UNIVERSITY OF KERALA

SYLLABUS

OF M.Sc PROGRAMME

IN

INTEGRATIVE BIOLOGY

Under CSS Programme of the University of Kerala

w.e.f 2017 admissions

at

CEIB

Centre for Evolutionary and Integrative Biology
University of Kerala
Kariavattom
Thiruvananthapuram 695 581

CENTRE FOR EVOLUTIONARY AND INTEGRATIVE BIOLOGY
UNIVERSITY OF KERALA
M.Sc. PROGRAMME IN INTEGRATIVE BIOLOGY

PROGRAMME OBJECTIVES:

- To provide students with an opportunity to learn about trans-disciplinary approaches to explore Modern Biology
- To help students learn the basic, fundamental and applied aspects of Biology
- To equip students to pursue research in various fields of Applied Biology
- To give a platform for students to perform well in competitive exams
- To inculcate interest in students for teaching, managing and research in Science
- To facilitate students to approach diverse scientific themes in a comprehensive way

Structure of the Programme

Sem No	Course Code	Name of the Course	Number of Credits
I	**Core Courses**		
	INB-C-411	~~Advanced Physiology and Stress~~ Physiology	3
	INB-C-412	Evolutionary Biology and Ethology	3
	INB-C-413	Animal Systematics and Diversity	3
	INB-C-414	Microbiology and Plant Physiology	3
	INB-C-415	Physiology Practical	2
II	**Core Courses**		
	INB-C-421	Bioinstrumentation, Biosafety and Bioethics	3
	INB-C-422	Environmental Biology	3
	INB-C-423	Biochemistry and Biophysics	4
	INB-C-424	Cell Biology and Genetics	3
	INB-C-425	Cell Biology and Biochemistry Practical	2
III	**Core Courses**		
	INB-C-431	Molecular Biology and Biotechnology	4
	INB-C-432	Immunology and Endocrinology	3
	INB-C-433	Neurobiology and Reproductive Biology	3
	INB-C-434	Research Methodology, Biostatistics and Bioinformatics	3
	INB-C-435	Molecular Biology Practical	2
	Internal Elective		
	INB-E-436	Molecular techniques in Integrative Biology	2
IV	**Core Courses**		
	INB-C-441	Structural and Developmental Biology	4
	INB-C-442	Integrative Biology	4
	INB-D-443	Dissertation	8
Extra Departmental Elective Courses			
II	INB-X-421	Introduction to Microbial Pathology	2
	INB-X-422	Introduction to Animal Behavior	2
	INB-X-423	Traditional Ethnomedicine	2

Semester : I
Course Code : INB-C-411
Course Title : ADVANCED PHYSIOLOGY AND STRESS PHYSIOLOGY
Credits : 3

AIM: This course focuses on the study and comparison of organ systems across the animal world. The topics give an over view of the comparative functioning of different systems in animals. The course also helps to learn more about human physiology. The stress physiology introduces the concepts related to various stress endured by the organisms and how they adapt to these adverse conditions.

OBJECTIVES: Advanced physiology introduces the concepts and principles of homeostasis and its regulation. The topics include how respiratory, cardiovascular and sensory systems work. The importance of stress physiology is emphasized. Principles of stress adaptations and stress tolerance are explained elaborately with special reference to ease and ease response. Environmental and adaptive physiology describes the effect of environment on all metabolic activities of organisms. Concepts of osmoregulation and thermoregulation and how it affects basic functioning of cells is also dealt in detail.

COURSE CONTENT

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

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

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

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 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 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.

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- Fish Ecophysiology, J. C. Rankin and F.B. Jensen, Chapman and Hall, London, 1993.
- General and Comparative Physiology, William S Hoar, Printice Hall, New York, 1983.
- Human Physiology: From Cells to Systems, Sherwood, 5 Ed, Thomson, Australia, 2004.
- Text Book of Medical Physiology, Arthur C. Guyton W.B. Sanders & Co. 1996
- The Physiology of Fishes, David. H. Evans, CRC press, London, 1993.

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Semester : I
Course Code : INB-C-412

Course Title : EVOLUTIONARY BIOLOGY AND ETHOLOGY
Credits : 3

AIM: This course outlines the fundamental principles of organic evolution and animal behaviour. It offers a better understanding of the role of organisms in the evolutionary process and how they interact with each other and its environment to adapt itself and to evolve into a much advanced species. Topics on basics and advances in ethology help in understanding the complexities of both animal and human behaviour.

