: Analyse different methods of aquaculture
M05: Apply the techniques to rear prawn, pearl and oyster.

Module VI: Laboratory animal science: General principle of breeding and maintenance of animals for research and academic purposes- *C. elegans*, *Drosophila,* fish, reptiles and small mammals.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the general principles of animal maintenance
M02: Understand the role of animals in research
M03: Evaluate the possibilities of using animal models
M04: Analyse the guidelines to maintain and use laboratory animals
M05: Apply various methods to successfully maintain and breed laboratory animals.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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- Shukla, G.S. and V. B.. Upadhyay. (2007). Economic Zoology. Rastogi Publications, Meerut, India.

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https://www.india.gov.in/topics/agriculture/sericulture
https://vikaspedia.in/agriculture/farm-based-enterprises/sericulture/silkworm-rearing
https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/sericulture

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Second Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-DE-527: Applied Zoology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Explain the uses of bee wax
2) Comment on various races of silk worms used for sericulture in India
3) Elaborate the principles of integrative pest management practices.
4) Write notes on any two poultry diseases and their causes.
5) Evaluate the use of *Drosophila* as a model organism in research
6) Briefly describe the chemical composition of venom
7) Describe how see weed culture is beneficial.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Describe the life cycle of *Bombyx mori*
9) Write elaborative note on the use of insects in forensic sciences.
10) Evaluate the possibilities of using animal models in research
11) Differentiate coastal, deep sea and inland fisheries.
12) Elaborate lac culture- the insects used, host plants, lac culture and by-products.
13) Give an account of the pests of various commercial crops and their management.
14) Diary farming carries a major source of income in India- substantiate with suitable examples.
15) Analyse the costs and benefits of insects in various applications.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Illustrate the importance of culturable organisms in fresh and marine waters. Explain how aquaculture is practiced.
17) Give an account of the general principle of breeding and maintenance of animals for research and academic purposes.
18) Evaluate pest control methods used for different insect-pests emphasizing the potential of IPM in India.
19) Elaborate on how bees can be used as resource, methods to maintain the culture and manage diseases.

(2x10=20 Marks)

SEMESTER II	Course Code: INB-DE-528	Credits: 2

MOLECULAR DIAGNOSTICS

Course Outcomes (CO)

CO1: To gain an overview of History of Infectious diseases, metabolic and genetic disorders, and disease diagnosis.
CO2: To understand about various Microbial diseases, pathogenicity and diagnosis.
CO3: To Evaluate the methodology for the diagnosis of genetic and metabolic disorders.
CO4: To analyse the significance of medical genetics and genetic markers for diseases.
CO5: To acquire knowledge on Human Cytogenetics and understanding various Chromosomal anomalies and disorders.
CO6: To evaluate the significance of various Genetic tests in the diagnosis of cancer and genetic disorders.

COURSE CONTENT

Module I: To gain an overview of History of Diseases and diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases. Types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites. Sample collection- method of collection, transport and processing of samples, Interpretation of results.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Understand the History of Diseases and diagnostics.
M02: Comprehend the significance of disease diagnosis
M03: Evaluate the methodology of disease diagnosis sample collection and transport
M04: Illustrate the sample processing and analyse the protocol
M05: Evaluate the significance of disease diagnosis.

Module II: Overview of diseases caused by bacteria *Staphylococcus*, *Streptococcus*, Coliforms, *Salmonella*, *Shigella*, *Vibrio*, and *Mycobacterium*. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. Diseases caused by DNA and RNA viruses- Orthomyxo and Paramyxo viruses, Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diseases caused by Protozoan: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Cancer different types. Major Metabolic disorders and its causes. Disease due to genetic disorders - Identifying human disease genes

Module Outcome:

After Completion of this module, the student should be able to:
M01: Comprehend and remember different kinds of Bacterial diseases and clinical diagnosis.
M02: Understand viral diseases, Laboratory diagnosis and Immunoprophylaxis
M03: Evaluate the diseases caused by Fungi, pathogenicity and Lab diagnosis
M04: Analyse the diseases caused Protozoan parasites, Pathogenicity and Lab diagnosis.
M05: Understanding Cancer, major metabolic and genetic disorders.

Module III: Methods available for the diagnosis of genetic diseases and metabolic disorders. Neonatal and Prenatal disease diagnostics. Analysis of mitochondrial DNA for maternal inheritance. Molecular diagnosis for early detection of cerebral palsy, Down syndrome, pathology of blood disorders (haemoglobinopathies, sickle cell anemia, hemophilia), Muscle disorders (Duchene muscular dystrophy-DMD, Becker's muscular dystrophy-BMD, spinal muscular atrophy-SMA), Bone disorders (Osteogenesis imperfecta, Rheumatoid arthritis), Skin disorder (Albinism) and Eye disorder (Retinitis pigmentosa).

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember the methods available for genetic and metabolic diseases.
M02: To acquire knowledge on Neonatal and Prenatal diagnosis.
M03: Evaluate the significance of the analysis of mitochondrial DNA for maternal inheritance.
M04: Analyse the importance of Molecular diagnosis for early detection of cerebral palsy, Down syndrome.
M05: Understanding diagnostic strategy of Cancer, Blood disorders, Muscle disorders, Bone disorders, Skin disorder and Eye disorders.

Module IV: Principles of inheritance- Mendelian and Non-Mendelian inheritance, Polygenic inheritance, Multifactorial trait, Threshold trait, Genetic Susceptibility & risk factors, Mitochondrial genome and disorders. Medical Genetics: Human genome Project, Genome Organization, Genome Annotations and databases, Identifying human disease genes. Genetic markers for diseases. Microsatellites, SNPs, Mapping and identification of disease genes (linkage analysis, LOD score, association study) SNPs in diagnostics

Module Outcome:

After Completion of this module, the student should be able to:

M01: To Understand the principles of inheritance Mendelian and Non-Mendelian inheritance
M02: To gain knowledge on Polygenic inheritance, Multifactorial trait, Threshold trait, Genetic Susceptibility & risk factors, Mitochondrial genome and disorders
M03: To illustrate Medical Genetics, Human genome Project, Genome Organization
M04: Evaluating the methodology for the detection of human disease genes and Genetic markers for diseases (Microsatellites, SNPs).
M05: Analysis of the significance of Mapping and identification of disease genes and SNPs in disease diagnostics.

Module V: Human Cytogenetics - Chromosomal basis of inheritance, sex chromosome, X-chromosome inactivation. Chromosome preparation from cultured lymphocytes, cell lines and solid tumors , Karyotyping, C-,G-banding and fluorescence banding, nomenclatures of bandings, In-situ hybridization techniques – FISH and GISH. Meiotic chromosomes- Chromosomal anomalies and disorders, Numerical variations (polyploidy, aneuploidy, autosomal, sex-chromosomal) Structural variations (deletion, duplication, translocation, inversion, isochromosome, ring chromosome) Chromosomal abnormalities in cancer.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember the concepts in Human Cytogenetics; Chromosomal basis of inheritance, sex chromosome, X-chromosome inactivation.
M02: Evaluate the methodology of Chromosome preparation from cells and Karyotyping, C-G-banding and fluorescence banding.
M03: Analysing the significance of In-situ hybridization techniques – FISH and GISH in disease diagnostics.
M04: To understand about the Chromosomal anomalies; Numerical and Structural variations and various chromosomal disorders.
M05: To Evaluate the Chromosomal abnormalities associated with cancer.

Module VI: Genetic disorders: Classification of genetic disorders, Single gene Disorders - Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Marfan's syndrome Multifactorial disorders - Diabetes, Atherosclerosis, Schizophrenia · Sex – linked inherited disorders. · Cancer genetics- Molecular basis of cancer, oncogenes, tumour suppressor genes. Gene therapy and other molecular based therapeutic approaches.
Molecular Techniques for diagnosis - PCR- RFLP, ELISA, MALDI-TOF, DNA Sequencing · Amniocentesis (AC), Population screening for genetic disorders.

Module Outcome:
After Completion of this module, the student should be able to:
M01: To understand and remember the Genetic disorders, Classification and various types.
M02: To illustrate Molecular basis of cancer and Cancer genetics in diagnostics.
M03: To Evaluate the methodology of Gene therapy and other molecular based Therapeutics
M04: To analyse the significance of Molecular Techniques in diagnosis PCR, RFLP, ELISA, Multiplex-PCR, MALDI-TOF and DNA Sequencing.
M05: To evaluate the methodology of Genetic tests for the detection of various disorders.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

Reference Books:

- Medical Microbiology (1997), Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.
- Parasitology (1997), Chatterjee K.D, Chatterjee Medical Publishers.
- Bailey & Scott's Diagnostic Microbiology (2002), Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfeld , Ernest A. Trevino, Published by C.V. Mosby
- Jawetz, Melnick, & Adelberg's Medical Microbiology (2004), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.

- Fundamentals of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
- Henry's Clinical Diagnosis And Management By Laboratory Methods (2007) Mcpherson
- Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
- Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.
- Molecular Pathology in Clinical Practice (2007). D. G. B. Leonard.
- Microbial Functional Genomics (2004) by J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje. J.Wiley & Sons Publishers.
- Expert Review of Molecular Diagnostics
- Genes IX by B. Lewin, Oxford University Press.
- An Introduction to Genetic Analysis (2000) by A.J.F. Griffiths, J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart, W.H. Freeman, New York.
- Molecular Biology of the Gene (2004) by J.D.Watson, Tania A baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Pearson Education Pte. Ltd. (Singapore).
- Essentials of Molecular Biology (1998) by G. M. Malacinski and D. Friefelder, Jones & Bartlett Publishers

On-line Sources:

https://www.academia.edu/44453642/Molecular_Diagnostics_Fundamentals_Methods_and_Clinical_Applications
https://www.perlego.com/book/1814485/molecular-diagnostics-pdf
https://www.perlego.com/book/1810621/molecular-diagnostics-techniques-and-applications-for-the-clinical-laboratory-pdf
https://link.springer.com/book/10.1007/978-981-16-1037-0
https://handoutset.com/wp-content/uploads/2022/07/Molecular-Diagnostics-Fundamentals-Methods-and-Clinical-Applications.-Lela-Buckingham.pdf
https://archive.org/details/MolecularDiagnosticsFundamentalsMethodsAndClinicalApplications2007

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Second Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-DE-528: Molecular Diagnostics

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Karyotyping is helpful in detecting chromosomal anomalies. Explicate.
2 Analyse how Amoebic dysentery differs from bacillary dysentery.
3) Illustrate on SNPs and its significance in diagnostics.
4) Evaluate the importance of WIDAL test in the detection of typhoid.
5) Analyse the advantage of PCR over nucleic acid hybridization techniques.
6) Illustrate the application of the technique FISH.
7) Comment on the significance of the technique Amniocentesis.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Analyse the significance of human genome project in disease diagnosis.
9) Evaluate the methodology of Mapping and its significance in disease diagnostics.
10) Explicate about different types of DNA sequencing and its application.
11) Explicate the molecular basis of cancer.
12) Illustrate the diseases caused by Fungi and various strategies of Laboratory Diagnosis.
13) Evaluate the pathogenesis and Laboratory diagnosis of malaria.
14) Create a methodology to cure Huntigtons disease employing genome editing tools.
15) Analyse how numerical variations of chromosomes are different from structural variations.

(6x5=30 Marks)

III. Answer **any two** of the following:
16) Evaluate how bacterial infection differs from viral infections and analyse the methodology of diagnostics.
17) Explicate the advances in laboratory diagnostics over the last two decades.
18) Analyse the significance of Molecular Techniques in disease diagnosis.
19) Evaluate the contribution of Genome editing tools in modern medicine.

(2x10=20 Marks)

SEMESTER III	Course Code: INB-CC-531	Credits: 3

GENETICS AND BIOTECHNOLOGY

Course Outcomes (CO)

CO1: Understand the basic concepts and new developments in molecular biology and biotechnology

CO2: Learn about methodologies currently used in recombinant DNA technology, its application and also discuss its adverse effects

CO3: Expand knowledge on modern biotechnological practices with emphasis on application in medical, industrial, environmental and agricultural areas

CO4: Comprehend and train in latest techniques and practices that are used in modern bioscience research laboratories

CO5: Gain knowledge about various genetic engineering and recombinant DNA technologies for the betterment of plant and animal life

CO6: Apply the knowledge gained as processes and products for use of biological life

CO7: Create new processes and products for betterment of all life

COURSE CONTENT

MODULE I: Principles of Genetic Transmission: Extension of Mendel's principles: allelic variation and gene function- incomplete dominance and codominance. Gene action-from genotype to phenotype-penetrance and expressivity, gene interaction epistasis, pleiotropy, genomic imprinting, phenocopy. Repetitive nucleotide sequences in eukaryotic genomes, kinetics of renaturation: Cot and Cot curve. Unique and repetitive sequences. Mini and micro satellites. Polytene chromosomes and Lampbrush chromosomes. Karyotyping. The standard genetic code, redundancy and Wobble Hypothesis. Interrupted genes in eukaryotes, exons and introns - R loops, significance of introns. Genes-within-genes (overlapping genes). Transposable elements in Bacteria –IS elements, composite transposons, medical significance. Transposable elements in Eukaryotes - P elements, Retrotransposons, significance of transposons.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember Mendelian principles of genetic transmission

M02: Understand mechanisms of gene interaction

M03: Evaluate kinetics of DNA renaturation

M04: Analyse fine structure of gene

M05: Apply techniques for chromosome banding

MODULE II: Genetic Linkage, Recombination and Chromosome Mapping: Chromosome theory of heredity, Linkage and recombination of genes in a chromosome, crossing over as the physical basis of recombination, Gene conversion. Meselson-Stahl experiment, semi conservative replication of DNA in chromosomes, Theta replication, rolling-circle replication, molecular mechanisms of eukaryotic replication. Gene Mutation: Molecular basis of gene mutation; mutant types - lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants. Induced mutation, The Ames test for mutagen/carcinogen detection.

