Name of the Programme:
M.Sc. Integrative Biology (Zoology)
(Syllabus effective from 2021 Admission onwards)

UNIVERSITY OF KERALA

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

2021

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 acquireskill, training and knowledge to enhance their thinking, comprehension andapplication abilities and prepare them to compete, succeed and excel globally. Sustainedinitiatives are required to reform the present higher education system for improving andupgrading the academic resources and learning environments by raising the quality ofteaching and standards of achievements in learning outcomes across all undergraduateprograms in science, humanities, commerce and professional streams of higher education.

One of the significant reforms in the undergraduate education is to introduce the LearningOutcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactiveand outcome-oriented with well-defined aims, objectives and goals to achieve. The UniversityGrants Commission (UGC) took the initiative of implementing the LOCF in the Colleges andthe 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 learnerincluding knowledge, application of knowledge, professional and life skills, attitudes andhuman 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. Integrative Biology (Zoology)

Programme Specific Outcomes (PSO) for M. Sc. Integrative Biology (Zoology)	
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. Integrative Biology (Zoology)

Semester	Course Code	Name of the course	Credits
I	**Core Courses (CC)**		
	INB-CC-511	Advanced Physiology and Stress Physiology	3
	INB-CC-512	Evolutionary Biology and Ethology	3
	INB-CC-513	Animal Systematics and Diversity	3
	INB-CC-514	Microbiology and Plant Physiology	3
	INB-CC-515	Practical I: Physiology, Systematics, Ethology and Microbiology	2
II	**Core Courses (CC)**		
	INB-CC-521	Bioinstrumentation, Biosafety and Bioethics	3
	INB-CC-522	Environmental Biology	3
	INB-CC-523	Biochemistry and Biophysics	4
	INB-CC-524	Cell Biology and Genetics	3
	INB-CC-525	Practical II: Cell Biology, Environmental Biology and Biochemistry	2
III	**Core Courses (CC)**		
	INB-CC-531	Molecular Biology and Biotechnology	4
	INB-CC-532	Immunology and Endocrinology	3
	INB-CC-533	Neurobiology and Reproductive Biology	3
	INB-CC-534	Research Methodology, Biostatistics and Bioinformatics	3
	INB-CC-535	Practical III: Molecular Biology, Developmental Biology, Bioinformatics and Research Methodology	2
	Discipline Specific Elective (DE)		
	INB-DE-536	Molecular techniques in Integrative Biology	2

	Core Courses (CC)		
IV	INB-CC-541	Structural and Developmental Biology	4
	INB-CC-542	Integrative Biology	4
	INB-CC-543	Project Work and Viva	8
	Generic Courses (GC)		
Any Semester (I-IV)	INB-GC-501	Molecular techniques in Integrative Biology	2
	INB-GC-502	Introduction to Microbial Pathology	2
	INB-GC-503	Introduction to Animal Behavior	2
	INB-GC-504	Traditional Ethnomedicine	2

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

ADVANCED PHYSIOLOGY AND STRESS PHYSIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify basic knowledge of study and comparison of organ systems across the animal 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 the organisms 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 in nature

COURSE CONTENT

Module I: Systemic and Cellular homeostasis: Concept and principles of homeostasis, mechanism of homeostasis, Homeostatic processes, Integrating factors of homeostasis. Nutrition: Normal diet and physiologic calorie value of food stuffs, antioxidant nutriens, Digestion and absorption of various nutrients, movement of GI tract, The role of hormones, energy balance and BMR. 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. The respiratory system: Structure, Gas transport, Transport of Oxygen and carbon dioxide. 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, Lymphatic and muscular system: Comparative anatomy of heart structure, myogenic heart, specialized tissue, Cardiac cycle, Anatomy of heart, Heart as pump. ECG – its principle and significance, heart as a pump, blood pressure, neural and chemical regulation of the processes. Lymph

channels, lymph composition and functions of lymphatic system. 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, Nervous and excretory physiology: Sense organs - Vision, hearing, smell and tactile response. Sensory receptors. Mechanism of hearing. Physiology of vision. Basic details of neurons and action potential, Gross neuroanatomy of the brain and spinal cord, diseased states of brain. Nitrogen excretion, Kidney physiology and its role in osmoregulation and acid-base balance. Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember principles of sensory perception
M02: Understand mechanisms of sensory, nervous and excretory physiology
M03: Evaluate functioning of brain, spinal cord, 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: Stress Physiology and Ease Physiology: Concepts of stress and ease, stressors, integrated stress response, ease response, eustress, distress. 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 and ease physiology
M02: Understand mechanisms of hormonal regulation of stress adaptation
M03: Evaluate stress response, tolerance and acclimation
M04: Analyse ease response in various organisms
M05: Apply techniques to determine levels of stress and ease in different organisms

MODULE V: 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 VI: 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

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

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

LEARNING RESOURCES
References

- Edwards and Hassall. (1971). *Biochemistry and Physiology of the cell* .2nd Edn. McGraw Hill Co. UK. Ltd.
- Evans, D. H. (1993). *The Physiology of Fishes*. CRC press, London, 1993.
- Giese, A.C. (1962). *Cell Physiology*. W. B. Saunders Co., Philadelphia, 592 pp.
- Guyton, A. C. (1996). *Text Book of Medical Physiology*. W.B. Sanders & Co.
- Hill, R. W., Wyse, G. A., and Anderson, M. (2008). *Animal physiology*. Sunderland, MA: Sinauer Associates.
- Rankin, J. C. and Jensen, F. B. (1993). *Fish Ecophysiology*. Chapman and Hall, London.
- Sherwood. (2004). *Human Physiology: From Cells to Systems*. 5th Ed, Thomson, Australia.
- William, S. H. (1983). *General and Comparative Physiology*. Printice Hall, New York.

On-line Sources

https://www.studyblue.com/notes/b/animal-physiology-second-edition/2856/0
http://wps.aw.com/bc_moyes_animalphys_2/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4369762/ Cell. 2015 Feb 26; 160(5): 816–827. doi: 10.1016/j.cell.2015.02.010

https://education.biu.ac.il/sites/education/files/shared/ssr-september-2015-085-094-klein-zion1.pdf
https://www.nature.com/articles/s51580-018-0068-0?proof=true
https://www.sciencedirect.com/science/article/pii/S0016648012003851
https://www.ncbi.nlm.nih.gov/books/NBK278995/
https://opentextbc.ca/anatomyandphysiology/chapter/10-7-cardiac-muscle-tissue/
https://teachmephysiology.com/cardiovascular-system/special-circulations/cardiac-muscle-circulation/
https://biologydictionary.net/integumentary-system/
https://www.innerbody.com/image/urinov.html
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3891255/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4297860/
https://www.researchgate.net/publication/300898318_Stress_Physiology
https://www.researchgate.net/publication/230627388_Adaptive_physiology
https://www.britannica.com/science/adaptation-biology-and-physiology
https://encyclopedia2.thefreedictionary.com/Environmental+Physiology
https://academic.oup.com/bioscience/article/69/2/152/5162974
https://www.sciencedirect.com/book/9780080273396/environmental-physiology

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. INTEGRATIVE BIOLOGY (ZOOLOGY)
INB-CC-511: ADVANCED PHYSIOLOGY AND STRESS 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) Illustrate the cardiac cycle.
5) Compile the causes of systemic edema.
6) What happens to eye lens of people suffering from myopia?
7) Mention the primary defenses with strong antiviral activity?

(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) Annotate the differences between fast and slow twitch muscle fibers.
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) How is the structure of the gills adapted for its function ?

(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) 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). Origin of basic biological molecules, concept of Oparin - Haldane, Miller-Urey Experiment. The First Cell. Evolution of Prokaryotes, origin of eukaryotic cells, evolution of unicellular eukaryotes. Genome evolution. 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 clocks, 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. Ethology and behavior of aquatic, gall forming and leaf mining insects. Social insects – social organisation, Caste differentiation, Aspects of social behaviour with reference to honey bee, termite and ant, Communication – acoustic, visual, tactile and chemical method (pheromones), Adaptations of parasitic and predatory insects.

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. Latency, summation, fatigue. Evolution of communication. Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual. Dance language of honey bees. Pheromonal communication (Ants and mammals).

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

- Alcock, J. (2009). *Animal Behaviour: An Evolutionary Approach*. 8th edn. Sinauer Associates Inc. Sunderland, Massachusetts.
- Campbell, B. G. (2009). *Human Evolution*. Transaction Publishers, NJ, USA
- Darwin, C. D. (1859). *On the Origin of Species by Means of Natural Selection*. John Murray, London.
- Dugatkin, L. A. (2009). *Principles of Animal behavior*. 2nd edn. W.W. Norton and Company. USA
- Elliott, S. (2008). *Evidences and Evolution: The Logic Behind the Science*. Cambridge University Press, UK.
- Fox, C. W and Wolf, J. B. (2006). Evolutionary Genetics-Concepts and Case Studies. 2nd edn. Sinauer Associates Inc. USA
- Goodenough, J. and McGuire, B. (2010). *Perspectives of Animal Behaviour*. John Wiley & Sons, USA.
- Hall, B. K and Hallgrimsson, B. (2008). *Strickberger's Evolution*. 4th edn. Jones and Bartlett Pub. London, UK.
- Kimura, M. (1983). *The neutral theory of molecular evolution*. Cambridge University Press, UK.

