JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR

Faculty of Education & Methodology

Department of Science & Technology

SYLLABUS

MASTER OF SCIENCE- ZOOLOGY

M.SC. ZOOLOGY

SESSION – 2022-23

DURATION – 2 YEARS/4 SEMESTER

SYLLABUS FOR:
I -II YEARS

Programme Objectives (POs):

The programme M.Sc. in Zoology aims to equip students with recent advances in Zoology from organismic to reductionist biology. It also aims to empower students to understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Reproductive health, Behavior and Biological time keeping, Cancer Biology, Micro biome and their roles in health and diseases, Bioremediation of pollutants and pesticides, etc. It also offers students to a series of core courses, so that they can choose to specialize in the specific area of their interests in Zoology.

Keeping the true spirit of choice-based credit system scheme, close to 40% of the total credits are offered as core courses. First, second and Third semester courses are offered as core courses, and in that 33% credits are assigned for lab work and hands-on experience. The UMC has been chosen to attract students from diverse interdisciplinary areas of sciences, such as Help Aid, Women Rights Law, Military Science, Yoga, Environmental studies, Biomedical Sciences, etc. This course is designed to ignite the inquisitive mind to enter in to research in interdisciplinary areas. The fourth semester offers a total of 2 core courses, which for logistics of programme management, are divided in to four streams, where a student has to choose a stream. In the fourth semester also, the major emphasis is on skill-based training into socially relevant areas of Zoology.

These courses are open for admission to students from Zoology (Hons.) to Life Sciences and Biomedical sciences if they have studied Zoology and Chemistry as generic elective at undergraduate level under CBCS scheme.

Programme Specific Outcomes (PSOs):

It is expected that a student after successfully completing four semesters of M.Sc. in Zoology programme would sufficiently be skilled and empowered to solve the problems in the realms of Zoology and its allied areas. They would have plethora of job opportunities in the education, environment, agriculture-based, and health related sectors. The bright and ignited mind may enter into research in the contemporary areas of Zoological/Biological Sciences. The broad skills and the deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

PROGRAM DETAIL

Name of Program	-	M.Sc. Zoology
Program Code	-	M.Sc.
Mode of Program	-	Yearly /Semester
Duration of Program	-	2 yrs/ 4 Semester
Total Credits of Program	-	160
Curriculum Type and Medium Choice	-	English

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SYLLABUS DETAIL

I SEMESTER

S. No.	Credit	Name of Course
1	8	Biosystematics, Ecology and Biodiversity
2	8	Cell Biology
3	8	Microbiology and Human Health Awareness
4	8	Animal Physiology and Metabolism
5	8	Animal Behavior and Chronobiology
Total	**40**	

II SEMESTER

S. No.	Credit	Name of Course
1	8	Reproductive biology and Embryology
2	8	Genetics and Evolutionary Biology
3	8	Molecular Biology
4	8	Fish Biology and Toxicology
5	8	Entomology and Applied Zoology
Total	**40**	

III SEMESTER

S. No.	Credit	Name of Course
1	8	Endocrinology & Neurology
2	8	Immunology
3	8	Cancer & Radiation Biology
4	8	Biochemistry
5	8	Parasitology
Total	**40**	

IV SEMESTER

S. No.	Credit	Name of Course
1	8	Biostatistics, Computational Biology and Bioinformatics
2	8	Bioinstrumentation
3	34	Dissertation
Total	**40**	

I SEMESTER

Biosystematics, Ecology and Biodiversity

Objectives: The primary objective of the course is to impart appreciation for different life forms on earth and drive home the relationship between different living forms both at the genetic and the ecological level. The objective of this course to make awareness among the young students about the taxonomy of animals, their surrounding environment, the impact of climate change and its mitigation, and biodiversity. The course will provide an account of various abiotic/climatic factors prevailing in biogeographically zones and biomes and an overview of the responses and adaptations of animals. The course will also give an insight into the ecosystem functioning, the food web, the flow of energy and cycling of nutrients. The concept of population, its characteristics and growth patterns and the changing relationship of man and environment will be elaborated. The community and its fundamental characteristics including niche segregation, succession and the positive and negative interactions in the community will be taught besides giving information on biodiversity status and the means of its documentation and mapping.