Extra Chromosomal Inheritance and Epigenetics: Inheritance of mitochondrial and chloroplast genes, maternal inheritance. Epigenetics - from phenomenon to field, a brief history of epigenetics - overview and concepts.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember chromosome theory of heredity, linkage and recombination
M02: Understand the phenomenon of crossing over as the physical basis of recombination
M03: Evaluate semi conservative mode of DNA replication
M04: Analyse mechanisms of DNA damage and repair
M05: Apply techniques to detect mutagen/carcinogen

MODULE III: Introduction to Biotechnology: Historical aspects, definitions and scope of Biotechnology. Cell and Tissue culture: Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, maintenance of cell culture and cell separation. Growth media: Physicochemical properties, natural and artificial, Balanced salt solutions, Complete Media, Serum, Serum-Free Media and protein free media and their applications. Biology and characterization of cultured cells, measurement of viability and cytotoxicity. Manipulation of cultured cell and tissues- scaling up of animal cell culture, cell synchronization, cell transformation, organ and histotypic culture. Tissue engineering: strategies and developments in tissue engineering, Biomaterials. Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cross-Contamination. Cryopreservation - importance and process of cryopreservation, cryopreservation of embryos, Cryogenics. Transfection Methods: $CaPO_4$ precipitation, Short Gun, Electroporation, Lipofection, Microinjection. Agrobacterium mediated gene transfer. Somatic cell nuclear transfer- reproductive cloning and therapeutic cloning. Gene knockout and knockin technology. Applications of transgenic animals.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Be trained and remember fundamental concepts in biotechnology
M02: Understand the principles in animal cell and tissue culture
M03: Evaluate the biology and characterization of cultured animal cells
M04: Analyse tissue engineering principles which can be used for synthesizing new products for betterment of all life forms
M05: Apply the knowledge about various techniques used in molecular biotechnology and create novel assays to measure the expression and levels of biomolecules with higher efficiency

MODULE IV: Tools and Techniques in Recombinant DNA Technology: Restriction endonucleases. Vectors: cloning and expression vectors. Plasmids, Ti and Ri plasmids, cosmids, phasmids, phagemids, bacteriophage, SV40, vectors with combination features, PUC19 and Bluescript vectors, shuttle vectors, viral vectors, BAC and YAC vectors. Polymerase chain Reaction: different types and applications. Molecular Markers and Probes - SNP, VNTR, RAPD, RFLP, SSR, STMS, FISH and GISH. DNA sequencing methods - Maxam and Gilberts chemical degradation method, Sanger and Coulson method, Automated DNA sequencers. Next generation sequencing. Whole genome

sequencing. Cloning Methodologies - Gene isolation. Shot gun method, Genome libraries, cDNA libraries. Methods of rDNA transfer to host cells- $CaCl_2$ treatment, Virus delivery. Selection and screening of the transformed cells, Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins. Blotting techniques- Southern, Northern, Western, Dot Blot, DNA finger printing.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and memorize tools and techniques used in recombinant DNA technology
M02: Understand the principle of PCR technology and apply it to create new protocols to improve the current efficiency of the assay
M03: Evaluate molecular markers and probes used determine expression of various genetic components in cell
M04: Analyse the DNA sequencing methods and apply it for whole genome sequencing of different life forms
M05: Learn and create novel rDNAs techniques for transforming cells with artificially generated genetic material and check its efficiency
M06: Apply the principles behind all the techniques learned to create new protocols with greater efficiency than the existing ones

MODULE V: Biotechnology in Healthcare: Disease prevention – DNA vaccines. Disease diagnosis - Probes, Monoclonal antibodies, detection of genetic disorders. Disease treatment - Therapeutic proteins, hormones and growth factors. RNAi, Drug targeting, Gene therapy. Forensic medicine. Biosensors - different types, applications - medical and non medical. Introduction to Biochips and their application in modern sciences. Stem cells and its research applications.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and remember the principles behind disease diagnosis using various probes
M02: Understand various disease treatment modalities using different biomolecules
M03: Learn and evaluate principles of gene therapy which decrease the side effects of current treatment regimes
M04: Analyse various biosensors for medical and non-medical applications
M05: Learn and apply idea of biochips for prophylactic, prognostic and therapeutic modalities

MODULE VI: Biotechnology in Industry and Agriculture: Fermentation. Metabolite production: Antibiotics, Organic acids, Amino acids, Vitamins. Upstream processing, downstream processing. Microbial production of enzymes. Food industry - Single cell protein, probiotics. Transgenic plants- Plants with resistance to pests. Biofertilizers and microbial inoculants, biocontrol agents, biopesticides, bioinsecticides, Environmental Biotechnology: Sewage treatment. Solid waste management. Biodegradation of xenobiotic compounds. Bioremediation and Biorestoration. Microbial leaching and mining. Biofuels. Transgenics and environment.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember the use of biotechnology in industry and agriculture
M02: Understand the production of various metabolites using biotechnological tools

M03: Evaluate different enzyme engineering and biotransformation methods using microbial, plant and animal sources
M04: Analyse use of biotechnological products for crop improvements in agriculture and consider their pros and cons
M05: Learn, apply and create waste management techniques and tools for cleaner environment and sustainable development

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

- Dale, J. W. and Schantz, M. V. (2002). *From Gene to Genomes*. John Wiley and Sons Ltd, NY, USA.
- Das, H. K. (2007). *Text book of Biotechnology*. Wiley India Pvt. Ltd. New Delhi, India.
- Doyle, A. and Griffith B. J. (1999). *Cell and Tissue Culture- Laboratory Procedures in Biotechnology*. Wiley International, NY, USA.
- Freshney, I. R. (2006). *Culture of Animal Cell*. (5th edn). Wiley - Liss publications, USA.
- Pandian, T. T. and Kandavel, D. (2008). *Text Book of Biotechnology*. I.K International Publishing House, New Delhi, India.
- Primrose, S. B., Twyman, R. M., and Old, R. W. (2001). *Principle of Gene Manipulation*. (6th edn). Blackwell Science Ltd, London, UK.

On-line Sources:

http://www.rothamsted.ac.uk/notebook/
https://www.studyblue.com/notes/b/molecular-biology-of-the-cell/2072/0
http://www.sparknotes.com/biology/
http://quizlet.com/10522203/biotechnology-study-guide-flash-cards/
http://quizlet.com/20752062/chapter-7-cellular-respiration-fermentation-and-secondary-metabolism-study-guide-flash-cards/
http://www.ck12.org/biology/Biotechnology/studyguide/Biotechnology-Study-Guide/

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Third Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-531: Genetics and Biotechnology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Technique that uses DNA polymorphism to pinpoint location of a gene. Clarify.
2) Differentiate diverse types of the catalyst used to copy DNA during transcription.
3) Collection of only the genes that gets encoded into proteins. List out its applications.
4) Expound about the technique used to deliver DNA segments into a cell for therapeutic purpose.
5) Explicate about the use of cloning vectors in rDNA technology.
6) Bioremediation is a technique, of organisms, by organisms and for organisms. Do you agree with the statement. Justify.
7) Can we store store biological samples for more than a decade. Support your answer.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Give your observations about the tool used to convert biological information into electrical signals and state its applications.
9) The technique used to recombine DNA strands with certain degree of sequence homology. Articulate the procedure and its applications.
10) Delineate the synthesis of transgenic plants and list out its pros and cons.
11) Summarize the steps involved in the generation of Recombinant DNA.
12) In Global proteome profiling, 2D PAGE is advantageous over 1D PAGE. How ?
13) How the differential expression of the genes is studied using Microarray technology?
14) Are biopesticides the solution to the problems arising due to use of chemical pesticides ? Substantiate your view.
15) Biofuels are the way forward in the energy dependent world. Discuss.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Annotate about the models of DNA replication. Mention the role of proteins involved in the process of DNA replication.
17) Deliberate about how Transgenic and gene knock out animals are prepared and how these techniques are used to study the functional aspects of a gene.
18) Expound about the basic techniques involved in mammalian cell culture. Present observations on the different types of media used.
19) Analyze about various blotting techniques. Comment on the application of blotting techniques.

(2x10=20 Marks)

SEMESTER III	Course Code: INB-CC-532	Credits: 3

IMMUNOLOGY AND MICROBIOLOGY

Course Outcomes (CO)

CO1: Clearly point up the fundamental knowledge of microbiology and immune systems across the animal world

CO2: Give an outline of the body's immune response to fight infections and cancer

CO3: Gain better understanding of the evolution of immune system and microbiology through time

CO4: Comprehend concepts related to microbial interaction and how immune responses regulate various metabolic processes in humans

CO5: Apply concepts and principles of immune-effector mechanisms to maintain homeostasis

CO6: Apply various systems to classify the microbes and plants using classical as well as modern molecular methods

COURSE CONTENT

Module I: Introduction to immune System: Types of immunity: innate and acquired. Mechanisms of innate immunity. Organs and cells involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, autoimmunity. Passive and active immunity. Pattern recognition receptors-scavenger receptors and Toll – like receptors. Humoral and cell-mediated immune responses. Haematopoiesis. Bcell and T-cell maturation and differentiation.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember types and mechanisms of immunity

M02: Understand the structure and function of immune system components

M03: Evaluate humoral and cell mediated immune responses

M04: Analyse primary and secondary immune modulation

M05: Apply methods to characterize immune responses

MODULE II: Antigens and Antibodies and MHC: Antigen processing and presentation. Abzymes. Genetic model compatible with Ig structure. Multi- gene organization of Ig genes. Variable region gene arrangements. Generation of antibody diversity. Expression of Ig genes and regulation of Ig genes transcription. Antibody genes and antibody engineering. Antigen-structure and properties, Haptens, Adjuvants, Epitopes, Immunoglobulins- structure, classes and functions. Antigen –Antibody Interactions: Mechanisms, Biological consequences of antigen - antibody reaction. Serological Reactions. Radio-allergosorbent Test (RAST). Immunoprecipitation. Immunofluorescence Immunoelectron microscopy. MHC: General organization and inheritance of MHC. MHC-peptide interaction. Expression of MHC molecules on

different cell types. Regulation of MHC expression. MHC and graft rejection. MHC and disease susceptibility. Biological significance of MHC. HLA typing.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember and understand the process of antigen presentation
M02: Understand the structure and properties of antigens and immunoglobulins
M03: Evaluate the mechanisms of antigen- antibody reactions
M04: Analyse the general organization and inheritance of MHC
M05: Apply techniques to localize antigens or antibodies in cells and tissues

MODULE III: Immune-Effector Mechanisms: Inflammatory Cells. Types of Inflammation- acute and chronic. Chemokines. Role of cytokines in immune system. Properties and functions of Cytokines. Therapeutic uses of cytokines. The Complement system: Terminal sequence of complement activation (MAC). Classical, Alternate and Lectin Pathways. Complement activation, Regulation of complement system. Biological consequences of complement activation. Complement deficiencies. Hypersensitivity: Allergy and hypersensitivity. Genetics of allergic response in humans. Autoimmunity. Organ- specific autoimmune diseases. Systemic auto-immune diseases. Treatment of autoimmune diseases. Transplantation immunology. Immunologic basis of graft rejection. Clinical manifestation of graft rejection. General and specific immunosuppressive therapy. Clinical transplantation. Tumour immunology. Vaccines, Whole organism vaccines, Purified macromolecules as Vaccines, Recombinant vector vaccines, Synthetic peptide vaccines, Multivalent subunit vaccines.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the different types of immune responses
M02: Understand the properties and functions of cytokines
M03: Evaluate mechanisms of activation and regulation of complement system
M04: Analyse the genetics of allergic response in humans
M05: Apply techniques to monitoring the level of immune response

MODULE IV: History and development of Microbiology. Main group of microorganisms, general characters. Classification: approaches to microbial classification, outline classification, Bergey's manual. Prokaryotic Cells: Cell structure, plasma membrane, cytoskeleton, cytoplasm, nucleoid, cytoplasmic inclusions. The prokaryotic cell envelope: peptidoglycan structure, gram positive and negative cell walls. Components outside the cellwall: capsules, slime layers and s-layers, pili and fimbriae, flagella and motility. Endospore: structure and formation.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Understand and remember history of microbiology
M02: Comprehend the approaches used in classifying microbes
M03: Evaluate the structural aspects of prokaryotic cells
M04: Analyse general characters of microbial life forms
M05: Apply tests to characterize bacteria using staining techniques

MODULE V: Microbial Metabolism: Energy acquisition by chemotrophs and phototrophs. Glycolysis (Embden- Meyerhof pathway). Fermentation, anaerobic oxidations, chemosynthesis. Photosynthesis, carbon assimilation. Nutrition and Growth: Common nutrient requirements, nutritional types, uptake of nutrients by the cell. Bacterial recombination. Transformation, transduction and conjugation. Regulation of gene expression in bacteria. Lac, Tryptophan, Arabinose operons. Culture media, culture methods. Reproduction and exponential growth, the growth curve. Biofilms. Quorum sensing.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember metabolic pathways in prokaryotes
M02: Understand the principles in fermentation and photosynthesis
M03: Evaluate various methods of bacterial genetic recombination
M04: Analyse the regulation of gene expression in bacteria and learn the concepts of quorum sensing
M05: Apply techniques to study the concept of operons and create new protocols to detect novel operons functioning in prokaryotes

MODULE VI: Microbial Interactions and Microbial Ecology: microbial interaction with plants and animals. Symbiosis, commensalism. Mutualism between microbes, microbes and plants, microbes and animals. Cooperation, competition, predation, antagonism. Parasitism, plant parasites, animal parasites. Bacteriological examination of drinking water. Microbial growth control: Sterilization methods – Physical, Chemical and Biological. Antimicrobial Agents: Antibiotics. Chemotherapeutic agents: major classes and mechanism of action. Minimal inhibitory concentration (MIC), Microbial Drug resistance. Clinical Microbiology and Immunology.
Virology: Properties of viruses**,** structure and chemical composition, genetic composition eclipse, host interaction and specificity**.** Classification: RNA virus,
DNA virus, plant virus, animal virus, bacteriophage. Lysis and lysogeny, Viral replication. Virioids and prions: Nature and significance. Pathogenic virus, oncovirus.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember the concepts in microbial ecology
M02: Understand the various interactions among microbes and the environment
M03: Evaluate perception of symbiosis with microbes and how it will benefit the environment
M04: Analyse pathogenic viruses affecting plant and animal life forms
M05: Apply techniques to identify viral infection, classify viruses and elucidate methods to produce vaccines against viruses

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates

- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

- Alcamo, I. E. (2003).*Microbes and Society*. *An Introduction to Microbiology*. Jones & Barlett Publishers, London. Education, NY International, NJ, USA.
- Brock, G. (2003). *Biology of Microorganisms*. Prentice Hall and Pearson Education, Inc. USA.
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- Ingraham, J L. and Ingraham, C. A. (2000). *Microbiology*. 2nd edn. Brooks/Cole-Thomson Learning, MA, USA.
- Prescot, L. M., Harley, J. P., and Klein, D. A. (2008). *Microbiology*. 7th edn. McGraw Hill. USA.
- Tortora, G., Funke, R., and Pearson C. C. (2002). *Microbiology: An Introduction*. 7th edition. UK.
- Wheelis, M. (2010). *Principles of Modern Microbiology*. Jones and Bartlett Publishers, NY, USA.