- Manning, A. and Dawkins, M. S. (2000). *An Introduction to Animal Behaviour*. 5th Edn. Cambridge University Press, U.K.
- Wilson, E.O. (2000). *Sociobiology: The new synthesis*. Harvard Univ. Press, Cambridge, Mass. USA.

On-line Sources

http://darwiniana.org/biology.htm
http://www.lsa.umich.edu/psych/courses/darmed/links.htm
http://libguides.brown.edu/EEB
http://animalbehaviour.net/JudithKBlackshaw/Chapter1.htm
http://sites.sinauer.com/bouton/index.html
https://www.livescience.com/474-controversy-evolution-works.html
https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Introductory_Biology_(CK-12)/01%3A_Introduction_to_Biology/1.08%3A_Evolution_of_Life
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4705322/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5535417/
https://books.google.co.in/books?id=Nr3cj_ER07sC&pg=PA2&lpg=PA2&dq=Geological+Timescale+and+Population+Genetics
https://www.britannica.com/science/gene-pool
https://www.nature.com/scitable/topicpage/the-molecular-clock-and-estimating-species-divergence-41971/
https://www.pbs.org/wgbh/evolution/library/glossary/index.html
https://www.khanacademy.org/science/biology/her/evolution-and-natural-selection/a/lines-of-evidence-for-evolution
https://www.journals.elsevier.com/hormones-and-behavior
https://nobaproject.com/modules/hormones-behavior
https://www.britannica.com/science/ethology
https://www.su.se/zoologi/english/research/2.50141/2.50017/courses/what-is-ethology-1.328947

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. INTEGRATIVE BIOLOGY (ZOOLOGY)
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

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 concepts: typological, Nominalistic, biological, evolutionary, recognition, ontological (theoretical) and operational (epistemological species concepts). Taxonomic diversity with in species, different kinds of species, sub species and other infra specific categories, hybrids. Biology and habits of the following Orders of insects – classification up to families giving salient features (for detailed study) 1. Ephemeridae 2. Odonata 3.Orthoptera 4. Thysanoptera 5. Homoptera 6. Heteroptera. 7. Blattaria 8. Mantoidea 9. Isoptera 10. Coleoptera 11. Lepidoptera 12. Hymenoptera 13. Diptera 14. Collembola 15.

Thysanura 16. Diplura 17. Protura. Biology, habits & important diagnostic features of the following Orders (Brief account) 1. Plecoptera 2. Embioptera 3. Phasmida 4. Dermaptera 5. Zoraptera 6. Psocoptera 7. Siphonoptera 8. Strepsiptera 9. Neuroptera 10. Mecoptera 11. Trichoptera. External morphology: Segmentation and division of the body. General morphology of the head – Opisthognathous, hypognathos and prognathos – Head segmentation- theories about the segmentation of the head. Head skeleton- different sutures and sclerites – Tentorium – Modification in head capsules – Cephalic appendages – Antenna: structure, function & types. Gnathal appendages: types, structure & function. Mouth parts of insects. Cervix. Thorax: Thoracic segmentation. Thoracic skeleton. Endothorax. Thoracic appendages. Modifications of thoracic legs. Wings: origin and evolution of wings, structure, venation, wing coupling apparatus, morphological variations. Abdomen: Segmentation. Skeletal composition. Pregenital and post genital segments. Abdominal appendages. External genitalia: male and female. Aquatic insects. Factors influencing the aquatic life. Food capture; modifications. Respiration in semi-aquatic and in truly aquatic insects. Oviposition methods. Anchorage, locomotion. Adaptations of swimming forms. Gall forming insects: Definition and features. Formation, economic importance. Common gall pests. Extent of gall making habits. Gall as dwelling place, the position of gall. Classification of galls by Orders. Adaptation for the gall making habits. Origin and types of galls (open & closed). Physiology of gall formation. Leaf mining insects. Definition and identification. Forms of leaf mines, economic importance. Extend of the leaf mining habits. Feeding habits and frass disposal. Ecological aspects of leaf mining. Insect-plant interdependence (co-evolution). Social insects – social organization. Caste differentiation. Aspects of social behaviour with reference to honey bee, termite and ant. Communication – acoustic, visual, tactile and chemical method (pheromones). 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, development of Code of Zoological Nomenclature: its operative principles, interpretation and application of important rules in the formation of scientific names of various taxa. Principle of priority. Homonymy and Synonymy. Type method and its significance. Different kinds of types in descriptive taxonomy

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 collections. Credit. Lending and borrowing of specimens. Loan of material. Exchange of materials. Collaboration and co-operation with co-workers. Use of language. Ethics related to taxonomic publications. Authorship of taxonomic papers. Correspondence. Suppression of data. Undesirable features of taxonomic papers. Taxonomists and user communities. Impediments to build up taxonomic collections and maintenance. Shortage of man power. Lack of funding for taxonomic research. Lack of training in taxonomy. Lack of Library facilities. Impediments in publishing taxonomic work. Solutions to overcome the impediments. International co-operation. Development of Taxonomic centres. Need for efficient international networking. The desired end product.

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

- Campbell, N. A and Reece, J. B. (2009). *Biology*. 8th edn. Benjamin Cummings Publ. NY,USA.
- David, M. H, Craig, M and Barbara, K. M. (1996). *Molecular Systematics*. Sinauer Associates, Inc.
- Kapoor, V. C. (1991). *Theory and Practice of Animal Taxonomy*. Oxford and IBH Publishing Co., Pvt. Ltd. New Delhi.
- Margulis, Lynn and Chapman, M. J. (2001). *Kingdoms and Domains: An Illustrated Guide to the Phyla of Life on Earth*. 4th edn. W.H.Freeman & Company, USA
- Mayr, E. (1969). *Principles of Systematic Zoology*. McGraw Hill Book Company, Inc., NY.
- Mayr, E. (1997). *This is Biology: The Science of Living world*. Universities Press Ltd.
- Niles, E. (2000). *Life on earth: an Encyclopedia of Biodiversity, Ecology and Evolution* (Vol.1&II). ABCCLIO, Inc.CA,USA
- Odum, E. P. (1996). *Ecology-A Bridge Between Science and Society*. Sinauer Associates Inc. Publishers.
- Strickberger, M. W. (2005). *Evolution*. Jones and Bartett Publishers, London.
- Winston, J. E. (2000). *Describing species: Practical Taxonomic Procedures for Biologists*. Columbia University Press,Columbia, USA.

On-line Sources
https://www.researchgate.net/publication/320513728_Difference_Between_Taxonomy_and_Systematics
https://www.biologyonline.com/dictionary/systematics
https://link.springer.com/chapter/10.1007/978-94-017-4380-8_4
https://www.toppr.com/guides/biology/biological-classification/introduction-to-biological-classification/
https://www.britannica.com/science/taxonomy/The-objectives-of-biological-classification

https://www.amentsoc.org/insects/glossary/terms/biological-classification#:~:text=Biological%20classification%20is%20the%20process,of%20techniques%20including%20genetic%20analysis.
https://www.springer.com/gp/book/9783764362560
https://www.infoplease.com/math-science/biology/genetics-evolution/systematics-taxonomy-and-classification-alternative-methods-of-classification
https://www.sinauer.com/media/wysiwyg/samples/Judd4e_Ch02_2.pdf
https://www.nap.edu/read/21293/chapter/20
https://www.nature.com/scitable/knowledge/library/conservation-biology-16089256/
https://conbio.org/publications/conservation-biology/
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/conservation-biology_5eSn6Cm6gIVxH0rCh3HmgA2EAAYAyAAEgL6OfD_BwE
http://ridge.icu.ac.jp/gen-ed/classif.html
http://eol.org/
http://www.biodiversitymapping.org/

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. Integrative Biology (Zoology)
INB-CC-513: 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 I	Course Code: INB-CC-514	Credits: 3

MICROBIOLOGY AND PLANT PHYSIOLOGY

Course Outcomes (CO)

CO1: Give an overview of microbial and plant life on the planet
CO2: Elaborate and represent basic structural and functional aspects of microbial and plant forms
CO3: Develop knowledge on the interaction of microbes and plants with the environment
CO4: Comprehend the role of microorganisms and plants in sustaining homeostasis in nature
CO5: Apply various systems to classify the microbes and plants using classical as well as modern molecular methods
CO6: Learn techniques for isolation and characterization of microorganisms and identification of plants

COURSE CONTENT

MODULE I: 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 II: 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 III: 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. Microbiome.