OBJECTIVES: Evolutionary Biology introduces the major concepts in evolution. Geological time scales deal with origin of Earth and life at various levels of organization. Molecular evolution and population genetics describes major events during evolution and how it affected the population genetics through molecular interactions. The Ethological principles outline how individual organism behaves and interacts with its community members and its environment. The course also deals with socio-biology of animals.

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 and 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 Experiments. 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 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 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 IV: Ethological principles, Motivation and learning: Concepts in ethology, Scope of ethology, goal-oriented drive, internal causal factor, Homeostatic and Non-homeostatic drives. Psycho-hydrologic model of motivation. Short and long term memory, Habituation,

Classical conditioning (Pavlov's experiments), Instrumental conditioning, Latent learning, Trial and error learning, Instinct, Imprinting

MODULE V: Communication and Neurophysiological Aspects of Behaviour: Reflex action, Kinesis, Taxes, 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, Pheromonal communication (Ants and mammals).

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.

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- Lee Alan Dugatkin .2009. Principles of Animal behaviour (2nd edn). W.W. Norton and Company.
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- Wilson, E.O.2000. Sociobiology: The new synthesis. Harvard Univ. Press, Cambridge, Mass. USA.

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http://animalbehaviour.net/JudithKBlackshaw/Chapter1.htm
http://sites.sinauer.com/bouton/index.html

Semester : I
Course Code : INB-C-413
Course Title : ANIMAL SYSTEMATICS AND DIVERSITY
Credits : 3

AIM: This course offers a thorough understanding of the principles and practices of systematics and diversity. It would help students acquire an in-depth knowledge on the diversity and relationships among organisms in the environment. The conservation biology portion would comprise the threats with regard to biodiversity, its assessment and protection.

OBJECTIVES: Animal systematics presents the principles in systematics and classification of organisms based on their structural organization and their part during the evolutionary processes. Molecular phylogeny and cladistic studies focus and direct towards the future possibilities in the field of systematics. Biodiversity and conservation biology describes the key diverse forms of life existing in the biosphere. Aspects of biodiversity assessment, threats to biodiversity and conservation strategies to be implemented to overcome the threats would be emphasized. This part will also focus on the diversity and meteorological conditions prevailing in the Indian subcontinent.

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.

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.

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.

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.

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 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 penology 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.

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http://www.biodiversitymapping.org/

Semester : I
Course Code : INB-C-414
Course Title : MICROBIOLOGY AND PLANT PHYSIOLOGY
Credits : 3

AIM: The course aims to ensure a thorough understanding of the basics of microbial life. Studies on cell structure, metabolism and interaction with the environment direct towards

understanding the roles of microorganisms in sustaining the homeostasis of nature. Plant physiology part focuses mainly on studying the mechanistic pathways of plant metabolism and their responses to various environmental signals.

OBJECTIVES: The course covers both structural and functional features of microbial cell. The portion also studies in detail about the microbial metabolism, the oxidation-reduction reactions in various microorganisms with different nutritional requirements. The studies on microbial interactions would direct towards understanding how nature nurtures the living organisms together to survive in a best possible way. The plant physiology portion highlights the molecular mechanisms behind various metabolic activities occurring in plants including the basic molecules required, their transport and their assimilation. The portion also deals with how plants respond to various environmental stress signals.

COURSE CONTENT

MODULE I: Introduction to Microbiology: 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 II: Microbial Metabolism: Energy acquisition by chemotrophs and phototrophs, glycolysis (Embden- Meyerhof pathway). Fermentation, anaerobic oxidations, chemosynthesis. Photosynthesis, carbon assimilation. Regulation of metabolism. Nutrition and Growth: Common nutrient requirements, nutritional types, growth factors, uptake of nutrients by the cell. Culture media, culture methods. Reproduction and exponential growth, the growth curve. Physical requirements for bacterial growth and influence of environmental factors on growth. Microbial growth in natural environments; Biofilms. Quorum sensing.

MODULE III: Microbial Interactions and Microbial Ecology: Symbiosis, commensalism. Mutualism between microbes, microbes and plants, microbes and animals. Cooperation, competition, predation, antagonism. Parasitism, plant parasites, animal parasites.

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 V: Immunology, Pathogenicity and Host Responses of Microorganism: Microbial growth control, Human Microbe interactions, Clinical Microbiology and Immunology. Microbial diseases, Microbiological applications**,** Industrial Microbiology, Biocatalysis, Genetic Engineering and Biotechnology.

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.