On-line Sources

http://www.austincc.edu/rohde/noteref.htm
http://www.mednotes.net/notes/microbiology/
http://www.cram.com/flashcards/microbiology-study-guide-one-250932
http://employees.csbsju.edu/ssaupe/biol327/lecture-home.htm
http://5e.plantphys.net/categories.php?t=t

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

First Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-532: Immunology and Microbiology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) 5-methylthioadenosine (MTA) is recycled to Methionine in plants. Clarify.
2) Is RNA alone infectious ? How does it differ from Virus ?
3) There are many pigments in bacteria which help in photosynthesis. Justify.
4) There are reports on Viruses as etiological factors of cancer. Elaborate.
5) Hydrogen peroxide forms by the photosynthesis. What is this reaction ?
6) Murein provides structural integrity to the bacterial cell wall. What is Murien and explain its structure ?
7) Electron transport chain of oxidative phosphorylation are located on the inner membrane of mitochondria in eukaryotes. Where does it locate in prokaryotes and name the cytochromes which differs from eukaryotes ?

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) How do you test for Vibrio cholera in a given water source ? Specify the kind of media you will be using and how does it helps to selectively culture *Vibrio cholera*.
9) What are secondary metabolites ? Describe the synthesis and biological roles of Terpenes.
10) When bacteria lives on a glucose deficient medium containing lactose. Discuss the scenario of Lac- operon.
11) “Phytochromes and biological clock”. Are they co-related ?
12) David Baltimore's contribution to the taxonomy of virus is vast. How did he classify it based on nucleic acid synthesis ?
13) Krebs cycle is significant in oxidative phosphorylation. Elaborate.
14) What is your take on the theory of Abiogenesis ? Discuss about the efforts of the scientists to disprove it.
15) Biotic stress is not uncommon in plants. How do they respond ?

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Do plants have chemical messengers that control and coordinate the cell functions ? Explain about their biosynthesis and mechanism of action.
17) Antibiotic resistant bacterial strains are common. How do you think bacteria acquire antibiotic resistance genes ? Describe various methods of genetic recombination in bacteria.
18) Plants synthesize amino acids. How do they do it ? Explicate.
19) What are the diagnostic methods you will adopt to find out the etiological agent of a particular infection in a clinical microbiology laboratory ?

(2x10=20 Marks)

SEMESTER III	Course Code: INB-CC-533	Credits: 4

ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify structural and functional features of the basic units of endocrine system and reproductive system

CO2: Give an overview of the role of signaling events in the physiology of endocrine and reproductive systems

CO3: Gain knowledge on reproductive physiology and endocrinology

CO4: Comprehend concepts related to endocrinology and reproductive biology to enable the students to analyse cellular and molecular organization of the systems

CO5: Apply concepts of endocrinology and reproductive biology to find management strategies for diseases related to the systmes

CO6: Understand the disrupted endocrine functions that could lead to abnormal conditions

MODULE I: Concepts in Endocrinology: Historical perspective, classes of chemical messengers, peptide hormones, steroid hormones, bioamines, eicosanoids chalones, neurotransmitters, neuropeptides, neurosteriods, neurohormones, phytohormones, synthetic hormones, prohormones, paracrine, merocrine, cytogenic secretion. Vertebrate endocrine glands: Morphology and anatomy of endocrine glands, evolution of endocrine, glands, Biosynthesis of hormones, hypothalamus and hypophyseal, secretion, hypothalamo hypophyseal interaction, endocrine axes, function, of hormones, disorders of hormonal imbalance, Regulation of hormone secretion, synthesis and metabolism of hormones, half-life of hormones, metabolic clearence rate, miscellaneus hormones, eicosanoids, prostaglandins, prostacyclins, thromoboxanes, leukotrienes.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember historical perspective of endocrinology

M02: Understand various classes of chemical messengers

M03: Evaluate the mechanism of biosynthesis of hormones

M04: Analyse the synthesis and metabolism of hormones

M05: Apply techniques to measure the levels of various hormones

MODULE II: Mechanism of hormone action: General and molecular mechanism of action of amines, polypeptide and steroid hormones –Mechanism of signal transduction in vertebrates, hormone receptors–as mediation of endocrine signals, classes of endocrine receptors, receptor-ligand interaction, cell surface receptors-structure and regulation of receptor units. Second messengers of hormonal action, cyclic nucleotides, inositol triphosphate, cAMP as second messengers, genomic action of cAMP, G protein and its dual control on adenylate cyclase, receptor crosstalk, ligand-gated ion channels, non-genomic actions of steroid hormones. Hormones and Cancer: Hormonal control of development of cancer, hormone therapy in cancer Treatment, Oncogenes and hormonal function, Breast cancer and Hormone receptor status, Ectopic production of hormones by tumour cells.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember the mechanism of cellular signal transduction
M02: Understand concepts of hormone action
M03: Evaluate the different classes hormone receptors
M04: Analyse receptor-ligand interaction
M05: Apply techniques to determine ectopic production of hormones

MODULE III: Functional Endocrinology: Hormones as signal transducers, hormones in developmental process, Role of hormones in behaviour of animals, Hormonal control of reproduction, Hormone therapy in reproductive impairments, Hormonal involvement in evolution. Invertebrate endocrine systems –Endocrine organs –Structure –Chemistry-Mechanisms of actions in Insects, –Growth-Moulting-Differentiation-Juvenile Hormone-Ecdysone –Neuro hormones, Neuro peptides. Endocrine control of vitellogenesis-Spermatogenesis-Diapause-Eclosion-Cuticular tanning –Excretion. Crustacean Endocrine organs-Sinus gland, X-organ-Androgenic glands-Maxillary glands-Mandibular glands-Hormonal principles-Chemistry-Action Hormonal control of sex Differentiation, Gonadial activity, Colour change, Retinal pigment Movement control, Heart beat.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember various functional roles of hormones
M02: Understand concepts of hormone therapy to treat various impairments
M03: Evaluate role of hormones in evolution
M04: Analyse the functioning endocrine system in invertebrates
M05: Apply techniques to determine endocrine control of vitellogenesis and spermatogenesis

MODULE IV: Organization of reproductive system: Development of Gonads, Sex differentiation, Differentiation of testes, and ovary, morphological ,biochemical and hormonal aspects. Development and morphogenesis of male and female sex organs. Male reproductive tract, testes, structure, spermatogenesis, Endocrine, paracrine and autocrine regulation, Accessory sex organs, prostrate, seminal vesicles, bulbourethral gland, structure function and regulation, Female reproductive tract, ovary structure, folliculogenesis. Ovulation, Steroidogenesis endocrine, paracrine, autocrine regulations. Fallopian tube structure, function, hormonal regulation, Sex cycles. hypothalamo-hypophysial regulation of reproductive function, Neuroendocrine perspectives of mammalian reproduction, Reproductive pheromones.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the structure of reproductive system
M02: Understand mechanisms of sex differentiation
M03: Evaluate the process of morphogenesis of male and female sex organs
M04: Analyse regulation of steroidogenesis
M05: Apply techniques to assess endocrine regulation of reproduction

MODULE V: Reproductive functioning: Pregnancy and Foetal Development: Process of Fertilization, Mechanism of fertilization, Cell division and Implantation of blastocyst, Placenta-its role, Hormonal and physical changes during pregnancy. Developmental

stages of foetus, Parturition, Lactation-its hormonal control. Contraceptive Methods: Chemical methods, surgical methods. New approaches of contraception.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember events in fertilization
M02: Understand concepts of pregnancy and foetal development
M03: Evaluate Hormonal changes during pregnancy
M04: Analyse foetal development and parturition
M05: Apply techniques to determine hormonal changes in reproduction

MODULE VI: Sexual Physiology: Sexual determination and differentiation, Abnormalities of sexual Differentiation, Human sexual response, Sexual dysfunction – Infertility, Anatomical, hormonal, chromosomal, immunological and Physiological factors.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember principles of sexual determination and differentiation
M02: Understand concepts of sexual dysfunction
M03: Evaluate physiological factors of sexual dysfunction.
M04: Analyse the phenomenon of human sexual response
M05: Apply techniques to evaluate the hormonal responses in reproductive physiology

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Third Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-533: Endocrinology and Reproductive Biology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Validate the role of Zona pellucida proteins in Sperm- oocyte interaction.
2) "Eicosanoids function in diverse physiological systems and pathological processes". Validate this.
3) Hormone receptor complex binds to certain specific DNA sequences in the promoter. What is this sequence called ? Note down its significance.
4) Substantiate the necessity of capacitation as a prerequisite for fertilization.
5) HCG test is a preliminary test for pregnancy. Justify.
6) Illustrate the different stages of development of fetus.
7) Cyclic AMP from ATP. How does it form? What is its significance in cell signalling ?

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) "Thymectomy compromises the overall metabolic activities in a human". Justify.
9) Role of hormones in reproduction. Discuss it with respect to mammals.
10) Discuss various types of Pituitary hormones and its function.
11) Spermatogonial stem cells differentiate into spermatozoa. What is this process called and expound on the process.
12) Cell cycle is regulated by cyclin/Cdk complex during post fertilization events. Justify.
13) Endocrine hormones act on specific target tissues during ovary development and after ovulation. Discuss about the hormones and their role?
14) Klinefelter syndrome and Turner syndrome are sex chromosomal anomalies. Differentiate between them.
15) Steroid hormones as medicine in diseases. Evaluate their mode of activity and apply the principles in devising new strategies for clinical applications.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Elucidate the regulation of reproduction in both sexes mediated by endocrine, paracrine and autocrine mechanisms.
17) Genes play an important role in sex determination. Which are the main genes involved in it and how are they being regulated?
18) What are hormones ? Discuss the method of action of peptide hormones and steroid hormones.
19) Define hypothalamo-hypophysial axis. How does it regulate the endocrine function ?

(2x10=20 Marks)

SEMESTER III	Course Code: INB-CC-534	Credits: 3

DEVELOPMENTAL BIOLOGY AND NEUROBIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify basic knowledge of early cellular organization and neural system

CO2: Give an overview of role of signaling events in the physiology of nervous system

CO3: Gain knowledge on basic concepts of developmental biology

CO4: Comprehend concepts related to neurobiology enable the students to analyse cellular and molecular organization of basic units of nervous system

CO5: Apply the new developments in animal embryology and neurobiology

CO6: Apply concepts of neurotransmitter signaling aberrations leading to clinical complications such as neurodegenerative diseases

COURSE CONTENT

MODULE I: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenic in analysis of development.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember basic concepts of development

M02: Understand mechanisms of induction

M03: Evaluate determination and differentiation

M04: Analyse cell fate and cell lineages

M05: Apply techniques to assess genomic equivalence

MODULE II: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenic in analysis of development. Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Memorize basic concepts of gametogenesis

M02: Comprehend mechanisms of fertilization

M03: Evaluate the process of embryogenesis and its regulation

M04: Differentiate pluripotent and totipotent stem cells and their use in biological research

M05: Apply knowledge on stem cells to create new treatments for metabolic diseases

MODULE III: Mechanisms of development: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in Drosophila, amphibia and chick; organogenesis– vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination. Molecular mechanisms of differential gene regulation during development. Programmed cell death, aging and senescence.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember fundamental mechanisms of development of organisms
M02: Understand concepts of induction and regeneration
M03: Evaluate environmental regulation of normal development
M04: Analyse organogenesis in different animal groups
M05: Apply techniques to determine molecular mechanisms of differential gene regulation during development

Module IV: Organization of neural system: Introduction to cellular and molecular neurobiology- Principles of Neurobiology-organization of brain- Organization of somatic and autonomic neurons system. Classes of neurons. Cell biology of neurons: Passive electrical membrane properties, the resting membrane potential, The action potential, Ion channels- Structure and diversity. Axons and dendrites-morphology and function, Synaptic transmission-presynaptic nerve terminals- Excitory and inhibitory transmission. Ultrastructure of neuron cells.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember structural organization of brain
M02: Understand organization of somatic and antonymic neurons system
M03: Evaluate electrical membrane properties
M04: Analyse ultrastructure of neuron cells
M05: Apply techniques to assess structure and diversity of ion channels

MODULE V: Mechanism of neural functioning: Neural circuits and plasticity, circadian rhythms synaptic plasticity, Cellular mechanisms, neural basis of behavior. Development of neural circuits, electrical synapses. Transport of ions across membranes, sodium, potassium and calcium transport. Ion channels, co-transport and anti-port mechanisms.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember and understand the process of membrane transport
M02: Understand different types of membrane transporters
M03: Evaluate working of various transporter proteins
M04: Analyse the neural basis of behaviour
M05: Apply techniques to assess the working of sodium potassium and calcium pump

MODULE VI: Mechanism of Neural transmission: Neurotransmitters and their receptor. Role of Glutamate, GABA, DOPA, Serotonin. Hippocampus. Neurodegenerative

diseases: Molecular mechanisms in Alzheimer's disease, Parkinson disease, Dementia-Etiology and treatments.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember principles of sensory perception
M02: Understand mechanisms of neural transmission
M03: Evaluate functioning of neuro transmitters
M04: Analyse the molecular mechanisms neurodegeneration
M05: Apply techniques to assess the etiology of neurodegenerative diseases

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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- Bear MF, Connors BW, Paradiso MA. *Neuroscience exploring the brain.* 4th edition. Philadelphia, PA: Wolters Kluwer; 2016.
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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Third Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-534: Developmental Biology and Neurobiology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) "Pluripotency and multipotency". Elaborate.
3) "Induction and competence". How this is important for development ?
4) First part of cell commitment is cell specification. What is autonomous specification ?
5) GABA is an inhibitory neurotransmitter. True or false. Substantiate your view.
6) Ca^{2+} ions are essential for the nerve transmission. Explicate the mechanism.
7) Alzheimer's is a neurodegenerative disease and the most common cause of dementia. Specify its etiology?