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 parasites to both plants and animals and how to deal with it
M05: Apply bacteriological tests to examine the quality of water

MODULE IV: 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: Learn and memorize the properties of viruses and their structures
M02: Understand the chemical and genetic composition of viruses
M03: Evaluate the methods of viral replication
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

MODULE V: 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. Genetic Engineering and Biotechnology.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Comprehend and remember the sterilization techniques to control microbial growth
M02: Understand mechanisms of physical, chemical and biological antimicrobial activity
M03: Evaluate microbial chemotherapeutic agents and their mechanism of action
M04: Analyse microbial drug resistance and its implications
M05: Apply and create various methods to study the activity of various antimicrobial agents

MODULE VI: Plant physiology: Photosynthesis - Light harvesting complexes. Mechanisms of electron transport. Photoprotective mechanisms. CO2 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 inplants
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

- 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.
- Cappuccino, A. and Sherman, M. (2004). *Microbiology: A Laboratory Manual*. Pearson Education Inc. USA.
- 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. Integrative Biology (Zoology)
INB-CC-514: Microbiology and Plant Physiology

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

PHYSIOLOGY, SYSTEMATICS, ETHOLOGY AND MICROBIOLOGY PRACTICAL

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. *In-vitro* quantitative determination of plasma Urea Concentration
2. *In-vitro* quantitative determination of plasma Glucose concentration Method
3. Measure Packed Cell Volume and ESR of Human blood using Microhematocrit
4. Effect of Tonicity on Human Blood Cells
5. Effect of salivary amylase on starch:- Influence of temperature and pH and calculation of Q10
6. Digestion in a vertebrate and calculation of peptic value.
7. Observation of mitochondria in Yeast cells
8. Na+/K+- ATPase activity in salinity acclimated and net confined Fresh water fish
9. Effect of drugs on the heartbeat of cockroach (Result with graphical Representation corresponding to different concentration and time intervals expected)
10. Oxygen consumption in fish (normal and stressed).
11. Differential count of Human WBC
12. Estimation of haemoglobin of Fish/Man – Sahli's method.
13. Feeding activity of paramecium
14. Larval forms - any 10 larvae from different taxa (emphasizing phylogenetic, morphological, ecological and pathological significance)
15. Mounting and Submission of any three larval forms
    (Diversity should be maintained depending on the number of students and one specimen each should be submitted for the practical examination, Repetition should be avoided for examination)
16. Dichotomous key using appropriate software or online tools (students should be familiarized with the computer aided keys)
17. Construction of Phylogenetic Tree
18. Microscopy
19. Sterilization methods
20. Preparation of microbial media. Nutrient broth and Nutrient Agar, Mac conkey Agar, Blood Agar

21. Motility Determination – Hanging drop method
22. Different types of microbial growth media
23. Culture methods: Isolation of Pure Colonies of Bacteria – Streak, Spread and Pour Plate
24. Staining Techniques: Simple and Gram Staining, Spore and Capsule Staining, Acid Fast Staining
25. Biochemical tests for identification of microorganisms: Indole Test, Methyl Red test, Voges Prauskaur test, Citrate Utilisation test, Catalase test
26. Determination of Anti-Microbial Activity by Disc Diffusion method
27. Impact of Osmotic Stress on Seedling Growth by Measurement of Free Proline Concentration
28. Separation of chloroplast pigments by Thin Layer Chromatography
29. Extraction and separation of chlorophylls and carotenoids by chemical method
30. Detection of Gibberellins by endosperm (barley/wheat/oats) test
31. Demonstration of osmosis by means of potato osmoscope
32. Testing of viability/germinability of seeds using tetrazolium salts

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

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

LEARNING RESOURCES
References

- Goldman, E. and Green L. H. (2015). *Practical handbook of Microbiology*. 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.
- Varshney, V. P. and Mona, B. (2018). *Ghai's Textbook of Practical Physiology*. 9th edn. Higher Education Text books.

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://sites.google.com/a/koyauniversity.org/anp6119/practical
https://www.worldscientific.com/worldscibooks/10.1142/1337

ASSESSMENT

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

SEMESTER II	Course Code: INB-CC-521	Credits: 3

BIONINSTRUMENTATION, BIOSAFETY AND BIOETHICS

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: 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.

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: Biosafety and Bioethics: 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: Study and remember basic fundamentals of biosafety and bioethics
M02: Understand and apply good laboratory practices
M03: Evaluate and practice principles of bioethics in day to day life
M04: Analyse issues pertaining to ethics in individual to environmental levels
M05: Apply information gained to create novel and innovative protocols for increasing safety during performing lab assays and to make sure people who are involved adhere to scientific ethics

MODULE VI: Intellectual Property Rights: Introduction to Intellectual Property Rights, Types of IP: Patents, Trademarks, Copyrights. Basics of Patents. Types of patents. Indian Patent Act 1970, Recent Amendments. IPs of relevance to Biotechnology and few Case Studies (Rice, Neem, Curcumin). Introduction to History of GATT, WTO, WIPO and TRIPS. Biosafety concepts and issues. General guidelines for recombinant DNA research activity.

Module Outcome:

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

M01: Learn and memorize details of intellectual property rights
M02: Understand the different types of intellectual properties
M03: Evaluate cases with regard to intellectual property rights and GMOs
M04: Analyse various organizations involved in regulating intellectual property rights
M05: Apply the knowledge to find disadvantages if any and rectify them with regard to intellectual property rights

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.
- Ghatak, K.L. (2011). *Techniques and Methods in Biology*. PHI Learning Pvt. Ltd. New Delhi.
- Gupta, A. (2009). *Instrumentation and Bio-Analytical Techniques*. Pragati Prakashan, Meerut.

- 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

Second Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc Integrative Biology (Zoology)
INB-CC-521: Bioinstrumentation, Biosafety and Bioethics

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. Weather and climate. Atmosphere-structure and composition; Local winds: Sea and land breezes; Polar easterlies, Westerlies; Trade winds; Indian and African Monsoon; Inversions: temperature or thermal inversions- causes –consequences – subsidence inversion; Clouds and their formation. Cloud categories: low, middle, and high clouds: Cirrus (Ci), Cirrocumulus (Cc), and Cirrostratus (Cs), Altocumulus (Ac), Altostratus (As), and Nimbostratus (Ns), Cumulus (Cu), Stratocumulus (Sc), Stratus (St), and Cumulonimbus (Cb). Element and factors of climate; External factors: solar radiation- Plate tectonics-Milankovitch Theory – Orbital eccentricity - obliquity- axial precession. Internal factors: earth's orography-oceanic and continental influence- Deforestation- surface albedo- snow and ice- Volcanic

activity- Dust particles- Greenhouse gas concentrations- Atmosphere- ocean heat exchange-Atmospheric Carbon Dioxide Variations. Human influences. Global climate changes – causes and consequences. Physical evidence for climatic change – Historical and archaeological evidence-Glaciers – Vegetation -Ice cores –Dendroclimatology-Pollen analysis-Sea level change. Human population. Exponential growth – geometric growth or geometric decay- Malthusian growth model –population momentum age structure – population pyramid, age structure diagram. Types of population pyramid - Young and aging populations – youth bulge - Current trends in global population with reference to developed and developing countries. Population explosion –Baby boom – History of population growth Projections of population growth. Demographic transition Carrying capacity – Human population in India.

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.
- Boitani, L and Fuller, T. K. (2000). *Research Techniques in Animal Ecology*. Columbia University Press, USA.
- Misra, S. P and Pandey S. N. (2009). *Essential Environmental Studies*. Ane Books Pvt. Ltd., India.
- Odum, E. P. (1996). *Fundamentals of Ecology*. W.B Saunders College Publishing, Philadelphia. US.
- Peter, H. R., Berg, L. R and Hassenzahl, D. M. (2008). *Environment*. 5th edn. John Wiley Publishers. US.
- Rana, S. V. S. (2009). *Essentials of Ecology and Environmental Science*. 4th edn. PHI learning Pvt. Ltd., New Delhi.
- 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/
https://www.toppr.com/guides/general-knowledge/basic-science/environmental-ecology/
http://environment-ecology.com/what-is-ecology/205-what-is-ecology.html
https://www.jagranjosh.com/general-knowledge/environment-ecology-a-complete-study-material-1464852780-1
https://www.thehansindia.com/posts/index/Education-and-Careers/2017-10-05/Ecology-and-environment/331067
https://www.esa.org/about/what-does-ecology-have-to-do-with-me/#gsc.tab=0
https://rskgroup.com/service/environment/ecology-and-biodiversity/?gclid
https://www.biologydiscussion.com/ecosystem/ecosystem-its-structure-and-functions-with-diagram/6666
http://www.brainkart.com/article/Structure-and-function-of-Ecosystem_989/
http://eagri.org/eagri50/ENVS302/pdf/lec04.pdf
https://www.tutorialspoint.com/environmental_studies/environmental_studies_functions_of_ecosystem.htm
https://populationmatters.org/the-facts/biodiversity?gclid
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 Integrative Biology (Zoology)
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: 4

BIOCHEMISTRY AND BIOPHYSICS

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 train in fundamental concepts in biophysics
CO5: Gain knowledge about various biophysical methods used to study diverse biomolecules at micro and macro levels
CO6: Apply knowledge perceived to generate new information and techniques using principles of biophysics

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.