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Semester : I
Course Code : INB-C-415
Course Title : PHYSIOLOGY PRACTICAL
Credits : 2

AIM: The assays aim at understanding the normal physiological processes of vertebrate and invertebrate animals and also help in comprehending basic human physiological activities.

OBJECTIVES: The osmoregulatory mechanisms are checked in the experiments using fish models along with human blood constituents. Thermoregulation and motility are studied using

Paramecium as model. Human blood typing and differential separation of component cells in human blood would also be performed.

COURSE CONTENT

Estimation of Osmolality.
In-vitro quantitative determination of plasma Urea Concentration (DAM Method).
In-vitro quantitative determination of plasma Glucose concentration Method.
Microhematocrit- Packed Cell Volume of Whole Blood.
Effect of Tonicity on Human Blood Cells.
Estimation of Electrolyte Minerals using Flame-Photometer.
Construction Of Phylogenetic Tree.
Habituation in *Trigoniulus corallines*.
Sexual Selection as an Evolutionary Mechanism in Brine Shrimps.
Microscopy.
Sterilization methods.
Preparation of microbial media.
Different types of media.
Culture methods.
Staining Techniques.
Biochemical tests for identification of microorganisms.
Impact of Osmotic Stress on Seedling Growth by Measurement of Free Proline Concentration.

Semester : II
Course Code : INB-C-421
Course Title : BIOINSTRUMENTATION, BIOSAFETY AND BIOETHICS
Credits : 3

AIM: This course introduces the major tools and techniques used for studying biochemical and biophysical nature of life along with the safety concerns which arise during and after the study. Bioinstrumentation portion describes the techniques and instruments used for studying various aspects in integrative biology. Issues regarding biosafety and bioethics are also described in detail.

OBJECTIVES: Basic tools used for understanding the concepts in integrative biology are explained in this course. Applications and principles of all major techniques used are dealt with in the chapters. The topics also include up-to-date information regarding the methods used for studying various aspects covered in integrative biology. Biosafety and bioethical concerns, precautionary measures and their regulation are also dealt in the portion along with overview of basic guidelines and significance of intellectual property rights.

COURSE CONTENT

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

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 Magneticresonance 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 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 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 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 VI: Intellectual Property Rights: Introduction to Intellectual PropertyRights, 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.

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

Semester : II
Course Code : INB-C-422
Course Title : ENVIRONMENTAL BIOLOGY
Credits : 3

AIM: This course introduces the concepts and fundamentals in ecological studies. The topics covered would help in better understanding of our environment, the problems it faces and how it can be managed. The chapters also help to gain critical understanding on human influence on environment. Applied ecology would deal with the practical aspects and applications of ecological studies.

OBJECTIVES: Environmental Biology introduces the basic concepts of ecology. The emphasis is on understanding how the biotic elements interact and adapt with the abiotic factors. Population and community ecology describes the structure, diversity and functioning of the ecosystem at higher levels of organization. Causes and consequences of pollution in the

environment and how it can be overcome using biological perspectives would be explained in the applied ecology section.

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 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.

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 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 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 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.

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Semester : II
Course Code : INB-C-423
Course Title : BIOCHEMISTRY AND BIOPHYSICS
Credits : 4

AIM: This course provides an overview of the important biochemical and biophysical parameters and processes occurring inside every living cell. Topics in this course provide an idea on structure and functioning of biologically important molecules. Introduction to the principles help in comprehending the biophysical properties and functioning of life processes.

OBJECTIVES: Biochemistry brings together the basic concepts of molecules and their roles in the diverse metabolic processes existing in cells. Studies on macromolecules including carbohydrates, lipids, proteins and nucleic acids are incorporated for improved understanding along with enzymes and their role in regulating specific biochemical reactions. Concepts of molecular structures and functions including bioenergetics are looked at, in the biophysics section. This course would help in understanding how a living cell works both at the cellular and organismal level.

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 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 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- examples Keratin, Collagen, Chaperons. Tertiary structure- *e.g.* Myoglobin. Quaternary structure – *e.g.* 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, Various theories, 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 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 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 VI: Bioenergetics: Thermodynamics- Laws of thermodynamics, Entropy, Enthalpy, Free energy. Reversible thermodynamics and irreversible thermodynamics; 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.

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Semester : II
Course Code : INB-C-424
Course Title : CELL BIOLOGY AND GENETICS
Credits : 3

AIM: This course introduces the structural and functional details of the basic unit of life at the molecular level. It gives an in-depth understanding of the principles and mechanisms of inheritance and a thorough knowledge on basic cell signalling events and the factors affecting gene expression and its regulation. Studies on genetic linkage, epigenetics and extra chromosomal inheritance would give insights on hereditary diseases and its control measures.