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) How will you generate insulin producing transgenic sheep ? Explain the protocol and its applications.
9) Cell cycle is regulated by cyclin/Cdk complex during post fertilization events. Justify.
10) Does epigenetic regulation play a role in genomic imprinting ? Present your view.
11) Can the Pluripotency be induced ? Discuss the concept and substantiate with your views.
12) Cranial nerves play an important role in connecting the sense organs to brain. Validate the statement.
13) Annotate about electric and chemical mediated nerve impulse conductions.
14) "Resting membrane potential and action potential". Articulate their differences.
15) Neuroanatomical techniques are essential to study intrinsic neural connectivity. Deliberate on the technique.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Differential gene expression plays an important role in axis patterning in Drosophila. Elaborate.
17) "Neural circuits and plasticity". Explicate this concept.
18) "Central nervous system and peripheral nervous system". How do they differ in the mode of action and function.
19) Technological advances established the concepts of developmental biology. Justify this statement.

(2x10=20 Marks)

SEMESTER II	Course Code: INB-CC-535	Credits: 2

PRACTICAL III: MICROBIOLOGY, BIOTECHNOLOGY, ENDOCRINOLOGY AND DEVELOPMENTAL BIOLOGY

Course Outcomes (CO)

CO1: Understand the most advanced techniques in molecular biology
CO2: Learn about functioning of genetic material in detail
CO3: Develop knowledge on genomic and plasmid DNA isolation from bacteria and separation of blood cells
CO4: Comprehend processes of western blotting and fluorescent based techniques
CO5: Study various bioinformatics tools
CO6: Apply most advanced molecular biology techniques in research

COURSE CONTENT

1. Microscopy
2. Sterilization methods
3. Preparation of microbial media. Nutrient broth and Nutrient Agar, Mac conkey Agar and Blood Agar
4. Motility Determination – Hanging drop method
5. Different types of microbial growth media
6. Culture methods: Isolation of Pure Colonies of Bacteria – Streak, Spread and Pour Plate
7. Staining Techniques: Simple and Gram Staining, Spore and Capsule Staining, Acid Fast Staining
8. Biochemical tests for identification of microorganisms: Indole Test, Methyl Red test, Voges Prauskaur test, Citrate Utilisation test, Catalase test
9. Determination of Anti-Microbial Activity by Disc Diffusion method
10. Isolation of genomic DNA from *E. coli*
11. Isolation of Plasmid DNA from *E. coli*
12. Separation of lymphocytes from whole blood
13. Immunoflurecensce assays
14. Western Blotting (Demonstration)
15. ELISA
16. Microplate Reader assay
17. Live cell imaging (Demonstration)
18. Bioinformatics tools:- Pubmed, Nucleotide databases, BLAST, FASTA, ClustalW multiple alignment, Primer designing for PCR

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Preparation and analysis of experimental data
- Practical skill development
- Develop expertise in handling lab equipments

LEARNING RESOURCES
References

- Carson, S., Miller, S H and Scott, W. D. *Molecular Biology Techniques.* 4th Edn eBook ISBN: 9780128157756. Paperback ISBN: 9780128180242
- Ghatak K, L. (2011).*Techniques and Methods in Biology*. PHI Learning Pvt. Ltd. New Delhi.

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ASSESSMENT

100% End-semester/Summative Assessment: 4 hour Practical and Viva Voce examination.

SEMESTER III	Course Code: INB-DE-536	Credits: 2

MOLECULAR TECHNIQUES IN INTEGRATIVE BIOLOGY

Course Outcomes (CO)

CO1: Understand the major tools and techniques used for studying biochemical and biophysical nature of life

CO2: Learn about analytical methods used for measuring biomolecules and pharmacologically active substances

CO3: Develop knowledge on safety concerns which arise during and after any biological assay is performed

CO4: Comprehend protocols better and create new procedures by improvising existing assays to measure various biomolecules

CO5: Gain awareness about the ethical aspects involved in biology and biological research including intellectual property rights

CO6: Apply knowledge achieved to create new assessments tools for measuring levels of biomolecules

COURSE CONTENT

MODULE I: Microscopy: Differential Interference contrast (Nomarsky) microscopy, Confocal microscope, Electron microscope – TEM, SEM, Scanning Tunneling and Atomic Force Microscopes. Light microscope and dark field microscope, Phase contrast microscope, Polarizing microscope, birefringence fluorescence microscope.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember history of microscopy

M02: Understand different parts of various microscopes

M03: Evaluate pros and cons of various microscopes

M04: Analyse functioning of electron microscopes

M05: Apply knowledge to design novel microscopes with improvements over existing Designs

MODULE II: Chromatography: Paper chromatography, Thin layer chromatography, Ion exchange chromatography. Gel permeation chromatography, Affinity chromatography, Gas chromatography, High pressure liquid chromatography (HPLC).

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and remember techniques in chromatography

M02: Understand principles of different types of chromatography methods

M03: Evaluate functioning of different types of chromatography methods

M04: Analyse the instruments used to assess levels of biomolecules using chromatography methods

M05: Apply the principles to create novel processes and instruments using principles in chromatography

MODULE III: Electrophoresis: Paper electrophoresis, Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and non SDS, Agarose gel electrophoresis, Disc electrophoresis, High voltage electrophoresis, immunoelectrophoresis, isoelectric focusing.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and remember techniques in electrophoresis
M02: Understand principles of different types of electrophoretic methods
M03: Evaluate functioning of different types of electrophoretic methods
M04: Analyse the instruments used to assess levels of biomolecules using electrophoretic methods
M05: Apply the principles to create novel processes and instruments using principles in Electrophoresis

MODULE IV: Colorimetry, Spectrophotometry and Spectroscopy: Principle and applications of colorimetry and spectrophotometry. Spectroscopy: Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic resonance spectroscopy (NMR), Circular dichroism spectroscopy, ESR spectroscopy, Mass spectroscopy.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and remember techniques in spectroscopy
M02: Understand principles of different types of spectroscopic methods
M03: Evaluate functioning of different types of spectroscopic methods
M04: Analyse the instruments used to assess levels of biomolecules using spectroscopic methods
M05: Apply the principles to create novel processes and instruments using principles in spectroscopy

MODULE V: Centrifugation: Basic principles of sedimentation, Types of centrifuges, Analytical and Preparative centrifugation, Differential and density gradient centrifugation.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and remember techniques in centrifugation
M02: Understand principles of different types of centrifugation methods
M03: Evaluate functioning of different types of centrifugation methods
M04: Analyse the instruments used to assess levels of biomolecules using centrifugation methods
M05: Apply the principles to create novel processes and instruments using principles in centrifugation

MODULE VI: Radioisotope Detection and Measurement: Dosimetry, Ionization chamber, GM counter, Solid and liquid scintillation counters, Autoradiography. Radio ImmunoAssay, Enzyme Linked Immuno Sorbant Assay (ELISA).

Module Outcome:

After Completion of this module, the student should be able to:
M01: Comprehend and remember basics of radioactivity
M02: Understand principles in radioisotope detection and its measurements
M03: Evaluate types of devices to measure radioactivity
M04: Analyse diverse radioactive biomolecules using principle of ELISA
M05: Apply knowledge to design novel methods and instruments to measure Radioactivity

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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http://www.purdue.edu/ehps/rem/home/booklets/bioman.pdf

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Third Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-DE-536: Molecular Techniques in Integrative Biology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Radio labelled antibodies are widely used in immunoassays for high sensitivity tests. Specify.
2) There are analytical techniques which measure the mass-to-charge ratio and present the result as a mass spectrum. Identify this spectroscopy and explain the principle.
3) There are techniques which employs the sublimation of ice to reveal internal structures. Clarify.
4) Which microscopy technique will you use to to study the surface of nano materials ?
5) There is a spectroscopy which is commonly used to study the secondary structure of proteins on the basis of chirality. What is your take on this ?
6) "Nuclear spin and spectroscopy". Discuss the concept.
7) How sucrose and cesium chloride are important in centrifugation. Comment.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Radiolabelling is important in the isolation of macromolecules such as DNA or protein. Name the technique which employs this principle and discuss the protocol.
9) What are the steps will you adopt for the disposal of bio-hazardous wastes ?
10) How will you analyse the serum of a patient with suspected food poisoning for botulinum toxin employing Immunoelectrophoresis ?
11) Can we modify the genome of an organism ? If yes how ? Discuss its application.
12) "Nanoparticles as sensors". Elaborate.
13) Beer lambert's contribution in the field of spectrophotometry. Comment.
14) How acetylcholine receptors can be purified from a mixture of proteins employing chromatography ?
15) Most advanced chromatographic techniques are used for the isolation and purification of bioactive compounds. Specify.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) What are the strategies that you will adopt to separate DNA and proteins employing electrophoresis ?
17) Discuss about the protocol to detect a specific protein from a cellular protein extract.
18) What safety measures will you adopt to work in a laboratory ?
19) Radioactive isotopes have immense application in biomedical research. How will you detect and measure it ?

(2x10=20 Marks)

SEMESTER III	Course Code: INB-DE-537	Credits: 2

VECTORS AND COMMUNICABLE DISEASES

Course Outcomes (CO)

CO1: Gain knowledge on bioecology and life-cycle of vectors
CO2: Give an overview of the scope and importance of vectors
CO3: Articulate and exemplify basic knowledge on communicable diseases
CO4: Comprehend concepts related to epidemiology and biology of vectors and pathogens, transmission cycles and symptoms of commonly occurring diseases
CO5: Understand the history of epidemics, scientists involved in discovery of communicable diseases
CO6: Apply concepts and principles of vector and vector borne diseases control

COURSE CONTENT

Module I: Introduction to vector biology; Scope and importance of vectors: Historical perspective – epidemics, scientists involved in the discovery of vectors and pathogens of communicable diseases.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Reminisce concepts of vector biology
M02: Comprehend the historical perspective of vector biology
M03: Assess the scope and importance of communicable diseases
M04: Analyse the various pathogens of communicable diseases
M05: Recollect the scientists involved in the discovery of vectors

Module II: Bio-ecology and life cycle of vectors. Vector-parasite interaction; Host-pathogen interaction, insect transmitting bacteria and viruses.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember the bio-ecology of vectors
M02: Understand the mechanisms of vector-parasite interactions
M03: Evaluate the life-cycle of vectors
M04: Analyse vector-parasite interactions
M05: Apply techniques to control and manage diseases caused by insect transmitting bacteria and viruses

Module III: Biological vectors and Communicable diseases: Epidemiology and biology of vectors and pathogens, Transmission cycles and symptoms of malaria, filariasis, yellow fewer, leishmaniasis, dengue, chikungunya, Japanese encephalitis, and plague, Covid-19: Epidemiology, Symptoms and Management.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Comprehend the epidemiology of vectors and pathogens
M02: Understand the transmission cycles of most common vectors
M03: Evaluate the symptoms and management of Covid-19

M04: Scrutinize the biology of various bacterial diseases
M05: Apply techniques to manage transmission of several viral diseases in India

Module IV: Mechanical vectors: House flies, cockroaches and bedbugs – Transmission of dysentery, diarrhoea, typhoidcholera, epidemic conjunctivitis and skin infections, Nematodes: Ancylostoma, Ascaris, Enterobius and Wuchereria. Tikes: Morphology and life history of: Argas and Haemaphysalis.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the nematodes that transmit various diseases
M02: Comprehend the mechanisms of transmission by mechanical vectors
M03: Assess different factors involved in the transmission of skin infections
M04: Evaluate the role of ticks and mites in communicable disease transmission
M05: Apply techniques to check the common fatal viral and bacterial diseases in India

Module V: Control of vectors and vector borne diseases: Cultural control methods, chemical methods, genetic and environmental methods, biological methods using microbes and predators.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Analyse the use of biological methods to control vector-borne diseases
M02: Understand differences between various control methods employed in India
M03: Evaluate genetic and environmental methods of vector control
M04: Remember the basic concepts used to control vectors
M05: Apply techniques to use microbes and predators of vectors to efficiently check disease transmission

Module VI: Integrated Vector Control and Management (IVCM). Insecticide resistance in vectors, Drug resistance in pathogens. Importance of education, awareness and community participation.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concept of Integrated Vector Control and Management
M02: Appreciate the importance of education and awareness in vector control
M03: Comprehend insecticide resistance in vectors
M04: Analyse the use of IVM in controlling Malaria
M05: Apply methods to promote community participation in vector control

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Third Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-DE-537: Vectors and Communicable Diseases

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Explicate Integrated Vector Control and Management.
2) Describe how genetic and environmental methods are used to control vectors.
3) Annotate how microbes or viruses sustain themselves within host organisms.
4) Interpret the use of chemicals for vector management despite their harmful consequences.
5) Compare the cause and transmission of dysentery and diarrhea.
6) Write a note on *Wuchereria* as a vector.
7) Demonstrate the ticks and mites in communicable disease transmission.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Insecticide resistance is expected to directly and profoundly affect the reemergence of vector borne diseases – substantiate the statement.
9) Enlighten the role of any two nematodes as disease-causing organisms.
10) Give an account of the importance of education, awareness and community participation in vector and vector-borne disease management.
11) Describe how the use of using microbes and predators to control vectors is a promising method to overcome the negative effects of using chemicals.
12) Write briefly on the transmission cycles and symptoms of malaria.
13) Explain the morphology and life history of Argas.
14) Annotate various types of mechanical vectors and their disease transmission mechanisms.
15) Expound on the disinfection process of vectors.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Mosquitos are unquestionably the most medically important arthropod vectors of disease. validate the statement with examples and suggest methods to manage mosquitoes.
17) Give an account of Covid-19 pandemic, its epidemiology, symptoms and management; explain how the pandemic was controlled and give an aftermath on the dynamics of vector control over the globe post Covid-19.
18) Explain the various methods used to control vectors and vector borne diseases around the globe with suitable examples.
19) Vectors can act as both antagonist and protagonists. Substantiate the statement with valid examples.