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. 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. 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, Ca^{2+} Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis. Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Glucuronic acid metabolism, Glycogen storage. 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 carbohydrates and lipids

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

M03: Assess the functional regulation of carbohydrates and lipids

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

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

MODULE III: 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. 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 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 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 IV: 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

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, Van't Hoff's laws. 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: Ionizing radiation, units of radioactivity, exposure and dose. 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

- Ackerman, E. (1962). *Biophysical Science*. Prentice Hall Inc. NJ, USA
- Alonso, A. and Arrondo, J. L. R. (2006). *Advanced Techniques in Biophysics*. Springer, UK
- Arora, M. P. (2007). *Biophysics*. Himalaya Publishing House, New Delhi.
- Creighton, T.E. (1993). *Protein Structure and Molecular Properties*. W.H. Freeman & Co, NY, USA.
- Deb, A. C. (2004). *Fundamentals of Biochemistry*. New Central Book Agency (P) Ltd. New Delhi, India.
- Elliott, W. H. and Elliott, C. (2003). *Biochemistry and Molecular Biology*. Oxford University Press, UK.
- Lenhninger, A. L. (2008). *Principles of Biochemistry*. (5th edn). CBS Publishers and Distributors, New Delhi, India.
- Narayanan, P. (2000). *Essentials of Biophysics*. New Age International (P) Ltd. Publishers, New Delhi. McGraw Hill Education Pvt. Ltd., New Delhi, India.
- Roy, R. N. (1996). *A Textbook of Biophysics*. New Central Book Agency (P) Ltd. Calcutta, India.
- Srivastava, P. K. (2006). *Elementary Biophysics: An Introduction*. Narosa Publishing House, New Delhi, India.
- 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 Integrative Biology (Zoology)
INB-CC-523: Biochemistry and Biophysics

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

CELL BIOLOGY AND GENETICS

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, Non muscle motility and contractility. 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, Translation in prokaryotes and eukaryotes, initiation, elongation and termination, post transcriptional modifications, 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. Riboswitches. 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: 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. Molecular Organization of Chromosomes: Genome size and C-value Paradox. Structure of eukaryotic chromosome, nucleosome model. Chromosome condensation - euchromatin and heterochromatin. Repetitive nucleotide sequences in eukaryotic genomes, kinetics of renaturation: Cot and Cot curve. Unique and repetitive sequences. Mini and micro satellites. Molecular structure of centromere and telomere. Polytene chromosomes and Lampbrush chromosomes. Chromosome banding techniques. Karyotyping. Gene Fine Structure: Evolution of the concept of gene function and structure.The definition of gene. The standard genetic code, redundancy and Wobble.DNA Structure- alternate forms of the Double Helix. Gene synthesis (in vitro synthesis) – works of Khorana and Kornberg. Modern findings on the nature of gene: 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, Tn3 elements, 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 V: 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, Recombination mapping with two-point and three –point test cross in *Drosophila*, Coincidence and Interference. Genetic mapping by interrupted mating, mapping with molecular markers and mapping using somatic cell. The 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. DNA damage and repair mechanisms

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 VI: 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; chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, estimation of heritability, genotype-environment interactions, molecular analysis of quantitative traits, phenotypic plasticity.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the concepts of extra chromosomal inheritance
M02: Understand the principles of epigenetics
M03: Evaluate the ways of chromatin modifications
M04: Analyse the concept of 'histone-code' hypothesis
M05: Apply techniques to estimate heritability

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

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

- Demonstration of simple experiments

LEARNING RESOURCES
References

- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. (2008). *Molecular Biology of the Cell*. Garland Science- Taylor and Francis group, USA.
- Becker, W. M., Kleinsmith, L. J. and Hardin, J. 2(007). *The World of the Cell*. Pearson, New Delhi.
- Brooker, (1999). *Genetics: Analysis and Principles*. Addison- Wesley, NY.
- Clark, D.P. (2010). *Molecular Biology*. Elsevier Publishers, London.
- Cooper, G.M. and Hausman, R.E. 2009. *The cell: A Molecular Approach*. 5thedn. Sinauer Associates, Inc, ASM Press, Washington DC.
- David, Allis and Thomas, J. (2007). *Epigenetics*. Cold Spring Harbor Laboratory Press. USA.
- Griffiths, A.J.F., Wesler, S.R., Carroll, S.B. and Doebley, J. (2008). *Introduction to Genetic Analysis*. W H Freeman and Company, USA.
- Hartl, D.L. (2000). *A Primer of Population Genetics*. Suinuaer Associate, Inc, Massachusetts. US.
- Hartl, L. D., and E. W. Jones. (2009). *Genetics: Analysis of Genes and Genomes*. 7th edn. Jones & Bartlett Pub., Inc. MA, USA.
- Hyde, D.R. (2010). *Genetics and Molecular Biology*. Tata McGraw Hill Education Private Ltd., New Delhi.
- Karp, G. (2010). *Cell and Molecular Biology.* 6th edn. John Wiley and Sons, Inc. NJ, USA.
- Klug, W.S. and Cummings, M. R. (2009). *Concept of Genetics*. Pearson Education. Inc. US.
- Krebs, J. E., Goldstein, E. S. and Kilpatrick, S. T. (2011). *Lewin's Genes X*. Jones and Bartlett publishers, NY.
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. (2007). *Molecular Cell Biology.* 6th edn. W H Freeman & Company. US.
- Pierce, B.A. (2008). *Genetics: A conceptual approach*. W H Freeman and Company.
- Pollard, T.D. and Earnshaw, W.C. (2008). *Cell Biology*. Saunders Elsevier.
- Snustad, D.P. and Simmons, M. J. (2010). *Principles of Genetics*. John Wiley and Sons, US.

On-line Sources

https://www.ck12.org/biology/cell-organization/lesson/Organization-of-Cells-BIO/
https://www.bioexplorer.net/cellular-organization.html/
https://sites.google.com/site/yfmteachingnotes/Home/basic-organization-of-cells
https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Kaiser)/Unit_1%3A_Introduction_to_Microbiology_and_Prokaryotic_Cell_Anatomy/1%3A_Fundamentals_of_Microbiology/1.2%3A_Cellular_Organization_-_Prokaryotic_and_Eukaryotic_Cells

https://www.nature.com/scitable/topicpage/gene-expression-15121669/
https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/gene-expression
https://link.springer.com/referenceworkentry/10.1007%2F978-1-4020-5614-7_1254
https://www.cliffsnotes.com/study-guides/biology/biology/classical-mendelian-genetics/principles-of-genetics
https://www.sciencelearn.org.nz/resources/2000-mendel-s-principles-of-inheritance
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 Integrative Biology (Zoology)
INB-CC-524: Cell Biology and Genetics

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) Some genes get expressed only because they are inherited from a specific parent or else they remain silent. Support your answer.
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) Linkage and recombination of genes in chromosomes decides the fate of each cell. Signify your view.
19) "Is the Cell death programmed?" Explain in detail.

(2x10=10 Marks)

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

CELL BIOLOGY, ENVIRONMENTAL BIOLOGY AND BIOCHEMISTRY PRACTICAL

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 mitotic 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 of biomolecules such as carbohydrates (PAS), Protein (Bromophenol blue), lipids (Sudan Black), DNA (Fuelgen stain).
6. Isolation of mitochondria and nuclei employing cell fractionation and differential Centrifugation.
7. Quantitative analysis of mitochondrial protein, blood albumin, urea, and evaluate SDH kinetics, Michele's Mendon Kinetics.
8. Estimation of BOD in polluted water sample.
9. Estimation of COD in water sample.
10. Ecological analysis - Estimation of following parameters
    Water:- Salinty, Phosphates, Nitrate , pH & Conductivity
    Soil:- Organic carbon and Chlorides.
11. Separation and identification of soil arthropods using Berlese funnel.
    (A minimum of five specimens should be reported with the comments in practical record)
12. Qualitative and Quantitative study of marine/freshwater planktons.
13. 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.
14. Identification of bacteria using PCR amplification of partial DNA encoding 16S rRNA and automated sequencing.
15. Evaluation of the Electrophoretic separation of DNA using Agarose gel electrophoresis.

16. To study the separation of proteins using SDS- PAGE electrophoresis
17. Purification of proteins by affinity chromatography.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

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

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

https://www.jove.com/science-education-library/2/basic-methods-in-cellular-and-molecular-biology
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 III	Course Code: INB-CC-531	Credits: 4

MOLECULAR BIOLOGY 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: 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, homologous and site-specific recombination. RNA synthesis and processing: 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. Structure and function of different types of RNA, RNA transport. Control of gene expression at transcription and translation level: regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing. Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination. Genetic code. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and 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 II: 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. Isolation, separation and analysis of carbohydrate and lipid molecules. Metagenomics. Histochemical and Immunotechniques: Antibody generation, Detection of molecules using ELISA, RIA, western blot immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, *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 III: Introduction to Biotechnology: Historical aspects, definitions and scope of Biotechnology. Biotechnology in India. 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. Stem cell culture: General and historical aspects, properties and types of stem cells, advantages and disadvantages, stem cell niche, application of stem cell technology in medicine.

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. DNA polymerases. Gene synthesis. 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. Chromosome walking, chromosome jumping, DNA foot printing. 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. Site directed mutagenesis, molecular chimeras. Cloning Methodologies - Gene isolation. Shot gun method, Genome libraries, cDNA libraries, Chemical synthesis. Splicing and integration of isolated gene - cohesive end ligation, homopolymer tailing, extending linkers. 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.