OBJECTIVES: Cell Biology deals with the general cell signalling events and the regulatory mechanisms which would help in understanding how cells work. The major cellular events like cell cycle, checkpoints in cell cycle and control of cell division are also highlighted in detail. The prerequisite studies for molecular genetics including studies on chromosomal organization, genetic transmission and gene structure are highlighted in a greater extent to understand the molecular organization that contributes to heredity. Molecular basis of gene alterations and DNA damage that contribute to mutations would be dealt in detail to understand the molecular basis of genetic diseases including cancer.

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 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 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 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 interactionepistasis, 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 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 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.

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Semester : II
Course Code : INB-C-425
Course Title : CELL BIOLOGY AND BIOCHEMISTRY PRACTICAL
Credits : 2

AIM: The experiments aim at understanding the genetic and biochemical mechanisms in living organisms and quantification of macromolecules.

OBJECTIVES: Assays with squash preparations help in studying the mitotic and meiotic cell divisions in different models. Effect of various drugs or inhibitors on cell division would be studied in detail. Separation of organelles and quantification of macromolecules in microtome sections of tissue samples will be performed.

COURSE CONTENT

Squash preparation of grasshopper testis to study meiotic stages.
Squash preparation and identification of salivary gland chromosomes in *Drosophila* / *Chironomus* larva.
Determination of mitotic index in the squash preparation of onion root tip.
Effect of drugs on cell division (Colchicine or any other inhibitor)
Preparation of Microtome section, spreading and histochemical staining of carbohydrates (PAS), Protein (Bromophenol blue), lipids (Sudan Black), DNA (Fuelgen stain).
Cell fractionation and Differential Centrifugation to isolate mitochondria and nuclei
Quatiification of mitochondrial protein, blood albumin, urea, SDH kinetics, Michele's Mendon Kinetics.
Isolation of genomic DNA using Agarose gel electrophoresis, Isolation of Plasmid DNA.,

Semester : III
Course Code : INB-C-431
Course Title : MOLECULAR BIOLOGY AND BIOTECHNOLOGY
Credits : 4

AIM: This course introduces the basic concepts and the new developments in molecular biology and its implications in human welfare. Fundamental studies on methodologies of recombinant DNA technology help in extending the conceptual ideas to the application level. The topics described help in understanding the modern biotechnological practices and approaches with an emphasis on application in medical, industrial, environmental and agricultural areas.

OBJECTIVES: Molecular biology deals with studying the basic gene architecture ranging from its structure to replication process. Fidelity of replication and recombination mechanisms would be studied in detail to understand the molecular organization of genetic events. Studies on gene expression and its regulation at transcription and translational levels would be highlighted along with viral and phage gene expressions. Various tools and techniques of recombinant DNA technology would be discussed in detail to have a thorough understanding on the methodologies used. Advancements in molecular mechanism of recombinant DNA technology contributing to the diagnostic field of medicine would also be focused in detail.

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 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 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 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- CaCl2 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 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 VI: Biotechnology in Industry and Agriculture: Metabolite production. Antibiotics, Organic acids, Amino acids, Vitamins, Upstream processing, downstream

processing. Microbial enzymes and biotranformation- 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.

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Semester : III
Course Code : INB-C-432
Course Title : IMMUNOLOGY AND ENDOCRINOLOGY
Credits : 3

AIM: This course provides an intensive and comprehensive knowledge in immunology and endocrinology. The topics help to understand the role of immunology and hormones in human health and well-being. The portion introduces the students to the new developments in immunology and endocrinology.

OBJECTIVES: This course familiarizes the essential concepts of immunology and endocrinology. It offers an improved understanding of how the immune system and endocrine system evolved through time. The functioning of a healthy immune system is explained along with the aberrations that could lead to abnormal conditions. The details of the endocrine system and how it is regulated are also dealt with in detail.

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 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.

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 IV: Concepts in Endocrinology: Historical perceptive, 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 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, Etopic production of hormones by tumour cells.

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.

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Semester : III
Course Code : INB-C-433
Course Title : NEUROBIOLOGY AND REPRODUCTIVE BIOLOGY
Credits : 3

AIM: The course introduces the structural and functional features of the basic units of neural system. Studies on basic concepts help in understanding the signalling events and the role played by various neurotransmitters. Reproductive physiology comprehends the structural features of male and female reproductive organs and also gives insights into various hormonal responses during pregnancy which would further contribute to clinical case studies.