(2x10=20 Marks)

SEMESTER IV	Course Code: INB-CC-541	Credits: 4

CONSERVATION BIOLOGY

Course Outcomes (CO)

CO1: Give an overview of the conservation of biodiversity
CO2: Learn about the various threats to biodiversity and the need of conservation
CO3: Articulate and exemplify basic knowledge on legislations made for conservation
CO4: Comprehend concepts related to conservation genetics, use of genetic tools in conservation biology.
CO5: Understand the various concepts and practices of conserving various habitats and landscapes
CO6: Apply advanced knowledge and techniques to conserve the endemic and endangered flora and fauna in Indian sub-continent.

COURSE CONTENT

Module I: Biodiversity: Definition, Concept and Values; Distribution of biological wealth in our planet, genetic, species and ecosystem diversity. Consumptive use, productive use, social, ethical, aesthetic and option values of biodiversity. Hotspots and Megadiversity Countries: India as a mega-diversity nation; flora and fauna of other Megadiversity countries; hot-spots of biodiversity; wealth of Indian hot-spots.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember concept of biodiversity and its values
M02: Understand the wealth of Indian hot-spots
M03: Comprehend distribution of biodiversity and its consumptive, productive, social and ethical values
M04: Analyse the designation of India as a mega-diversity nation
M05: Evaluate the concept of biodiversity hotspots

Module II: Levels of and Threats to Biodiversity: Biodiversity at global, regional and local levels. Monitoring and measurement of Biodiversity; useful indices. Threats likeoverexploitation, fragmentation, habitat loss, poaching of wildlife, man-wildlife conflicts, natural calamities, effect of degeneration of biodiversity on future of evolution.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Recollect the different levels of biodiversity
M02: Understand the methods to monitor and measure biodiversity at various levels
M03: Comprehend the threats to biodiversity due to anthropogenic reasons
M04: Analyse the use of indices in measurement of biodiversity
M05: Evaluate the various effects of biodiversity degeneration on future of evolution

Module III: Principles of conservation: development, prevention of waste, preservation of natural resources for the benefit of the many; *In situ* and *Ex situ* Conservation: Concept and practice; manipulation of wild populations; control of predators, herbivores

and competitors; management of problem species; captive breeding; plant propagation; re-establishment and relocation, advance technology in service of endangered species, zoos and botanical gardens, conservation of plant diversity in seed banks, gene banks or germplasm reserves, conservation beyond park, sanctuaries & reserves.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Assess the concept and practice of *in situ* and *ex situ* conservation
M02: Appreciate the principles of conservation
M03: Comprehend the role of zoos and botanical gardens in conserving flora and fauna
M04: Remember different methods employed to conserve endangered plants
M05: Evaluate the practice of wildlife manipulation in biodiversity conservation

Module IV: The conservation of habitats and landscapes: the definition, concept and importance of habitat, habitat loss by fragmentation, isolation, edge effects, the role of corridors on habitat conservation, habitat management; Conservation of Aquatic environment: conservation challenges of freshwater habitats, Riparian zones, marine habitat conservation, causes of degradation, threats to coral reefs, rehabilitation techniques, marine reserves, marine protected areas. Wetland Conservation; Major wetlands of India, types and locations, fertility, disturbances, major threats, Conservation management in islands. Major pollutants and reasons for eutrophication, consequences of eutrophication.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the major wetlands types and locations in India
M02: Analyse the challenges in conservation of freshwater and marine habitats
M03: Assess the importance of island biodiversity conservation
M04: Evaluate the threats to coral reefs and its implications on biodiversity
M05: Apply management strategies to check eutrophication in aquatic ecosystems

Module V: Conservation genetics**:** loss of genetic diversity; bottleneck effect and genetic drift, rare alleles, inbreeding depression, inbreeding effects- environmental and demographic variability, importing genetic diversity- genetic restoration of inbred populations, use of genetic techniques for conservation- Allozyme electrophoresis, Random Amplified Polymorphic DNA analysis, DNA fingerprinting, Mitochondrial DNA, Genetic conservation reserves, implications of captive breeding and retaining gene diversity, Genetic forensics- to determine if the conservation laws and Treaties are being obeyed.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Assess the role of advanced genetic techniques in conservation of biodiversity
M02: Understand the genetics of biodiversity loss
M03: Remember various genetic techniques used to assess biodiversity and aid conservation
M04: Evaluate role of genetic forensics in proper implementation of conservation strategies
M05: Comprehend the implications of captive breeding in maintaining gene diversity

Module VI: Endangered and Endemic species of India: Scheduled species and their distribution; conservation efforts in Indian flora & fauna - Case studies. Indian Legislation to Biodiversity Conservation- Wildlife protection Act (1972),Integrated Development of Wildlife Habitats, Forest Conservation Act (1980), Biodiversity conservation Act (2002), National Conservation Strategy and Policy statement on Environment and Development, National Biodiversity Action Plan (2009).

Module Outcome:

After Completion of this module, the student should be able to:

M01: Recollect the endangered and endemic species in India
M02: Understand the conservation efforts in India by case studies
M03: Comprehend the legislations made by the Government to conserve biodiversity in our country
M04: Analyse the importance of Biodiversity conservation Act (2002) and its implications
M05: Evaluate the consequences of enforcing various acts and strategies to conserve biodiversity around the globe and in India

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

- Pullin, A. S. (2002). Conservation Biology. United Kingdom: Cambridge University Press.
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- Fiedler, P. L., Jain S. K. (2012). Conservation Biology: The Theory and Practice of Nature Conservation Preservation and Management. United States: Springer US.
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https://www.sanfoundry.com/best-reference-books-conservation-biology-wildlife/
https://conbio.org/publications/free-textbook

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Third Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-541: Conservation Biology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Explain role of inbreeding depression.
2) Describe how genetic conservation reserves aid conservation.
3) Annotate how is the biodiversity between two different landscapes are compared.
4) Giant panda numbers have been recovering following decades of effort by WWF- elucidate the role of in-situ and ex-situ conservation in case of giant panda.
5) Illustrate how DNA fingerprinting is useful in wildlife conservation.
6) Differentiate endangered and endemic species.
7) Demonstrate the significance of corridors in conservation.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Enlighten the role of Biodiversity conservation Act (2002) in wildlife conservation with suitable examples.
9) Give an account of the use of genetic forensics in conservation.
10) Describe India as a mega-diversity nation.
11) Comprehend distribution of biodiversity and its consumptive, productive, social and ethical values.
12) Over half of coral reef cover across the world has been lost since 1950- evaluate the statement, give reasons of loss and conservation strategies.
13) Annotate the causes and consequences of eutrophication.
14) Explain how dynamics of genes in a population is related to biodiversity conservation.
15) Sustainable development is the way forward in conservation Biology. Articulate.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Conservation of aquatic environment deals with a number of challenges. List out the causes and repercussion and list out the challenges in conserving aquatic biodiversity.
17) Give an account of the Indian Legislation for Biodiversity Conservation with suitable examples.
18) Explain in-situ and ex-situ conservation, the principles and practices with examples from Indian sub-continent.
19) Only anthropogenic intervention can help in conserving the biosphere. Substantiate the statement with examples.

(2x10=20 Marks)

SEMESTER IV	Course Code: INB-CC-542	Credits: 4

INTEGRATIVE BIOLOGY

Course Outcomes (CO)

CO1: Explain about different fields of biological sciences and how they are connected
CO2: **P**resent an overview of integrative cell signaling
CO3: Gain knowledge on Integrative Biology
CO4: Understand to analyze the fundamental mechanisms of the most modern techniques in applied biology
CO5: Apply concepts such as conserved genes and stress genes in animal diversity and evolutionary biology
CO6: Understand to integrate and evaluate the biological applications in the field of molecular medicine and industry

COURSE CONTENT

Module I: Concepts in Integrative Biology: unifying and diversifying principles. Integrative cell signaling- Cellular communication, general principles of cellular and intercellular communication, cell adhesion and roles of different adhesion molecules, gap junctions, Extracellular matrix, integrins, neurotransmission and its regulation.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of cellular communication
M02: Understand unifying and diversifying principles
M03: Evaluate roles of different adhesion molecules
M04: Analyse general principles of cellular and intercellular communication
M05: Apply techniques to study integrative cell signaling

MODULE II: Diversity and Convergence in animals, Analysis of common ancestry among distant taxa, Role of conserved genes and its expression, Biophysical and biochemical basis of life processes, Biomolecules and energy transduction, Biomechanics and its implications, Evolutionism vs common ancestry; divergence and convergence in biology.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember the basic concepts of evolution
M02: Understand various aspects of life
M03: Evaluate running of life processes
M04: Analyse the role of conserved genes
M05: Apply techniques to assess the mechanical aspects of biological systems

MODULE III: Integrative Physiology: Physiology of stress and ease as models of integrative physiology, Concepts of stress and ease; stress response and ease response. Mechanisms of stress and ease response, endocrinology of stress and ease, Evolution of stress genes and physiological mechanism, Implications on life processes, Integrating principles of chemical, physical and biological processes in life forms.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the concepts of stress and ease
M02: Understand mechanisms of stress physiology
M03: Evaluate functioning of hormones during stress conditions
M04: Analyse the role of stress genes in physiological mechanism
M05: Apply stress and ease as models of integrative physiology

MODULE IV: Concepts of biological integration and regulation: Theories of Biointegration, Biostatics and Bioneutrality. Evidences and mechanisms, Intra and inter cellular signaling as a means of integration. Role of hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember cellular communication
M02: Understand mechanisms of integrative cell signalling
M03: Evaluate the role of second messengers
M04: Analyse signaling pathways in various organisms
M05: Apply techniques to determine light signaling in plants

MODULE V: Biological techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM, image processing methods in microscopy. Histopathology. Karyotyping. Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods. Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concept of microscopy
M02: Understand different types of microscopes
M03: Evaluate different fixation and staining techniques
M04: Analyse various image processing methods in microscopy
M05: Apply techniques to analyse structure of proteins

MODULE VI: Applications of Biology: Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals. Transgenic animals and plants, molecular approaches to diagnosis and strain identification. Genomics and its application to health and agriculture, including gene therapy, ART, Bioresource and uses of biodiversity. Breeding in plants and animals, including marker–assisted selection. Bioremediation and phytoremediation. Biosensors and biofilms.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember principles of immunology
M02: Understand methods for plant and animal cell culture
M03: Evaluate mechanism of transgenesis
M04: Analyse genomics and its application
M05: Apply molecular techniques and microorganisms to the development of various diagnostic approaches

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

- Cooper, G.M., and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. 5th edn. Sinauer Associates, Inc, ASM Press, Washington DC.
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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

Fourth Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-CC-542: Integrative Biology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Explicate on the role of second messengers during cell signaling.
2) Elaborate on the process of neurotransmission.
3) List out important hormones and receptors involved in growth of a human.
4) Articulate on the evolution of stress genes.
5) Delineate on Beer-Lambert's law.
6) Outline the differences between Freeze etching and freeze fracture methods.
7) Phase contrast microscopy
8) Signify the importance of Extracellular matrix in the dynamics of tissue organization.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

9) Analyze GPCR signaling as one of the most important cell signaling pathways.
10) Briefly outline the process of cell communication, types and its importance.
11) Peruse on cell adhesion and role of different adhesion molecules.
12) Integration in intercellular signaling. Present your views.
13) Elucidate about the principle and application of fluorescence in Cell Biology.
14) Give an outline on Gene therapy and its pros and cons.
15) Electron microscopy is the epitome of microscopic techniques. Justify.
16) Comment on Circular Dichroism and its significance in classifying biomolecules.

(6x5=30 Marks)

III. Answer **any two** of the following:

17) Illustrate in detail the process of hematopoiesis and how it is regulated.
18) Outline various spectroscopic methods, their principles and their importance in studying Science.
19) Speculate on the various microscopic techniques and their importance with respect to its application in biological research.
20) Explicate about the integrating principles of chemical, physical and biological processes in life forms.

(2x10=10 Marks)

SEMESTER IV	Course Code: INB-CC-543	Credits: 8

PROJECT WORK AND VIVA

Course Outcomes (CO)

CO1: Able to identify a specific research area and conduct literature survey
CO2: Identify a research hypothesis and prepare research plan
CO3: Standardize the research methodology
CO4: Organize data and perform statistical analysis
CO5: Analyze and evaluate the results, discuss it with previous findings and interpret the conclusion
CO6: Prepare the dissertation and presentation and put forth directions for future research

COURSE CONTENT

The student will undertake an independent time bound research project under the supervision of a faculty in the Department. The periodic progress of the project will be monitored. The project planning may be initiated from the first semester onwards. A dissertation of about 30-60 pages should be submitted.

ASSESSMENT

The evaluation will be based on the assessment of dissertation, presentation and viva voce.