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: Metabolite production: Antibiotics, Organic acids, Amino acids, Vitamins. Upstream processing, downstream

processing. Microbial enzymes and biotransformation - Microbial production of enzymes, fermentation, Enzyme engineering and applications. Food industry - Single cell protein, probiotics. Transgenic plants- Plants with resistance to pests, plants with increased shelf life. Biofertilizers and microbial inoculants, biotechnology of nitrogen fixation, biocontrol agents, biopesticides, bioinsecticides, Terminator gene technology – concept and basics. 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: INTEGRATIVE BIOLOGY (ZOOLOGY)
INB-CC-531: MOLECULAR BIOLOGY 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 ENDOCRINOLOGY

Course Outcomes (CO)

CO1: Clearly point up the fundamental knowledge of endocrine 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 endocrine system through time
CO4: Comprehend concepts related to integrative working of hormones work to maintain homeostasis
CO5: Apply concepts and principles of immune-effector mechanisms to maintain homeostasis
CO6: Understand the disrupted endocrine functions that could lead to abnormal conditions

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: Antigen- Antibody reactions: Mechanisms, Biological consequences of antigen-antibody reaction. Serological Reactions. Radio-allergosorbent Test (RAST).Immunoprecipitation. Immunofluorescence. Flow cytometry and fluorescence. Immunoelectron microscopy. MHC: General organization and inheritance of MHC. MHC molecules and genes.

Genomic map of H-2 Complex in the mouse. HLA Complex in humans. 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. Host-Pathogen interactions.

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. Immunity in Health and Disease: Immune response during bacterial (tuberculosis), Parasitic (Malaria) and viral (HIV) infections. Congenital immunodeficiency diseases (SCID, WAS, CVI, Ataxia, CGD, LAD).Acquired Immunodeficiency Disease (AIDS). Autoimmunity. Organ- specific autoimmune diseases. Systemic auto-immune diseases. Animal 49 models for autoimmune disease. Evidences implicating CD4+ T cell, MHC and TCR in autoimmunity. Induction of autoimmunity. 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: 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 V: 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 VI: 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

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

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

LEARNING RESOURCES
References

- Abbas, A. K., Lichtman, A. K. and Pober, J. S. (1997). *Cellular and Molecular Immunology*. W.B. Saunders Co., US.
- Chakraborty, A. K. (2006). *Immunology and Immunotechnology*. Oxford University Press, New Delhi.
- Darla, J., Wise and Gordeon, R. C. (2004). *Immunology- A Comprehensive Review*. Iowa State University, US.
- David, N. (2007). *Vertebrate Endocrinology*. 4th edn. Elsevier Academic Press.
- Ivan, M. R. (2002). *Essentials of Immunology*. ELBS, New Delhi.
- James, S. E. (2010). *Applied Animal Endocrinology.* 2nd Edn. CAB International.
- Kuby, J. (2000). *Immunology.*7th edn. WH Freeman & Co. New York. Press. A Blackwell Pub. US.
- Richard, C and Geoffrey, S. (2009). *Immunology: A short course*. Wiley-Blackwell, CA, USA.

On-line Sources

https://www.cliffsnotes.com/study-guides/biology/microbiology/the-immune-system/introduction-to-the-immune-system
https://aacijournal.biomedcentral.com/articles/10.1186/1710-1492-7-S1-S1
https://www.sciencedirect.com/science/article/pii/B9780123852458000017
https://pubmed.ncbi.nlm.nih.gov/12995007/
https://www.ncbi.nlm.nih.gov/books/NBK20/
https://www.sciencedirect.com/topics/neuroscience/endocrinology
https://www.toppr.com/guides/biology/chemical-coordination-and-integration/mechanism-of-hormone-action/
http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/moaction/surface.html
http://www.raymondcheong.com/Year1/immuno.html
http://www.cas.miamioh.edu/~stevenjr/mbi202/immunity202.html
http://www.sonoma.edu/users/t/thatcher/biol480/voc1.htm
http://www.umich.edu/~bmsteach/lopatin/Immunology/Immunology.html
http://www.bumc.bu.edu/mybusm/study-guides/
http://www.cram.com/flashcards/watson-endocrinology-study-guide-436952

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: INTEGRATIVE BIOLOGY (ZOOLOGY)
INB-CC-532: IMMUNOLOGY AND ENDOCRINOLOGY

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

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

1) One of the main reasons for the tremendous diversity of antibodies is somatic recombination. Specify.
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) Explicate about role of Flow cytometry in Immunology.
5) "Altered Immunological tolerance". What does it lead to ?
6) "Immune response and Hypersensitivity". Clarify.
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 immune response". Justify.
9) Role of hormones in reproduction. Discuss it with respect to mammals.
10) Discuss various types of Pituitary hormones and its function.
11) "Genome is equivalent in all cells except B and T lymphocytes". Justify.
12) Autoimmunity has multiple etiological factors. Discuss about various autoimmune diseases.
13) Antibodies are Immunoglobulin class of proteins. Discuss its structure.
14) Cytokines plays a major role in immune system. Clarify.
15) MHC molecules help the T cell to recognize its antigens. How ? What are the different types of MHCs ?

(6x5=30 Marks)

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

16) Fab region of Antibody is variable. How the variability is achieved ?
17) How immunological techniques are significant in Medical diagnosis ?
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-533	Credits: 3

NEUROBIOLOGY AND REPRODUCTIVE BIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify structural and functional features of the basic units of neural system and reproductive system
CO2: Give an overview of the role of signaling events in the physiology of nervous and reproductive systems
CO3: Gain knowledge on reproductive physiology
CO4: Comprehend concepts related to neurobiology enable the students to analyse cellular and molecular organization of basic units of nervous system
CO5: Apply concepts of neurotransmitter signaling aberrations leading to clinical complications such as neurodegenerative diseases
CO6: Understand the mechanisms of synaptic transmission and evaluate the functioning of neural circuits and synaptic plasticity

COURSE CONTENT

Module I: Organization of neural system: Introduction to cellular and molecular neurobiology- Principles of Neurobiology-organization of brain- Organization of somatic and antonymic neurons system. Duralsinuses, vascular and ventricular organization of the brain and spinal-Ascending and descending tracts. Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system Classes of neurons. The cell biology of neurons: Passive electrical membrane properties, the resting membrane potential, The action potential, ion channels- Structure and diversity. Ion channel of signaling passive membrane properties. Axons and dendrites-morphology and function, mechanosensation synaptic transmission-presynaptic nerve terminals- Excitory and inhibitory transmission, electrical transmission. Ultrastructure of neuron cells-Neuro anatomical techniques.

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 II: Mechanism of neural functioning: Neural circuits and plasticity, circadian rhythms synaptic plasticity, Intrinsic plasticity, cellular mechanisms, neural basis of behaviour, Development of neural circuits, electrical synapses. Transport of ions across membranes, sodium, potassium and calcium transport, 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 III: Mechanism of Neural transmission: Neuro transmitters and their receptor. Role of glutamate, GABA, DOPA, serotonin, Limbic system and hippocampus, central cortex-functional organization. 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

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

- Bentley, P. J. (1998). *Comparative Vertebrate Endocrinology*. 3rd edn. Cambridge University Press. London.
- Guyton, A.C. (1996). *Text Book of Medical physiology*. Prism Books Pvt. Ltd. Bangalore
- Hill, W.R., Wyse, G.A and Anderson, M. (2007). *Animal Physiology*. 2nd edn. Sinauer Associates Inc. Publishers, MA, USA.
- Larsson, P.R. (2002). *William's Text Book of Endocrinology*. 10th edn. W.B. Saunders, Philadelphia.
- Moyers, D.C and Schulte, P. M. (2007). *Principles of Animal Physiology*. 2nd edn. Benjamin Cummings, CA, USA
- Randall, D., Burgrenn, W. and French, K. (1997). *Eckert Animal physiology*. W. H. freeman & Co, New York.

On-line Sources

https://www.studyblue.com/notes/b/neuroscience-exploring-the-brain/2759/0
http://www.getbodysmart.com/ap/nervoussystem/neurophysiology/menu/menu.html
http://neuroscience.uth.tmc.edu/toc.htm
http://ocw.mit.edu/courses/health-sciences-and-technology/hst-131-introduction-to-neuroscience-fall-2005/study-materials/
http://ibguides.com/biology/notes/reproduction
http://slaterscience.weebly.com/uploads/4/9/2/4/4924503/biology_study_guide_asexual_and_sexual_reproductionkey-1.pdf

https://www.emotiv.com/glossary/neurobiology/
https://www.sciencedirect.com/topics/psychology/neurobiology
https://study.com/academy/lesson/neurobiology-definition-lesson-quiz.html
https://vet.tufts.edu/department-of-biomedical-sciences/research/neuroscience-and-reproductive-biology/
http://koki.hu/organization/reproductive-neurobiology-106452
https://www.webmd.com/sex-relationships/guide/male-reproductive-system#1
https://www.webmd.com/sex-relationships/guide/your-guide-female-reproductive-system#1
https://www.cell.com/trends/endocrinology-metabolism/fulltext/S1043-2760(02)00691-4
https://www.livescience.com/26741-reproductive-system.html

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: INTEGRATIVE BIOLOGY (ZOOLOGY)
INB-CC-533: NEUROBIOLOGY AND REPRODUCTIVE BIOLOGY

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

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

1) Role of Zona pellucida proteins in Sperm- oocyte interaction.
3) Capacitation is a prerequisite for fertilization. How ?
4) HCG test is a preliminary test for pregnancy. Justify.
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) Spermatogonial stem cells differentiate into spermatozoa. What is this process called and expound on the process.
9) Cell cycle is regulated by cyclin/Cdk complex during post fertilization events. Justify.
10) Endocrine hormones act on specific target tissues during ovary development and after ovulation. Discuss about the hormones and their role?
11) Klinefelter syndrome and Turner syndrome are sex chromosomal anomalies. Distinguish between them.
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) Elucidate the regulation of reproduction in both sexes mediated by endocrine, paracrine and autocrine mechanisms.
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) Genes play an important role in sex determination. Which are the main genes involved in it and how are they being regulated?