OBJECTIVES: Neurobiology focuses on the cellular and molecular organization of basic units of nervous system emphasizing on neuroanatomical structures. Concepts of membrane potential and synaptic transmission help to gain a better understanding on the neural circuits and plasticity. Studying the role of neurotransmitters and the successive signalling events would facilitate a better understanding on neurodegenerative diseases like Alzheimer's and Parkinson's disease. Reproductive physiology covers studies on female reproductive organs, developmental stages of pregnancy and the hormonal changes that give a wide insight into the topics of sexual dysfunctionality and infertility.

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 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 III: Mechanism of Neural transmission: Neuro transmitters and their receptor. Role of glutamate, GABA, DOPA, serotonin Limbic system and hippocamprus, central cortex-functional organization. Neurodegenerative diseases: Molecular mechanisms in Alzheimer's disease, Parkinson disease, dementia- Etiology and treatments.

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, Steroidgenesis 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 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, Parturation, Lactation-its hormonal control. Contraceptive Methods: Chemical methods, surgical methods. New approaches of contraception.

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.

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Semester : III
Course Code : INB-C-434
Course Title : RESEARCH METHODOLOGY, BIOSTATISTICS AND BIOINFORMATICS
Credits : 3

AIM: This course introduces the fundamental concepts which help to generate enthusiasm and awareness about the tools and accessories used for biological research. The topics included help the students to improve their analytical and critical thinking skills through problem solving. Bioinformatics explains the applications of information technology in various aspects related to biology and how it can be used for studying and evaluating biology.

OBJECTIVES: Research methodology familiarizes the basic concepts in sciences and life sciences along with fundamentals of research. Research formulation and designing would highlight the methods of performing research and how the data should be collected. Scientific documentation and communication explains about the analysis and presentation of data in a scientific format. Biostatistics deals with the measures of central tendency and dispersion as well as correlation and regression analysis for hypothesis testing. Bioinformatics introduces the concepts of biological databases, sequence analysis and its role in biological milieu.

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 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 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).

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 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 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.

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Semester : III
Course Code : INB-C-435
Course Title : MOLECULAR BIOLOGY PRACTICAL
Credits : 2

AIM: The assays give hands on training on most recent techniques of recombinant DNA technology and their application.

OBJECTIVES: The practical sessions would include isolation of the genomic material from various tissue samples. The assays will also help in understanding techniques for separating cellular components from human blood samples. Advanced techniques to study various expression patterns in both *in vivo* and *in vitro* samples qualitatively and quantitatively will also be performed.

COURSE CONTENT

Isolation of genomic DNA using Agarose gel electrophoresis
Isolation of Plasmid DNA.
Separation of lymphocytes from whole blood.
Separation of T and B lymphocytes
Blood Typing in Man.
Immunoflurecensce assays
Western Blotting –Demonstration
ELISA
Microplate Reader assay
Immuno electrophoresis- Demonstration
PCR assays, gene expression assays
Live cell imaging and quantification

ELECTIVE (Internal)

Semester : III
Course Code : INB-E-436
Course Title : MOLECULAR TECHNIQUES IN INTEGRATIVE BIOLOGY
Credits : 2

AIM: This course introduces the major tools and techniques used for studying biochemical and biophysical nature of life along with the safety concerns which arise during and after the study. The topics covered describe the techniques and instruments used for studying various aspects in integrative biology.

OBJECTIVES: Basic tools used for understanding the concepts in integrative biology are explained in this course. Applications and principles of all major techniques used are dealt with in the chapters. The topics also include up-to-date information regarding the methods used for studying various aspects covered in integrative biology.

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

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

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Semester : IV
Course Code : INB-C-441
Course Title : STRUCTURAL AND DEVELOPMENTAL BIOLOGY
Credits : 4

AIM: This course introduces the concepts and processes in structural and developmental biology. It would help in better understanding of how cells are organized and how they communicate with each other. The topics help students to understand and appreciate the genetic mechanisms during the process of development. This course also exposes the students to the new developments in plant and animal embryology.

OBJECTIVES: Structural biology deals with the structural organization of cells and mechanisms for both intra and inter-cellular communications. The role of specific molecules in cellular communication is also highlighted. Developmental biology focuses on the basic concepts of how gametes are formed, the process of fertilization and the processes involved in the development of an organism. Morphogenesis and organogenesis in both plants and animals are also dealt along with the description of the progress of differentiation and the process of programed cell death.