SEMESTER	Course Code: INB-GC-501	Credits: 2

INTRODUCTION TO MICROBIAL PATHOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify the common microbial infections in humans, its laboratory diagnosis and common prophylactic measures

CO2: Give an overview of the pathogenesis of various microbial infections in human beings

CO3: Gain knowledge on normal laboratory practices and culture of microbes in a medical laboratory

CO4: Comprehend concepts and principles of microbiology laboratory safety, culture practices of pathogens

CO5: Apply knowledge on common infections in human beings to tackle the problems sticking to the motto of prevention is better than cure.

CO6: Understand various infections, diagnostic measures and prophylaxis

COURSE CONTENT

Module I: Microbiology Laboratory Safety and the Laboratory Role in Infection Control: General Safety Principles, microbial culture practices, handling of Biologic Hazards, Disposal of Infectious waste. General concepts in infection control practice, Outbreak investigation, education, emerging and re-emerging pathogens.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember concepts of microbiology

M02: Understand microbiology laboratory general safety principles

M03: Evaluate laboratory role in infection control

M04: Analyse handling of biologic hazards

M05: Apply various microbial culture production techniques

MODULE II: Common bacterial infections, diagnosis and prophylactic measures: Common bacterial infections: pneumonia, gonorrhoea, diphtheria, anthrax, tetanus, botulism, bacillary dysentery, typhoid, cholera, plague, tuberculosis, syphilis, small pox.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn and understand the common bacterial infections

M02: Understand various diagnosis and prophylactic measures

M03: Evaluate working of diagnostic techniques

M04: Analyse the common features of bacterial infections

M05: Apply techniques to make bacterial cultures

MODULE III: Common viral infections, diagnosis and prophylactic measures: Common viral infections: chicken pox, small pox, polio, common cold and flu, measles, mumps, chikungunya, dengue, rabies, hepatitis, SARS, AIDS, COVID-19.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember common viral infections
M02: Understand symptoms of common viral infections
M03: Evaluate functioning of diagnosis and prophylactic measures
M04: Analyse the processes of transmission of infection
M05: Apply molecular techniques to analyse infectious agents

MODULE IV: Common fungal and protozoan infections, diagnosis and prophylactic measures: Common fungal infections in man. Superficial and deep mycoses. Opportunistic fungal infections and Mycotic poisoning. Common Protozoan infections in man: malaria, leishmaniasis, amoebic dysentery.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember common fungal infections in man
M02: Understand protozoan infections
M03: Evaluate diagnostic measures of common fungal infections
M04: Analyse prophylactic measures to different infections
M05: Apply techniques to identify various infectious agents

MODULE V: Immunoprophylaxis and national immunisation schedule (India): Active immunisation, national immunisation schedule, Passive immnunisation, active and passive (combined) immunisation.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concept of vaccination
M02: Understand types of immunisation
M03: Evaluate immunoprophylaxis measures
M04: Analyse process of combined immunisation
M05: Apply techniques to detect proteins using antibodies

MODULE VI: Future perspectives of microbial pathology: Rise in infectious diseases and role of microbial pathology. Microbes as bioweapons. Pathology in detecting and preventing microbes as bioweapons.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn future perspectives of pathology
M02: Comprehend the rise in infectious diseases
M03: Evaluate role of pathology in understanding etiology of infectious diseases
M04: Analyse microbes as bioweapons
M05: Apply techniques and tools to detect and prevent microbes as potential bioweapons

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates

- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

- Alcamo, I. E. (2003). *Microbes and Society - An Introduction to Microbiology*, Jones & Barlett Publishers, London. Education, NY International, NJ, USA.
- Arora, D. R. and Arora, B. (2008). *Text Book of Microbiology*. CBS Publishers and Distributers, New Delhi.
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ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

M. Sc. (CSS) Degree Examination
Branch: Post Graduate Programmes
INB-GC-501: Introduction to Microbial Pathology

Time: **3 Hours** Max. Marks: **60**

1) What are vaccines ? Is it a passive or active immunization ? Elaborate.
2) AIDS is a secondary immune deficiency disease. True or false. Substantiate your view.
3) Leishmaniasis is a common disease in Africa. Causative agent and pathogenesis.
4) There are reports on Viruses as etiological factors of cancer. Justify.
5) There are only two BSL4 labs in India. What does BSL mean ? Specify.
6) "SARS and MERS". What do they mean ? Explain.
7) Oral Polio vaccine is widely used in the eradication of Polio. Explicate on the pathogenesis?

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Fungal infections are common in developing countries. Write about deep mycotic infections?
9) National immunisation schedule of India. Articulate.
10) Malaria parasite (Plasmodium) completes the life cycle in human and mosquito. Which is the definitive host ? Why ? Explain the life cycle.
11) "Plasma therapy is very effective to tackle the infection at the last stage". Justify.
12) Is the Rabies virus a DNA virus or RNA virus ? Illustrate the structure of this virus with a diagram.
13) VDRL test is used for the diagnosis of syphilis. Name the causative organism and expound the protocol of the test.
14) Which bacteria causes Botulism and annotate the pathogenesis.
15) Typhoid is a water borne disease. Elucidate the diagnostic approach for typhoid.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Dysentery caused by Amoeba and Bacteria differs in etiology. How do the bacillary dysentery differ from amoebic dysentery ?
17) Most of the Parainfluenza viral diseases are child borne in nature. List out various Parainfluenza viral diseases, their pathogenesis and their prophylaxis.
18) Tetanus toxoid is generally administered if there is a deep wound in our body. Is it a prophylactic measure ? Describe the pathogenesis and prophylaxis of Tetanus.
19) What are the diagnostic methods you will adopt to find out the etiological agent of a particular infection in a clinical microbiology laboratory?

(2x10=20 Marks)

SEMESTER	Course Code: INB-GC-502	Credits: 2

INTRODUCTION TO ANIMAL BEHAVIOR

Course Outcomes (CO)

CO1: Clearly exemplify basic knowledge of ethology
CO2: Give an overview of the evolutionary causes of animal behaviour
CO3: Gain knowledge on ethological principles
CO4: Comprehend concepts related to animal behaviour, including communication, foraging, anti-predator and social behaviours
CO5: Apply concepts and principles of neuroethological model of learning and motivation
CO6: Understand the endogenous cycles which influence the rhythms in physiology and behavior

COURSE CONTENT

Module I: Ethological principles, Motivation and learning: Concepts in ethology, Scope of ethology, Learning- Types of learning, Motivation, Models of motivation (Psycho-hydrologic model). Memory, Habituation, Classical conditioning (Pavlov's experiments), Instrumental conditioning, Latent learning, Insight learning, Imprinting, Neural mechanism of learning, Brain centres in learning.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts in ethology
M02: Understand types of learning
M03: Evaluate different models of motivation
M04: Analyse habituation and Pavlov's experiments
M05: Apply methods to understand neural mechanism of learning

MODULE II: Communication and Neurophysiological Aspects of Behaviour: Reflex action, Kinesis, sign stimulus, Fixed action patterns. Sherrington's neuro-physiological concepts in behaviour – Latency, summation, fatigue. Evolution of communication, Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual. Dance language of honey bees, pheromones and behavior (Ants and mammals). Navigation and migration

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember and understand communication behaviour
M02: Understand reflex action
M03: Evaluate working of fixed action patterns
M04: Analyse the neuro-physiological concepts in behaviour
M05: Apply techniques to assess the role of pheromones in behavior

MODULE III: Hormones and behaviour, Social Behaviour: Sociobiology, social organization (ants, bees, mammals), Aggregations – schooling in fishes, herding in mammals, Group selection, Kin selection, altruism, reciprocal altruism, inclusive fitness, co-operation, territoriality, alarm call.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember principles of sociobiology
M02: Understand role of hormones in behaviour
M03: Evaluate social organization of different animal groups
M04: Analyse the processes of group selection and kin selection
M05: Apply methods to find out inclusive fitness of organisms

MODULE IV: Biological rhythms: Biological rhythms – Circadian, Circannual, Lunar periodicity, Tidal rhythms. Genetics of biological rhythms, Clock genes.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concept of circadian rhythms
M02: Understand lunar periodicity and tidal rhythms
M03: Evaluate role of clock genes in homeostasis
M04: Analyse role of genes in biological rhythms
M05: Apply techniques to determine hormonal control of biological rhythms

MODULE V: Prey-Predator Behaviour: Crypsis and Mimicry, Polymorphism, Deception mechanisms, Fighting, Vigilance, Communal. Defence, Predation and foraging Trade-offs.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember interaction between species
M02: Understand concepts of prey-predator relationship
M03: Evaluate environmental influence on animal behaviour
M04: Analyse various defence mechanisms
M05: Apply models to assess prey-predator relationship

MODULE VI: Behavioral responses to stressors: Quantitative and qualitative measurement of behavioural responses, Animal models of depression, Antidepressant screening tests (Despair based, Anxiety based, Reward based).

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember principles of behaviour
M02: Understand stressor reponse
M03: Evaluate quantitative and qualitative measurement of behavioural responses
M04: Analyse the various animal models of depression
M05: Apply models to resolve antidepressant screening tests

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics

- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES
References

- Alcock John. (2009). *Animal Behaviour: An Evolutionary Approach*. 8th edn. Sinauer Associates Inc. Sunderland, Massachusetts.
- Fatik, B. M. (2009). *A Textbook of Animal Behaviour*. PHI Learning Private Limited, New Delhi.
- Hauser, M. (1998). *The Evolution of Communication*. MIT Press, Cambridge, Mass. USA.
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http://www.jblearning.com/samples/0763740511/Ch%202_Seaward_Managing%20Stress_5e.pdf

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

M. Sc. (CSS) Degree Examination
Branch: Post Graduate Programmes
INB-GC-502: Introduction to Animal Behaviour

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Speculate on motivated behavior.
2) Imprinting in new born animals. What does it signify ?
3) Articulate on the process of latent learning.
4) Altruistic behavior is essential for survival of a species. Justify the statement.
5) Expound on Pheromones as communication medium in animals.
6) Signify the importance of Sociobiology in present world setting post corona.
7) Delineate on anti-depressing screening tests.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) List out the significance of prey-predator behavior.
9) Present your view on diverse aggregations in nature.
10) Depict chemical communication as a method of information transfer among animals.
11) Put in your words why ethology is considered as the scientific and objective study of animal behavior ?
12) Elucidate on varied forms of learning in animals.
13) Summarize about the clock control of the rhythmic physiology in marine organisms.
14) Connote on various research tools as a simulation used to investigate depression and action of antidepressants in animals?
15) How does the body react to common stressors ? Is there any impact of stressors on your physical and mental well being ?

(6x5=30 Marks)

III. Answer **any two** of the following:

16) The influence of biological rhythms in our day-to-day life. Elucidate with examples.
17) How is the structure of the nervous system related to an animal's behavior ?
18) Measuring the behavioral responses by quantitative and qualitative means. Is it possible ? If yes, validate your choice.
19) Can you correlate and find similarities between dance language in Honey bees and human social interactions. Elucidate its significances as well.

(2x10=20 Marks)

SEMESTER	Course Code: INB-GC-503	Credits: 2

STRESS PHYSIOLOGY AND ADAPTATION BIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify basic knowledge of study of stress in the animal world
CO2: Give an overview of the comparative functioning of different adaptive systems in animals.
CO3: Gain knowledge on physiological stress
CO4: Comprehend concepts related to various stress endured by the organisms and how they adapt to these adverse conditions
CO5: Apply concepts and principles of adaptive functioning of respiratory, cardiovascular and sensory systems
CO6: Understand Environmental and adaptive physiology and apply its concepts for the betterment of animals in nature

COURSE CONTENT

Module I: Stress Physiology and Ease Physiology: Concepts of stress and ease, stressors, integrated stress response, ease response, eustress, distress.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of stress and ease physiology
M02: Understand mechanisms of hormonal regulation of stress adaptation
M03: Evaluate stress response, ease response
M04: Analyse ease response in various organisms
M05: Apply techniques to determine levels of stress and ease in different organisms

Module II: Stress adaptation and tolerance. Mechanism of stress tolerance, stress acclimation, stress proteins. Endocrinology of stress and ease, endocrine stress axis. Hormonal regulation of stress adaptation. Hormonal control of ease response in fish and mammals.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of stress tolerance
M02: Understand mechanisms of hormonal regulation of stress adaptation
M03: Evaluate stress tolerance and acclimation
M04: Analyse ease response in various organisms
M05: Apply various methods to evaluate stress in animals from stress protein/hormone analyses.

Module III: Definition, Types of adaptations-Physical and behavioural, Environmental conditions of aquatic, terrestrial, xeric and aerial habitats. Nature of interaction with the environment-Tolerance, resistance, acclimation and acclimatization, Physiological Effects of temperature change in animals-Q 10 effect; Lethal temperature, causes of thermal death (high and low temperature). Light conditions - eclosion in insects.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember concepts of physical and behavioural adaptation
M02: Understand the nature of interaction of animals with the environment
M03: Evaluate physiological effects of temperature change in animals
M04: Analyse different types of physical and behavioural adaptations
M05: Apply strategies to evaluate tolerances to environmental and physical conditions in animals.

Module IV: Aquatic life: Adaptations of marine, intertidal, estuarine and fresh water animals (Lentic and lotic) with emphasis on morphological and physiological adaptations. Terrestrial and aerial life: Adaptations for life in forest, grass land and desert. Flight adaptations-morphological and physiological in insects and birds.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember diverse aquatic, terrestrial and ariel adaptations
M02: Understand morphological and physiological adaptations of aquatic animals
M03: Evaluate distinctive adaptations in marine, estuarine and freshwater fishes
M04: Analyse various terrestrial adaptations to live in forest, grassland and desert.
M05: Apply and develop new methods to study flight adaptation differences and similarities in insects and birds.

Module V: Life in extreme environments: Adaptations for life in Deep -sea and caves; Effects of depleted oxygen availability; adaptations for deep-sea diving and high altitude conditions.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the life forms in extreme environments
M02: Understand the divergent adaptations for deep-sea and caves
M03: Evaluate the effects of Oxygen in the life in extreme environments
M04: Analyse the differences between deep-sea and cave adaptations
M05: Apply techniques to explore deep-sea and high altitudes to study more about life in extreme conditions

Module VI: Biological rhythms: Rhythms as adaptive feature, Types of rhythms, Circadian rhythms – Examples in man, jet lag, health Impacts of disruption in sleep-wake rhythm, Entrainment, Phase shift, Phase response curves (PRC) and phase transition curves (PTC).