(2x10=20 Marks)

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

RESEARCH METHODOLOGY, BIOSTATISTICS AND BIOINFORMATICS

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 biostatistical techniques and softwares to analyze data obtained during research analysis
CO6: Apply the knowledge gained to utilize information technology in assays related to biology and evaluate biology using bioinformatics
CO7: Create new processes and products using bioformatics to store biology related information and process it and perform statistical analysis 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. Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications. Safety and precaution - ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards. Extension: Lab to Field, Extension communication, Extension tools.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Learn and remember basic concepts in life science research
M02: Understand the principles related to scientific temper, empiricism and rationalism
M03: Evaluate the various presentation techniques used to represent data and information gained during life science research
M04: Analyse different methods to save data and information gained during life science research
M05: Apply the knowledge about various techniques used for safety and lab protocol and create new extension tools for scientific documentation

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, Induction, 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. Hypothesis -Null and alternate hypothesis and testing of hypothesis - Theory, Principle, Law and Canon. 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.

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
M03: Evaluate about research process and research formulation
M04: Analyse the procedure involved in literature review
M05: Apply the knowledge gained about hypothesis and different types and research designs to create new protocols for carrying out research

MODULE III: 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. Statistical Analysis Tools - Parametric and Non-Parametric; Bivariate and Multivariate Analysis. Interpretation and Forecasting. 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. Calculations/Problems for frequency table. Standard Error and Relative Measures of Dispersion, Skewness and Kurtosis (Brief account only). Advanced statistical tools.

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 analysis tools and perform tests using measures of central tendency and measures of dispersion
M05: Apply the knowledge about various techniques to perform and create new tools for efficient analysis of information obtained during research

MODULE IV: Correlation, Regression, Probability and Hypothesis testing: Correlation - types and methods of correlation analysis, Problems for Karl Pearson's correlation coefficient and Spearman's rank correlation. Regression Analysis: Regression and Line

of Best Fit, Types and methods of regression analysis. Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of strait line through regression equation). Probit Analysis (Brief account only), Mathematical Models in Biology (Brief account only). Length - Weight Relationship.Von- Bertalanffy's Growth (VBG) Model. Theory of Probability: Measures of Probability and Theorem sinrobability. Probability distributions – Binomial, Poisson and Normal (Brief Account only). Testing of Hypothesis: Hypothesis and types, Confidence Interval, Sampling, Methods and Errors. Tests of significance (For large and small samples – Critical Ratio and P value). Z Test (Problem for small samples), Chi- Square Test (Problem for 2×2 table only). 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). Non-parametric tests: Mc Nemar and Mann Whitney U test (Brief account only).

Module Outcome:

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

M01: Be trained and remember fundamentals in correlation and regression analysis
M02: Understand the principles of probability and its use in research
M03: Evaluate the process of testing of hypothesis and its types
M04: Analyse and apply the concept of significance on the information gained after performing statistical operation
M05: Apply the knowledge about diverse tools and techniques studied and create novel protocols to get precise information after research

MODULE V: Introduction to Bioinformatics and Biological Databases: Definitions of bioinformatics, applications of bioinformatics and scope of bioinformatics. Biological Databases: Primary databases - Nucleotide sequence databases: Gene Bank, EMBL, DDBJ; Protein sequence databases: SWISSPROT, PIR; Structure databases: PDB, NDB; Secondary databases: PROSITE, Pfam,CATH; Composite databases: OWL. Literature database: PubMed. Database searching – Entrez; Database sequence submission – BankIt

Module Outcome:

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

M01: Learn and get trained in concepts of bioinformatics
M02: Understand the principles behind biological databases and how they work
M03: Evaluate various primary and secondary databases
M04: Analyse different nucleotide sequence databases and learn how to retrieve information from these databases for performing operations with it
M05: Apply the knowledge and create new bioinformatics tools and techniques for better data and information storage and analysis

MODULE VI: Sequence Analysis and implications of OMIC studies: Sequence analysis softwares: BLAST, FASTA, CLUSTAL. Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, construction of phylogenetic trees. Genomics and Proteomics: Structural genomics, functional genomics, comparative genomics, data mining in proteomics – Microarrays, metabolomics, gene network, synthetic biology. Significance of proteomics and drug design.

Module Outcome:

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

M01: Be trained and remember basic principles in omics study

M02: Understand the concepts of sequence alignment and their methods
M03: Evaluate the construction of phylogenetic trees and apply it to create new information
M04: Analyse the genomics at both structural and functional levels and use it for data Mining for analysis
M05: Apply and create novel microarrays for metabolomics and synthetic biology assays and interpret its results

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.
- Attwood T.K. and Smith, P. D. (2006). *Introduction to Bioinformatics*. Pearson Education. UK.
- Bailey, N. T. J. (1994). *Statistical Methods in Biology*. (3rd edn). Cambridge University Press. UK.
- Bourne P. E and Weissig H. (2003). *Structural Bioinformatics*. Wiley-Liss. USA.
- Chap T. Le. (2003). *Introductory Biostatistics*. John Wiley & Sons, NJ, USA.
- Daniel, W.W. (2006). *Biostatistics: A Foundation for Analysis in the Health Sciences.* (7th edn). John Wiley & Sons, New York, USA.
- David W. M. (2004). *Bioinformatics, Sequence and Genome Analysis*. (2nd edn). CSHP, New York, USA.
- Harry, F. and Althoen, S. C. (1995). *Statistics: Concepts and Applications*. Cambridge University Press. UK.
- 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.
- Pagano, M. and Gauvreau, K. (2000). *Principles of Biostatistics*. Brooks/Cole, CA, USA.
- Prabhakara, G. N. (2006). *Biostatistics*. Jaypee Bro. New Delhi, India.
- Rao, P. S. S. and Richard, J. (2006). *Introduction to Biostatistics and Research Methods*. (4th edn). Prentice Hall, New Delhi, India.
- Sinha, P. and Priti Sinha, P. (2010). *Computer Fundamentals*. BPB Publications., New Delhi, India.
- Tisdall, J. D. (2001). *Beginning Perl for Bioinformatics*. O'Reilly Media Inc. CA, USA.
- Tomita, M. and Nishioka, T. (2005). *Metabolomics*. The Frontier of Systems Biology. Springer, Japan.

- Torbert, S. (2011). *Applied Computer Science*. Springer-verlag, New York, USA.
- Zar, J. H. (2008). *Biostatistical Analysis*. (3rd edn.). Pearson Education Inc., 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.istl.org/02-winter/internet.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: INTEGRATIVE BIOLOGY (ZOOLOGY)
INB-CC-534: RESEARCH METHODOLOGY, BIOSTATISTICS AND BIOINFORMATICS

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

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

1) Elucidate on Scatter method.
2) Explicate on Induction in terms of research methodology.
3) Present your views on the role of Fundamental research in present scenario.
4) Gap penalty is an unavoidable feature in sequence alignment. Validate the statement.
5) Expound about the role of Poisson distribution in biological research.
6) "Reason is the unique source of knowledge". Articulate.
7) Signify the role of biological databases.

(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 vital statistics.
10) Construe about the process of regression analysis and its importance in research.
11) What is a scientific hypothesis? Formulate the various steps in hypothesis formation.
12) Briefly put in plain words the significance of skewness and curtosis in statistical analysis of research data.
13) Compile the best databases for biological research.
14) Parse about the features of good research design?
15) Analyze the various steps involved during the process of sequence analysis.

(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 drug designing is using bioinformatics". Expound. Annotate the role of proteomics in drug designing?