COURSE CONTENT

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

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 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, anigiogensis, Cell-ECM interaction.

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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 transgenics in analysis of development.

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 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.

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Semester : IV
Course Code : INB-C-442
Course Title : INTEGRATIVE BIOLOGY
Credits : 4

AIM: The course helps in studying different fields of biological science and how the basic knowledge can be integrated to contribute towards commercial and industrial development. The topics explain how to integrate biological applications in the field of clinical science and industry. The course also highlights the fundamental mechanisms of the most modern techniques in applied biology especially molecular medicine.

OBJECTIVES: Integrative biology introduces the fundamental concepts in detail. Cross-talk between signalling pathways, intra and inter cellular signalling events and its regulation explains the idea of integrative cell signalling. Studies on topics including role of conserved genes, evolution of stress genes would help in understanding how integrative biology can be used in animal diversity and evolutionary fields. Industrial applications of microorganisms give insights to the development of various diagnostic approaches and applications in the field of healthcare and agriculture. A thorough study on molecular techniques helps in gaining more knowledge in the field of applied biology.

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 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 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 IV: Concepts of biological integration and regulation: Theories of Biointegration, Biostasis 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 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 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.

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ELECTIVE (External)

Semester : II
Course Code : INB-X-421
Course Title : INTRODUCTION TO MICROBIAL PATHOLOGY
Credits : 2

AIM: This course focuses on the study to understand the common microbial infections in humans, its laboratory diagnosis and various prophylactic measures commonly employed. The course also helps to understand the pathogenesis of various microbial infections in human beings and the normal laboratory practises and culture of microbes in a medical laboratory.

OBJECTIVES: Medical microbiology introduces the concepts and principles of microbiology laboratory safety, culture practices of pathogens. This course also emphasizes the common infections in human beings caused by bacteria, viruses and protozoa, its pathogenesis, diagnostic measures routinely used and prophylaxis. This common understanding about various infections and their route of entry would help the society to tackle these problems sticking to the motto of prevention is better than cure.

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 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 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.

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

REFERENCES

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

ELECTIVE (External)

Semester : II
Course Code : INB-X-422
Course Title : INTRODUCTION TO ANIMAL BEHAVIOR
Credits : 2

AIM: The course focuses on the evolutionary causes of animal behaviour, including communication, foraging, anti-predator behavior and social behaviours. This course also explores the various behaviours that animals have to maintain in order to confront various challenges in the nature.

OBJECTIVES: Introduction to animal behavior describes the ethological principles and focuses on behaviour processes across animal species as a way to adapt to changing environments. The course also helps to learn a neuroethological model of learning and motivation by which an animal is able to function perfectly in their environment and to adapt to changes in it. The topics include how animals are able to communicate effectively with other individuals and about the types of communication signals used by them for variety of functions they serve. The endogenous cycles which influence the rhythms in physiology and behavior through biological clocks are well explained in this course. Anti-Predator Behavior descirbes the predator avoidance mechanisms and antipredator defensive behavior patterns.

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 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, pheromonal and behavior (Ants and mammals). Navigation and migration

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

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

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).

REFERENCES

- Alcock John. 2009. Animal Behaviour: An Evolutionary Approach (8th edn). Sinauer Associates Inc. Sunderland, Massachusetts.
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- Eibl – Ebesfeldt, I. Hol.1970. Ethology: The Biology of Behaviour. Reinhart & Winston. New York.
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ELECTIVE (External)

Semester : II
Course Code : INB-X-423
Course Title : TRADITIONAL ETHNOMEDICINE
Credits : 2

AIM: This course focuses on the study and use of plants and plant based medicine across the world. The topics give an over view of the use of herbs and herbal drugs in different systems around the globe. The course also helps to learn more about nutraceuticals. The course introduces the concepts related to additive and synergistic activity of phytochemicals and how they play a role in shaping evolution.

OBJECTIVES: The course initially deals with the ancient food habits and how it has caused changes in the evolution of humans. It also describes about the current trends in diet. The indigenous and traditional practices are dealt with in detail along with the role of phytochemicals and nutraceuticals with examples. The synergism and integration in ethnomedicine is discussed and the future directions of use of ethnomedicine are also outlined.

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 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 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 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 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.

REFERENCES

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- Sharma, P. V. 2000. Charaka Samhitha with English translation. Chaukhambha Orientalia publications, Varanasi, India.

OTHER RESOURCES:

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