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the various types of biological rhythms
M02: Understand principles of rhythms in animals
M03: Evaluate the adaptive feature of biological rhythms.
M04: Analyse health impacts of disruption in circadian rhythms
M05: Apply new approaches to understand circadian rhythms in animals

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Iwama GK, Pickering AD, Sumpter JP (2011) Fish Stress and Health in Aquaculture. Cambridge University Press, Cambridge, UK
- Jay, C. D., Jennifer. J. Loros, Patricia J. DeCoursey (ed.), (2004) ChronobiologyBiological Timekeeping: Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
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https://www.health.harvard.edu/staying-healthy/understanding-the-stress-response
https://education.nationalgeographic.org/resource/adaptation/

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

First Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc. M. Sc. Zoology with specialization in Integrative Biology
INB-GC-503: Stress Physiology and Adaptation Biology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Annotate on the direct and indirect effects of physiological distress.
2) Explain lethal temperature.
3) Write a note on stress indicators.
4) Distinguish between physical and behavioural adaptations.
5) Expound the incidence of jetlag.
6) Evaluate physiological effects of temperature change in animals.
7) Elaborate the idea of tolerance and resistance in adaptation.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Give an account of various stress hormones.
9) Describe pre – adaptation.
10) Hormonal functions get messed up when you are stressed. Account for this statement.
11) All animals do not show the same adaptations for terrestrial habitats. Evaluate with examples.
12) Annotate the differences between flight adaptations of birds and insects.
13) Give an account of the role of stress leading to evolution.
14) Explain the different types of biological rhythms.
15)Expound the mechanism of ease response.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) When animal is exposed to various stressors, which all stress hormones will be analyzed to confirm the animal is stressed? How hormones mediate the body's response to stress?
17) How do bony fishes adapt to different osmoregulatory strategies in fresh water, estuarine and marine environments.
18) Illustrate how life is possible in extreme conditions with suitable examples.
19) Substantiate the role of stress in adaptation and acclimation process.

(2x10=20 Marks)

SEMESTER	Course Code: INB-GC-504	Credits: 2

CANCER: CAUSES, PREVENTION AND TREATMENT

Course Outcomes (CO)

CO1: Understand the genesis, prevalence and meaning of cancer
CO2: Give an outline of the disease cancer and its causes
CO3: Expand understanding of the causes of cancer and how to prevent it
CO4: Comprehend the treatment modalities of cancer and related co-morbidities
CO5: Apply concepts learnt about the disease to create knowledge on how to prevent and treat cancer
CO6: Create novel strategies, techniques and tools to create awareness in public about cancer

COURSE CONTENT

Module I: Cancer: Historical perspective. Incidence. Cancer before the molecular era. Initial definitions and classification of cancer. Earliest treatment methods.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn about cancer
M02: Understand history of the disease
M03: Differentiate early classification methods
M04: Analyse defects and drawbacks in old treatment methods
M05: Evaluate old and new information related to cancer

MODULE II: Cancer in the present world. Cancer statistics. Classification of cancers: Types based on location, stage, cell. Etiology. Causes: Avoidable and unavoidable.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Remember statistics related to cancer
M02: Understand present classification
M03: Evaluate the etiology of cancer
M04: Differentiate and analyze various causes of cancer
M05: Apply the knowledge to further increase understanding of the disease

MODULE III: Genetics of cancer. Major genes involved in initiating cancer. Oncogenes and Tumour Suppressor genes. Cell signaling triggering cancer.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Learn about genes involved in causing cancer
M02: Understand concept of cellular signaling and how it works in cancer
M03: Differentiate between Oncogenes and Tumour Suppressor genes.
M04: Analyse the regulation of signalling pathways in cancer
M05: Apply the concept of cell signalling in blocking the pathways

MODULE IV: Cancer treatment. Classification: Surgery, chemotherapy and radiation. Monoclonal antibodies. Chemotherapy: drug classes, mechanism of action. Resistance

and Recurrence. Latest methods in treating cancer. Palliation. Role of counseling and support groups.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn treatment options in cancer
M02: Understand mechanisms of drug action
M03: Evaluate and differentiate various treatment regimens
M04: Analyse cancer recurrence and how cancer cells resist treatment
M05: Comprehend the concept of palliation

MODULE V: Cancer prevention. Various levels of prevention: life style, food, exercise. Clinical prevention strategies including chemotherapy and surgeries. Ethics in prevention strategies. Phytochemicals as prophylactic and therapeutic agents.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn and remember principles prevention
M02: Differentiate methods of cancer prevention
M03: Evaluate clinical prevention strategies
M04: Analyse the role of phytochemicals in cancer prevention
M05: Create new methods to prevent cancer using the knowledge gained

MODULE VI: Cancer in future world and its awareness. Future trends in cancer statistics. Creating awareness in public. Cancer in literature, media and popular culture. Case studies. Role of life science students in cancer awareness. Research dimensions related to cancer: Statistical, Economical, Chemo-Physico-Biological studies, Literature and all fields of study.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Comprehend about awareness on cancer
M02: Understand the future trends in cancer
M03: Evaluate the role of media and literature in cancer awareness
M04: Analyse various research dimensions in cancer
M05: Apply the knowledge you learnt to create awareness in public

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES
References

- Adami, H. O., Hunter, D., and Trichopoulos, D., eds. 2002. *Textbook of Cancer Epidemiology*, Vol. 33 of *Monographs in Epidemiology and Biostatistics*. Oxford University Press, New York.
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On-line Sources

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https://www.who.int/news-room/fact-sheets/detail/cancer#:~:text=Cancer%20is%20a%20leading%20cause,and%20rectum%20and%20prostate%20cancers.
https://www.cancer.gov/about-cancer/understanding/statistics

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

M. Sc. (CSS) Degree Examination
Branch: Post Graduate Programmes
INB-GC-504: Cancer: Causes, Prevention and Treatment

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Cancer existed from time immemorial. Justify the statement.
2) Only oncogenes cause cancer. True or false. Validate your view.
3) Articulate on present classification system of cancer.
4) Explicate on palliation in cancer.
5) Illustrate the role of media in cancer awareness.
6) Outline the role of phytochemicals in preventing cancer.
7) Present your views on drug resistance in cancer.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Articulate on the earliest treatment methods against cancer.
9) Expound on role of statistics in cancer studies.
10) Elucidate about chemotherapy in cancer treatment.
11) Delineate stages of cancer treatment.
12) Discuss your view on clinical cancer prevention strategies.
13) Describe about how cancer cells resist cancer treatment.
14) In your view, what would be the future cancer trends in the world ? Give reasons.
15) Present your views on the role of counseling and support groups for cancer patients and their care givers.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) Cancer nowadays is an almost preventable disease. Do you agree with the statement. Corroborate your view with valid points.
17) Elucidate about the role of genes in causing or preventing cancer.
18) Deliberate about the role of consumption of phytochemicals as therapeutic and prophylactic agents in cancer.
19) With the help of your area of interest, make novel methods or strategies to create awareness to general public about cancer and how to prevent it.

(2x10=20 Marks)

SEMESTER	Course Code: INB-SE-501	Credits: 2

BIOFERTILIZER PRODUCTION AND TECHNOLOGY

Course Outcomes (CO)

CO1: To gain an overview of Biofertilizers
CO2: To understand about different Types of Biofertilizers
CO3: To acquire knowledge on culturing of Microbes, staining and Biochemical characterization
CO4: To evaluate the advantages of biofertilizers over chemical fertilizers
CO5: To formulate the methodology of mass production
CO6: To create technology for the synthesis of carrier-based biofertilizers and field application

COURSE CONTENT

MODULE I: Introduction to Biofertilizers. Microbial interaction with plants, Nitrogen fixation Nitrogen fixing bacteria; Symbiotic and free living bacteria, Phosphate-solubilization; Phosphate-solubilizing bacteria. Soil fertility.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Understand and remember Biofertilizers
M02: Comprehend the significance of Microbial Interaction with Plants
M03: Analyse the significance of Phosphate solubilisation and Nitrogen fixation.
M04: Evaluate the role of Nitrogen fixation and Phosphate solubilization in soil fertility
M05: Create new techniques to analyze soil fertility

MODULE II: Biofertilizers different kinds: Bacterial, fungal and Algal biofertilizers. Rhizobium, Acetobacter, Azospirillum, Azotobacter, Mycorrhiza, Potassium Solubilizing Bacteria, Phosphate solubilizing bacteria, Zinc Solubilizing Bacteria, Sulphur Solubilizing Bacteria.

Module Outcome:

After Completion of this module, the student should be able to:

M01: Comprehend and remember different kinds of Biofertilizers
M02: Understand the mechanisms of Bacterial, Fungal and Algal biofertilizers.
M03: Evaluate the significance of Bacterial biofertilizers such as Rhizobium, Acetobacter, Azospirillum, Azotobacter.
M04: Analyse the significance of Mycorrhiza, Potassium Solubilizing Bacteria, Phosphate solubilizing bacteria, Zinc Solubilizing Bacteria and Sulphur Solubilizing Bacteria in soil fertility
M05: Synthesize classification system for bacteria

MODULE III: To acquire knowledge on culturing of Microbes, staining and Biochemical characterization. Media preparation for the selective culture of Nitrogen fixers and various solubilizing bacteria. Simple staining, Gram's staining. Biochemical characterization of bacteria.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember the concepts in culturing of microbes.
M02: To acquire knowledge on the preparation of various culture media
M03: Understand the various staining methods of microbes.
M04: Evaluate the biochemical characteristics of bacteria.
M05: Apply techniques learnt to differentiate bacterial classes

MODULE IV: Chemical Fertilizers; Different types. Nitrogenous, phosphate-based and potassium blended. Properties of Chemical fertilizers. Advantages of Biofertilizers over chemical fertilizers.

Module Outcome:
After Completion of this module, the student should be able to:
M01: To Understand about chemical fertilizers
M02: To gain knowledge on various types of chemical fertilizers
M03: Evaluate the mechanism of Chemical fertilizers.
M04: To Analyse advantages of Biofertilizers over chemical fertilizers.
M05: Apply knowledge learnt to differentiate biofertilizers

MODULE V: To understand technology of Mass scale production. Preparation of Mother or Starter Cultures, Broth Cultures: Carrier mixing: Curing or Maturation:

Module Outcome:
After Completion of this module, the student should be able to:
M01: Comprehend and remember the methodology of mass production
M02: Understand mechanisms of Preparation of Mother or Starter Cultures
M03: Analyze various Broth cultures
M04: Differentiate carrier mixing via curing and maturation
M05: Formulate cultures for mass scale production

MODULE VI: To create technology for the synthesis of carrier-based biofertilizers and field application, Carrier materials; Properties of Carrier materials, Criteria for Carrier selection, Different types of Carrier materials. Field application ;Seedling root dip, Seed Treatment, Soil Treatment

Module Outcome:
After Completion of this module, the student should be able to:
M01: To understand and remember carrier materials
M02: To analyse the properties of Carrier materials
M03: To Evaluate the strategies for Carrier material selection
M04: To Comprehend about different types of Carrier particles
M05: To formulate methodology for field application for various crops

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates

- Quiz

LEARNING RESOURCES
References

- General Microbiology- Dubey and Maheswari.
- Motsora,M.R.,P.Bhattacharya and Beena Srivastava (1995). Biofertilizer Technology,Marketing and Usage-A Source Bookcum-Glossary(FDCO, New Delhi).
- Subbarao, N.S. 1993. Biofertilizers in Agriculture and Forestry (Oxford and IBH Pub. Co., New Delhi).

On-line Sources

- Objectives and outcomes of Biofertilizers - 1 hr
- https://spark.adobe.com/page/2ja6zwVXjjHCh/
- http://courseware.cutm.ac.in/wp-content/uploads/2020/06/Introduction-and-Structure-of-Biofertilizers.pdf

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-SE-501: Biofertilizer Production Technology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Biofertilizers enhance soil fertility. Clarify.
2 Analyse the significance of Mycorhiza?
3) Illustrate the significance of Phosphate solubilizing bacteria?
4) There are reports on Cyanobacteria as biofertilizers. Evaluate?
5) Comment on the method of seed inoculation in field application of biofertilizers?
6) A bacterium gives Indole test positive in biochemical characterization. Analyse?
7) Comment on Chemical fertilizers?

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) Microbial association with the root system of leguminous plants enhances soil fertility. Analyse.
9) Biofertilizers are advantageous over chemical fertilizers for sustainable nutrient management. Evaluate.
10) Analyse the strategy for the identification of Nitrogen fixing bacteria isolated from a soil ecosystem.
11) Illustrate the use of sterilization strategies in the microbiology laboratory?
12) Evaluate the significance of carrier particles in biofertilizer production?
13) Illustrate the metabolic pathway associated with Nitrogen fixation?
14) Evaluate the process of strain selection?
15) Analyse the different types of culture media for the isolation Nitrogen fixing and Phosphate mobilizing bacteria.

(6x5=30 Marks)

III. Answer **any two** of the following:
16) Suppose you wanted to produce biofertilizer in a laboratory. Analyse the various steps involved in it.
17) Illustrate about various types of microorganisms which are widely used as biofertilizers.
18) Illustrate the staining and biochemical characterization methods used for the identification of bacteria.
19) Evaluate the contribution of biofertlilizers in Agroindustry.

(2x10=20 Marks)

SEMESTER	Course Code: INB-SE-502	Credits: 2

HISTOLOGY AND HISTOPATHOLOGY

Course Outcomes (CO)

CO1: Give an overview of the fundamentals of histology
CO2: Acquire an in-depth knowledge on tissue fixation and staining of different tissues
CO3: Gain knowledge on principles and methods of application and utility of classical histochemical techniques
CO4: Comprehend concepts related to tumours in tissues and difference in functional morphology of affected tissues.
CO5: Apply concepts and principles of histopathology and histochemical techniques to evaluate various pathological conditions in different tissues.
CO6: Articulate and exemplify the principles and practices of immunohistochemical techniques.