(2x10=20 Marks)

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

MOLECULAR BIOLOGY, DEVELOPMENTAL BIOLOGY, BIOINFORMATICS AND RESEARCH METHODOLOGY PRACTICAL

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. Isolation of genomic DNA from *E. Coli*
2. Isolation of Plasmid DNA from *E. Coli*
3. Separation of lymphocytes from whole blood.
4. Separation of T and B lymphocytes
5. Immunoflurecensce assays
6. Western Blotting – Demonstration
7. ELISA
8. Microplate Reader assay
9. Immuno electrophoresis - Demonstration
10. PCR assays, gene expression assays
11. Live cell imaging and quantification.
12. Restriction Digestion, Ligation and gene cloning experiments.
13. Induced ovulation in fish.
14. Hormones in Amphibian metamorphosis - Thyroxine/Iodine solution.
15. Demonstration of sperm of rat/calotes/frog
16. Study of the developmental stages of Drosophila.
17. Study of the developmental stages of frog (egg, blastula, gastrula, neurula, tadpole, with external gill and internal gill) using permanent slides/Diagrams.
18. Study of serial sections of embryo (tadpole/chick).
19. Vital staining of early gastrula of chick - Window method.
20. Blastoderm mounting and age determination of chick embryo using vital stains.
21. Morphological and histological details of different types of mammalian placenta.
22. Localization of proteins expressed during larval developmental stages of Zebra fish using immunofluorescence
23. Immunohistochemistry of molecular markers in different stages of development in chick embryo
24. Bioinformatics tools:- Pubmed, Nucleotide databases, BLAST, FASTA, ClustalW multiple alignment, Protein domain prediction using SMART Anlaysis, STRING network analysis, Primer designing for PCR
25. Writing a project proposal
26. Preparation of original research article and review article
27. Analysis of mean and standard deviation using statistical tools and softwares

28. 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
- Seminar Presentation on selected topics
- Debates
- Quiz

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.

On-line Sources

https://www.sciencedirect.com/book/9780123855542/molecular-biology-techniques
https://www.news-medical.net/life-sciences/Molecular-Biology-Techniques.aspx
https://www.researchgate.net/publication/226072152_Basic_Techniques_in_Molecular_Biology
https://andrew.gibiansky.com/blog/genetics/technique-primers/

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

- Baker, E.J. and Silverton R. E. (1978). *Introduction to Medical Laboratory Technology*. ELBS. London, UK.
- Edward, A.L. (1997). *Radiation Biophysics.* Academic Press, NY, USA.
- Ernster, L. (Ed.). (1985). *Bioenergetics*. Elsivier, NewYork, USA.
- Ghatak, K.L. (2011). *Techniques and Methods in Biology*. PHI Learning Pvt. Ltd. New Delhi.
- Gupta, A. (2009). *Instrumentation and Bio-Analytical Techniques*. Pragati Prakashan, Meerut.
- 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

Third Semester M. Sc. (CSS) Degree Examination
Branch: M. Sc Integrative Biology (Zoology)
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 IV	Course Code: INB-CC-541	Credits: 4

STRUCTURAL AND DEVELOPMENTAL BIOLOGY

Course Outcomes (CO)

CO1: Articulate and exemplify basic knowledge of cell organization
CO2: Give an overview of the intra and inter-cellular communication mechanisms
CO3: Gain knowledge on basic concepts of developmental biology
CO4: Comprehend concepts related to gametogenesis and fertilization
CO5: Apply the new developments in plant and animal embryology
CO6: Understand and appreciate the genetic mechanisms during the process of development

COURSE CONTENT

Module I: Cellular Membranes: Membrane structure and chemistry, dynamic nature of the plasma membrane, membrane functions, membrane potentials, ion channels.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember structure of biomembrane
M02: Understand the dynamic nature of the plasma membrane
M03: Evaluate transport of various biomolecules
M04: Analyse variousfunctions of plasma membrane
M05: Apply techniques to measure membrane potentials

MODULE II: Cell junctions, Cell adhesion and Extracellular matrix: Extracellular matrix: Basal membrane and laminin, Collagen, Proteoglycan, Fibronectin. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens. Junctions and desmosomes. Tight junctions, Gap junctions and Plasmodesmata.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember the components of extracellular matrix
M02: Understand various types of cell adhesion molecules
M03: Evaluate different cell-ECM interaction mechanisms
M04: Analyse the various types cell-cell interactions
M05: Apply techniques to assess membrane fluidity

MODULE III: Over view of matrisome, cell scaffoldings and signaling platforms, molecular architecture and function of matrix adhesions, Focal adhesions, Genetic analysis of integrin signaling. ECM degradation and remodeling, role of MMPs, cell migration, angiogenesis, Cell-ECM interaction.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember cell signaling platforms
M02: Understand mechanisms of cell-cell interaction

M03: Evaluate functioning of MMPs
M04: Analyse the processes of angiogenesis
M05: Apply techniques to study cell migration

MODULE IV: 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 V: 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: Remember gametogenesis and fertilization
M02: Understand concept of fertilization in plants
M03: Evaluate the functioning of cell surface molecules in sperm-egg recognition
M04: Analyse gastrulation and formation of germ layers in animals
M05: Apply techniques to determine environmental effects on seed germination

MODULE VI: 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

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

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

LEARNING RESOURCES
References

- Balinsky, B. I. (2004). *An Introduction to Embryology*. W. B. Saunders Co., Philadelphia, US.
- Berril, N. J. (1979). *Developmental Biology*. Tata McGraw-Hill Pub. Co. Ltd., New Delhi.
- Gilbert, S.F. (2010). *Developmental Biology*. 12th edn. Sinauer Associates Inc., Publishers, Masachusettes, USA.
- Lewis Wolpert. (2007). *Principles of Development*. Oxford University Press. Oxford. UK.
- Subramanian, T. (2002). *Developmental Biology*. Alpha Science International Ltd., New Delhi.
- Sunstard, D. P., Simmons, M. J. and Jenkins, J. B. (1997). *Principles of Genetics*. John Wiley and sons, New York, US.
- Wolpert, L. and Tickle, C. (2011). *Principles of Development*. 4th edn. Oxford University Press, Oxford, UK.

On-line Sources

https://www.nigms.nih.gov/education/fact-sheets/Pages/structural-biology.aspx
https://www.sciencedirect.com/science/article/pii/S1369526618301596
https://www.studyblue.com/notes/b/developmental-biology-eighth-edition/3596/0
http://www.sparknotes.com/biology/
http://www.mednotes.net/notes/biology/
http://quizlet.com/4103515/biology-chapter-7-development-study-guide-flash-cards/
http://www.mun.ca/biology/desmid/brian/BIOL3530/DB_01/DBNHist.html
https://www.khanacademy.org/science/biology/developmental-biology/development-and-differentiation/a/introduction-to-development
https://www.lab.anhb.uwa.edu.au/hb313/main_pages/timetable/lectures/2008%20Lectures/Dev%20Biol%20I%202008.pdf
https://www.khanacademy.org/science/biology/developmental-biology
https://www.studocu.com/en-gb/document/the-university-of-edinburgh/molecules-genes-and-cells-1/lecture-notes/lecture-29-basic-concepts-in-developmental-biology/1086838/view
https://www.ncbi.nlm.nih.gov/books/NBK26825/
https://www.ncbi.nlm.nih.gov/books/NBK217800/
https://www.britannica.com/science/biological-development/Types-of-development
http://biology.kenyon.edu/courses/biol114/Chap11/Chapter_11.html

https://embryology.med.unsw.edu.au/embryology/index.php/Developmental_Mechanisms
http://www2.centralcatholichs.com/APbiologysite/development/AlbertsChapter%2022_Develop.pdf

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 Integrative Biology (Zoology)
INB-CC-541: Structural and Developmental Biology

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

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

1) "Pluripotency and multipotency". Elaborate.
2) Integrins maintains inter cellular junctions. How ?
3) Plasmodesmata plays important role in cell to cell junctions. Clarify.
4) "Degradation and removal of ECM". Which proteinases functions in it ?
5) "Induction and competence". How this is important for development ?
6) First part of cell commitment is cell specification. What is autonomous specification ?
7) Despite the genomic equivalence, how is a Muscle cell different from a liver cell. Your Thoughts.
8) "Cell death is programmed". Explicate.

(5x2=10 Marks)

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

9) "Dynamic nature of Plasma membrane". Expound.
10) Are Intercelluar junctions organized ? Discuss various types of junctions.
11) How angiogenesis is significant in development ?
12) Degradation and remodelling of Extra Cellular Matrix. Clarify.
13) How will you generate insulin producing transgenic sheep ? Explain the protocol and its applications.
14) Does epigenetic regulation play a role in genomic imprinting ? Present your view.
15) Floral development in Arabidopsis. Elaborate.
16) Can the Pluripotency be induced ? Discuss it.

(6x5=30 Marks)

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

17)" Ions transport across the membrane". Annotate with example.
18) Differential gene expression plays an important role in axis patterning in Drosophila. Elaborate.
19) Articulate on vulva formation in *C. elegans*.
20) Technological advances established the concepts of developmental biology. Justify this statement.

(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.
- Deb, A.C. (2004). *Fundamentals of Biochemistry*. New Central Book Agency (P) Ltd. New Delhi.
- Elliott, W. H. and Elliott, C. (2003). *Biochemistry and Molecular Biology*. Oxford University Press, Oxford, UK.
- Ghatak, K. L. (2011). *Techniques and Methods in Biology*. PHI Learning Pvt. Ltd. New Delhi
- Srivastava, P. K. (2006). *Elementary Biophysics. An Introduction*. Narosa Publishing House, New Delhi.
- Weesner, F.M. (1960). *General Zoological Microtechniques*. The Williams & Wilkins Co., Baltimore. USA.

On-line Sources

https://www.studyblue.com/notes/university-of-california-berkeley/c/intbio-131/162653/0
https://moodle.kent.ac.uk/external/mod/book/view.php?id=2604&chapterid=163
http://private.nmr.ru/manuals/biophys/OLTB/Textbook.html
http://www.mednotes.net/notes/biophysics/
https://www.nature.com/nrmicro/animation/index.html
https://www.ncbi.nlm.nih.gov
https://ib.berkeley.edu/undergrad/whatisib.php
https://www.researchgate.net/publication/272152357_What_is_Integrative_Biology
https://academic.oup.com/icb/article/43/2/239/609511

https://home.liebertpub.com/publications/omics-a-journal-of-integrative-biology/43/for-authors
https://www.shomusbiology.com/biological-techniques.html
https://www.genengnews.com/magazine/112/practical-applications-of-systems-biology/
https://pubmed.ncbi.nlm.nih.gov/11475693/

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 Integrative Biology (Zoology)
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	Course Code: INB-GC-501	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

- 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: Integrative Biology (Zoology)
INB-GC-501: 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	Course Code: INB-GC-502	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: Remember 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

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.
- Brock. (2003). *Biology of Microorganisms*. Michael. T. Martinko and Jack Parker Prentice Hall and Pearson Education, Inc.
- Cappuccino and Sherman. (2004). *Microbiology- A Laboratory Manual*. Pearson Education Inc. USA.
- Gerard, T., Berdell, F and Christian, C. P. (2002). *Microbiology: An Introduction, 7th edition*. UK.

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 : Integrative Biology (Zoology)
INB-GC-502: 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-503	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, Deutsch's 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.
- Jeffrey, C. H. (2003). *Genetics and Molecular Biology of Rhythms in Drosophila and other Insects*. Elsevier Science, USA.
- Judith, G and Betty, M. (2010). *Perspectives of Animal Behaviour*. John Wiley & Sons Inc. USA
- Lee, A. D. (2009). *Principles of Animal behavior*. 2nd edn. W.W. Norton and Company. USA.
- Macfarland, D. (1998). *Animal Behaviour – Psychobiology, Ethology and Evolution*. Pitman publication Ltd. London.
- Scott, G. (2005). *Essential animal behavior*. Blackwell Publications Company, Oxford, UK.

On-line Sources

https://www.studyblue.com/notes/b/animal-physiology-second-edition/2856/0
http://wps.aw.com/bc_moyes_animalphys_2/
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: INTEGRATIVE BIOLOGY (ZOOLOGY)
INB-GC-503: 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-504	Credits: 2

TRADITIONAL ETHNOMEDICINE

Course Outcomes (CO)

CO1: Articulate and exemplify the use of plants and plant based medicine across the world
CO2: Give an overview of the of the use of herbs and herbal drugs in different systems around the globe
CO3: Gain knowledge on nutraceuticals
CO4: Comprehend concepts related to additive and synergistic activity of phytochemicals and how they play a role in shaping evolution
CO5: Apply concepts and principles of synergism and integration in ethnomedicine for future use
CO6: Understand the indigenous and traditional practices in ethnomedicine

COURSE CONTENT

Module I: Atavistic and modern food habits and Evolution: Food as a major factor in designing the course of evolution. Ancient culinary practices. Historical perspectives at local, national and global levels. Origin and development of herbal culture in human civilizations. Current trends in diet and nutrition. Defects and drawbacks in present food habits.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concepts of evolution
M02: Understand ancient and modern food habits
M03: Evaluate current trends in diet and nutrition
M04: Analyse defects and drawbacks in present food habits
M05: Apply methods to assess nutritional status

MODULE II: Indigenous and tribal Ethnomedicinal practices: Origin and development of biomedicine; Indian Systems of Medicine (*Ayurveda, Siddha, Unani*) *Ayurveda*: Historical perspective, measures to be adopted for maintaining the health of healthy person in a positive way through prevention, promotion and correction. Fundamental principles of *Ayurveda*: *Panchabhootha* theory, *Thridosha* theory, *Saptadhatu* theory and *Ama* theory; Ayurvedic Pharmacopoeia. Indigenous medicines of Kerala.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember Indian systems of medicine
M02: Understand various indigenous and tribal ethnomedicinal practices
M03: Evaluate functioning of ethnomedicinal practices
M04: Analyse the fundamental principles of *Ayurveda*
M05: Apply techniques of traditional medical practices

MODULE III: Phytochemicals as therapeutics and nutraceuticals: Plant drugs with antimicrobial, anti-inflammatory activities; Plant chemicals in modern pharmacology: Biochemistry and pharmacology of curcumin, piperine, gingerol, caffeine, opioids, taxol, Vinca alkaloids; synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and biotransformation.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember uses of phytochemicals
M02: Understand antimicrobial and anti-inflammatory activities of plant drugs
M03: Evaluate role of plant chemicals in modern pharmacology
M04: Analyse the mechanism of action of plant drugs
M05: Apply techniques to assess drug improvement

MODULE IV: Synergism and integration in Ethnomedicines: Cell signalling and current drug targets. The drawback of current strategy. Examples of cancer recurrence and drug resistance in TB. Need for targeting multiple cell signalling pathways concurrently. Benefits of principles in traditional medicines using combination of phytochemicals.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember concepts of cell signaling
M02: Understand mechanisms of drug action
M03: Evaluate phenomenon of drug resistance
M04: Analyse cancer recurrence
M05: Apply techniques to identify drug targets

MODULE V: The future of Ethnomedicine and nutraceuticals: Epigenetics. The shift of diet regimes from fast food to natural and functional food. Problems related to consumption of phytochemicals and its effect on Environment. Solutions to overcome the problems caused due to over use of plants and herbs. Going back to nature and farming. Maintaining homeostasis in the Environment.

Module Outcome:
After Completion of this module, the student should be able to:
M01: Remember epigenetics
M02: Understand concepts of ethnomedicine and nutraceuticals
M03: Evaluate solutions to overcome problems due to over use of phytochemicals
M04: Analyse the future of ethnomedicine
M05: Apply techniques to determine environmental effect of phytochemicals

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

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

LEARNING RESOURCES
References

- Barar, F.S.K. (2004). *Essentials of Pharmacotherapeutics*. S.Chand and Company, New Delhi.
- Cotton, C.M. (1996). *Ethnobotany: principles and applications*. John Wiley & Sons, New York.
- Kulkarni, V.M and Bothera, K.G. (2005). *Drug Design*. 8th edition. Nirali Publications, Pune.
- Pushpangadan, P. (1995). *Ethnobiology in India: a Status Report*. All India Coordinated Research Project on Ethnobiology. Ministry of Environment and Forests, Govt. of India, New Delhi.
- Pushpangadan, P., Nyman, U. and George, V. (1995). *Glimpses of Indian Ethno-pharmacology*. Tropical Botanic Garden and Research Institute, Thiruvananthapuram, Kerala.
- Rao, A.P. (1999). *Herbs that heal*. Diamond Pocket Books (P) Ltd., New Delhi.
- Schultes, R.E. and Reis, S. von (eds). (1995). *Ethnobotany: evolution of a discipline*. Chapman and Hall, London.
- Sharma, P. V. (2000). *Charaka Samhitha with English translation*. Chaukhambha Orientalia publications, Varanasi, India.

On-line Sources

http://ayush.gov.in/
https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl
http://www.nofa.org/tnf/Summer2012B.pdf
ayurveda.iloveindia.com/herbology/medicinal-value-of-herbs.html
www.drugs.com/forum/alternative-medicine/importance-herbal-medicines-58521.html

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: INTEGRATIVE BIOLOGY (ZOOLOGY)
INB-GC-504: Traditional Ethnomedicine

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

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

1) Curcumin is a potent miracle phytochemical. Justify the statement.
2) Opioids and pain management. Present your views.
3) Articulate on Vinca alkaloids.
4) Explicate on Indigenious medicines of Kerala.
5) Exemplify the concept of Tridosha theory.
6) Outline the role of phytochemicals in preventing and treating cancer
7) Present your views on drug resistance in TB and how ethnomedicine can help prevent it.

(5x2=10 Marks)

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

8) Articulate on the shift of diet regimes from fast food to natural and functional food.
9) Expound on cell signaling, current drug targets and role of ethnomedicine.
10) Elucidate about drug improvement by structure modification and biotransformation.
11) Delineate on plant chemicals in modern pharmacology.
12) Exemplify the concept of evolution of biomedicine.
13) Describe about the defects and drawbacks in present food habits.
14) Peruse on the current trends in diet and nutrition.
15) Illustrate the role of food as a major factor in designing the course of evolution.

(6x5=30 Marks)

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

16) More than a system of medicine, *Ayurveda* is a way of life. Justify.
17) Elucidate about the role of nutraceuticals and its effect on epigenetics of humans.
18) Deliberate about the role of consumption of phytochemicals as therapeutic and prophylactic agents and its effect on environment as well.
19) Ethnomedicine as a model for synergism and integration. Enunciate your view.

(2x10=20 Marks)