COURSE CONTENT

Module I: Tissue fixation and staining: Histology, Histochemistry and Histopathology: Meaning, objectives and applications, Tissue fixation: Objectives, methods, chemical fixatives, Dyes – Classification, Natural and Synthetic.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember the general principles histology
M02: Understand objectives of histopathology
M03: Evaluate the scope of histology and histopathology
M04: Analyse the opportunities and obstacles of histology
M05: Apply techniques to fix and stain different tissues.

Module II: Histology: Epithelium: Types and modifications – cilia, microvilli, stereocilia, flagella, junctional complexes. Functional Morphology of mammalian tissues.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember functional morphology of tissues
M02: Understand types and modifications of epithelium
M03: Evaluate the alterations in junctional complexes
M04: Analyse the prospects and hindrances of functional differences in tissues
M05: Apply practices to study histology of mammalian tissues.

Module III: Classical Histochemistry: Principles and methods of application and utility of classical histochemical techniques: Examples: Localization of glycoproteins (PAS), nucleic acids (Feulgen) and steroid dehydrogenase activity.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Remember examples of histochemical techniques
M02: Understand principles of histochemistry
M03: Evaluate various methods to utilize histochemistry

M04: Analyse the utility of histochemical staining
M05: Apply the techniques to localize proteins, steroids and nucleic acids in tissues

Module IV: Immunohistochemistry: Principles and methods of application of Immunohistochemistry and immunofluorescence techniques. Examples: Localization of proteins in endocrine cells (Pituitary cell types orislet of Langerhans).

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember immunohistochemical techniques
M02: Understand the concept of immunohistochemistry
M03: Evaluate the possibilities of immunofluorescence techniques
M04: Analyse the methods to localize proteins using immune histochemistry
M05: Apply techniques to fix and stain protein in endocrine cells

Module V: Histopathology: Morphological alterations in cells due to disease, Etiology, pathogenesis and histopathology of Liver cirrhosis and atherosclerosis, Neuropathology of alcoholism and methanol poisoning.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember cellular alterations during diseases
M02: Understand pathogenesis of liver cirrhosis
M03: Evaluate neuropathology of alcoholism and methanol poisoning
M04: Analyse potential uses of histopathology
M05: Apply practices to utilize the histopathological methods

Module VI: Tumours- malignant and non-malignant, types of carcinoma, histopathology of breast and prostate tumours.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the types of tumours
M02: Understand cellular variations during tumour
M03: Evaluate the types of carcinomas
M04: Analyse the alterations during tumour formation in breast
M05: Apply methodsvalidate histopathology of tumours

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz

LEARNING RESOURCES
References

- Boyd, W. 1976: A text book of Pathology. Structure and function in disease, 4th edition. Lea and Fibiger, Philadephia.
- Cotran, R. S., Kumar, V., andRobbins, S. L. (1989): Robbins Pathologic basis of Disease, 4th Ed., W. B. Saunders Company, London.
- Pearse, A. G. E. (1980): Histochemistry, theoretical and Applied, J & A, Churchill Ltd., London.
- Rogers, A. W. (1983): Cells and Tissues, An introduction to Histology and Cell Biology, Academic Press, NY.
- Telford, I. R. and Bridgman, C. F. (1990). Introduction to Functional Histology, Harper and Row, NY.

On-line Sources

https://www.kenhub.com/en/library/anatomy/introduction-to-histology
https://www.ncbi.nlm.nih.gov/books/NBK557663/
https://www.rcpath.org/discover-pathology/news/fact-sheets/histopathology.html#:~:text=Histopathology%20is%20the%20diagnosis%20and,clinicians%20manage%20a%20patient's%20care.
https://www.verywellhealth.com/histopathology-2252152

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-SE-502: Histology and Histopathology

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:
1) Write in brief what is tissue fixation.
2) Explain the principle of histochemistry
3) In your words, describe immunohistochemistry
4) Analyse the cellular variations during tumour
5) Write a note on synthetic dyes.
6) Differentiate cilia and flagella.
7) Define histopathology and its applications in medicine.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:
8) Elaborate the functional morphology of mammalian kidney.
9) Describe the types and methods of tissue fixation for histology.
10) Not all dyes stain all tissues- validate the statement.
11) Histochemistry is widely used for localization of proteins in animal tissues- evaluate the statement.
12) Annotate the differences between Immunohistochemistry and immunofluorescence
13) Give an account of the malignant and non-malignant tumours with reference to histology.
14) Explain the morphological alterations in cells due to alcoholism and methanol poisoning.
15) Expound the role of histopathology in disease evaluation and prognosis.

(6x5=30 Marks)

III. Answer **any two** of the following:
16) In your words, describe the significance and applications of histology in modern science.
17) Epithelium is modified to adapt to various living conditions in different animals- explain the statement with suitable examples.
18) Illustrate etiology, pathogenesis and histopathology of liver cirrhosis.
19) Elucidate the principles and methods of application of immunohistochemistry and immunofluorescence techniques in modern medicine.

(2x10=20 Marks)

SEMESTER	Course Code: INB-SE-502	Credits: 2

ADVANCED MOLECULAR TECHNIQUES

Course Outcomes (CO)

CO1: Understand the major tools and techniques used in the study of biomolecules
CO2: Learn about Microscopy methods used for studying microorganisms and biomolecules
CO3: Develop knowledge on Chromatography technique used for the separation of biomolecules.
CO4: Comprehend Electrophoresis techniques used for the quantitative and qualitative analysis of biomolecules
CO5: Gain awareness about the structural elucidation and quantitative analysis employing spectroscopy.
CO6: Apply knowledge achieved to create new assessments tools for the quantitative analysis employing RIA and ELISA

COURSE CONTENT

Module I: Microscopy: Differential Interference contrast (Nomarsky) microscopy, Confocal microscope, Electron microscope – TEM, SEM, Scanning Tunneling and Atomic Force Microscopes. Light microscope and dark field microscope, Phase contrast microscope, Polarizing microscope, birefringence fluorescence microscope.

Module Outcome:

After Completion of this module, the student should be able to:
M01: Comprehend and remember history of microscopy
M02: Understand different parts of various microscopes
M03: Evaluate pros and cons of various microscopes
M04: Analyse functioning of electron microscopes
M05: Apply knowledge to design novel microscopes with improvements over existing designs

Module II: Chromatography: Paper chromatography, Thin layer chromatography, Ion exchange chromatography. Gel permeation chromatography, Affinity chromatography, Gas chromatography, High pressure liquid chromatography (HPLC).

Module Outcome:

After Completion of this module, the student should be able to:
M01: Learn and remember techniques in chromatography
M02: Understand principles of different types of chromatography methods
M03: Evaluate functioning of different types of chromatography methods
M04: Analyse the instruments used to assess levels of biomolecules using chromatography methods
M05: Apply the principles to create novel processes and instruments using principles in chromatography

Module III: Electrophoresis: Paper electrophoresis, Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and non SDS, Agarose gel electrophoresis, Disc

electrophoresis, High voltage electrophoresis, immunoelectrophoresis, isoelectric focusing.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn and remember techniques in electrophoresis
M02: Understand principles of different types of electrophoretic methods
M03: Evaluate functioning of different types of electrophoretic methods
M04: Analyse the instruments used to assess levels of biomolecules using electrophoretic methods
M05: Apply the principles to create novel processes and instruments using principles in Electrophoresis

Module IV: Colorimetry, Spectrophotometry and Spectroscopy: Principle and applications of colorimetry and spectrophotometry. Spectroscopy: Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic resonance spectroscopy (NMR), Circular dichroism spectroscopy, ESR spectroscopy, Mass spectroscopy.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn and remember techniques in spectroscopy
M02: Understand principles of different types of spectroscopic methods
M03: Evaluate functioning of different types of spectroscopic methods
M04: Analyse the instruments used to assess levels of biomolecules using spectroscopic methods
M05: Apply the principles to create novel processes and instruments using principles in spectroscopy

Module V: Centrifugation: Basic principles of sedimentation, Types of centrifuges, Analytical and Preparative centrifugation, Differential and density gradient centrifugation.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn and remember techniques in centrifugation
M02: Understand principles of different types of centrifugation methods
M03: Evaluate functioning of different types of centrifugation methods
M04: Analyse the instruments used to assess levels of biomolecules using centrifugation methods
M05: Apply the principles to create novel processes and instruments using principles in centrifugation

Module VI: Radioisotope Detection and Measurement: Dosimetry, Ionization chamber, GM counter, Solid and liquid scintillation counters, Autoradiography. Radio ImmunoAssay, Enzyme Linked Immuno Sorbant Assay (ELISA).

Module Outcome:
After Completion of this module, the student should be able to:
M01: Comprehend and remember basics of radioactivity

M02: Understand principles in radioisotope detection and its measurements
M03: Evaluate types of devices to measure radioactivity
M04: Analyse diverse radioactive biomolecules using principle of ELISA
M05: Apply knowledge to design novel methods and instruments to measure radioactivity

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Seminar Presentation on selected topics
- Debates
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Baker, E.J. and Silverton R. E. (1978). *Introduction to Medical Laboratory Technology*. ELBS. London, UK.
- Das, D. (1991). *Biophysics and Biophysical Chemistry*. Academic Publishers, Calcutta.
- Edward, A.L. (1997). *Radiation Biophysics.* Academic Press, NY, USA.
- Ernster, L. (Ed.). (1985). *Bioenergetics*. Elsivier, NewYork, USA.
- Pearse, A.G.E. (1980). *Histochemistry*. Vol. & Vol. II. Churchill Livingstone, NY., USA.
- Pradeep, T. (2007). *NANO: The Essentials. Understanding Nanoscience and Nanotechnology*. Tata Mc.Graw Hill Publications, India.
- Sandhu, G.S. (1990). *Research Techniques in Biological Sciences*. Anmol Publications, New Delhi, India.
- Weesner, F.M. (1960). *General Zoological Microtechniques*. The Williams & Wilkins Co., Baltimore, USA.

On-line Sources

http://www.rsc.org/globalassets/09-careers/personal-professional-development/professional-scientists/qp-study-guide.pdf
https://moodle.kent.ac.uk/external/mod/book/view.php?id=2604&chapterid=163
http://www.purdue.edu/ehps/rem/home/booklets/bioman.pdf

ASSESSMENT

40% Continuous / Formative Assessment (see PG Regulations).
60% End-semester/Summative Assessment: 3 hour written Exam.

Model Question Paper

M. Sc. (CSS) Degree Examination
Branch: M. Sc. Zoology with specialization in Integrative Biology
INB-SE-503: Advanced Molecular Techniques

Time: **3 Hours** Max. Marks: **60**

I. Answer **any five** of the following:

1) Clarify about spectroscopy technique used to study the secondary structure of proteins.
2) Analyse the reason for better resolution shown by Electron Microscopy Images.
3) Illustrate the principle of Fluorescence.
4) Absorbance at 260nm was measured for a DNA solution. Then this DNA solution was heated at 100 and measured the Absorbance at 260nm. Will be same value ? Analyse.
5) There are reports on Stress induced animals secretes volatile hormones such as Glucocorticoids in fecal matter. Analyse the chromatography method to purify them.
6) Evaluate the methodology to check the purity of RNA used for Microarray analysis.
7) Illustrate the application of SDS in Proteomics.

(5x2=10 Marks)

II. Write short notes on **any six** of the following:

8) There are reports on CdK2 interacts with Cyclin M1 to form a complex which regulates Cell cycle. Evaluate a fluorescence based method to study this interaction.
9) RAFT associated membrane proteins is isolated from the tissue lysate employing Ultra centrifugation. Here sucrose is added into the lysate before centrifugation. Evaluate the significance of this step?
10) Evaluate the strategy to check the serum of a patient with suspected food poisoning for Botulinum toxin employing Immunoelectrophoresis ?
11) Illustrate the principle of Mass spectroscopy?
12) Analyse the type of ion exchange resins which can be used for the purification of a Protein of Isoelectric point 6.8 (pI= 6.8) in a buffer of pH 8.8 and when the pH of the extract is changed to 4.8 by adding 1N HCl?
13) Evaluate the methodology to study the change in the expression of Succinate Dehydrogenase in Mitochondria due to Silencing of a gene namely Nphp1 employing shRNA approach.
14) A mixture of Proteins contains three proteins of mol. wt 1000 kDa, 100 kDa and 10 kDa. Analyse the chromatography most advisable for the separation of these proteins.
15) Describe about the law which stays as the foundation in the field of spectroscopy.

(6x5=30 Marks)

III. Answer **any two** of the following:

16) LIF is a factor supplemented in Embryonic Stem cell culture for maintaining the self renewal of ESCs. Evaluate the strategy to synthesize LIF in the laboratory.
17) A Pseudo virus of SARS CoV2 is generated in the Laboratory to study the interaction of spike protein and ACE2 receptor. Analyse the methods to detect it.
18) Suppose you have noticed the DMSO extract of leaves of *Ocimum sativum* has high anticancer activity against Prostrate cancer cell lines. Evaluate the method to study the purification and identification of bioactive compound of this extract.
19) Laboratory safety measures have to be strictly followed to work in BSL level labs. Illustrate.

(2x10=20 Marks)

University of Kerala was founded as the University of Travancore in the erstwhile princely state of Travancore in 1937. Sri Chithira Thirunal Balarama Varma, Maharaja of Travancore, was the first Chancellor of the University. Sir C. P. Ramaswamy (the Diwan of the state) was the first Vice-Chancellor. Now as our University is crossing 85 years of existence, the "Mother University" has achieved a CGPA of 3.67 out of 4 in NAAC ranking, thus becoming the first University in Kerala to achieve NAAC A++ grade and also is ranked 24th among universities in the country in the India rankings 2023 under the National Institutional Ranking Framework (NIRF).