UNIT I Concept of species and Concept of species

Concept of species: Species, Polytypic species, Importance of recognition of Polytypic species taxa. Intraspecific categories, subspecies, temporal subspecies, race and cline; Population taxonomy, the new systematic and super species. Speciation: Sympatric, Parapatric and allopatric speciation, Speciation in time, sibling species. Taxonomic characters: Molecular, Behavioral, Ecological and geographical characters, weighing of characters, characters with low and high taxonomic weight. Intrapopulation variations: Non-genetic and Genetic variations. Interpretation and application of important rules.

Biosystematics - definition and role in biology, biological classification- theories and objectives, types of taxonomy, taxonomic diversity- definition and types; Basic concepts, importance and applications of Biosystematics. Trends in Biosystematics: conventional and current approaches (chemotaxonomy, cytotaxonomy and molecular taxonomy). Theories of biological classification and its importance; hierarchy of categories. Taxonomic procedures: Taxonomic collections, preservation, curating, process of identification. Typification: Details of different zoological types. Taxonomic keys: Different kinds of taxonomic keys, their merits and demerits. International code of zoological Nomenclature (ICZN): principles, interpretation and application of important rules, formation of scientific names of various taxa.

Unit II Concept of Ecology

Introduction to ecology, evolutionary ecology, environmental concepts – laws and limiting factors, ecological models. Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure. Competition and coexistence, intraspecific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions. Interactions between environment and biota; Concept and types of ecosystem, Stability and complexity of ecosystems; Limiting factor; food chain and energy flow, Ecological pyramids, Community structure and organization Ecosystem - Nature of ecosystem, production, food webs, energy flow through ecosystem, bio-geochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes; Bioremediation - Major classes of contaminants. Uptake, biotransformation, detoxification, elimination and accumulation of toxicants. Factors influencing bioaccumulation from food and trophic transfer. Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Impact of chemicals on biodiversity of microbes, animals and plants.

Unit III Structure of ecosystem

Structure of ecosystem-variations in physical environment and adaptations, Homeostasis, stability concept; Biodiversity of ecosystem – Salient features of aquatic and terrestrial ecosystem and their biotic communities; Biotic community concept and community analysis – organization, population density, relative abundance, frequency, dominance, carrying capacity, species richness and species diversity; Community development: Types of community changes, causes and examples of ecological succession, Climax community and stability; The Niche concept, ecological niche, niche overlap and separation; Population ecology- growth pattern, life tables & survivorship curve and density dependent & independent factors; Life history strategies: K- or r-selection, Age and sex ratio; Trophic structure, food chain and food webs, energy flow and Lindeman's trophic dynamics concept, Food web pattern and measurement in ecosystem energy flow model, concept of productivity and measurement of primary productivity; Characterisitic of population: population growth curves ,Concept of metapoulations: demes and dispersals and interdemic extinctions, Age structured population; Biogeographical zone and realms of India; Global environmental change

Unit IV Biodiversity

Assessment, conservation and management, biodiversity act and related international conventions. Sustainable development, natural resource management in changing environment. Molecular ecology, genetic analysis of single and multiple population, phylogeography, molecular approach to behavioural ecology, conservation genetics. Biodiversity, status, monitoring and documentation; Magnitude and distribution of biodiversity, Major drivers of biodiversity change, biodiversity management approach. origination and extinction, rates of change in origination and extinction, causes of extinction, causes of differential rates of diversification, current status and future of biodiversity; Wild life: Speciation and extinctions; economic value, wildlife biology, conservation strategies. Wildlife and livelihood; Wildlife hunting, illegal trade, poaching and & control. Animal trafficking; Climate change - Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations.

Suggested Readings :

1. Mayr E: Principles of Systematics Zoology. Tata McGraw Hill Pub. Company Ltd. 1980
2. Minelli A: Biological Systematics. Chapman and Hall. 1993
3. Alfred J R B, Das A K and Sanyal A K; Faunal Diversity in India. Zoological Survey of India. 1998
4. Environment, Development, and Evolution-Toward a Synthesisd by Brian K. Hall, Roy D. Pearson and Gerd B. Müller,The MIT Press,2003
5. Field Sampling: Principles and Practices in Environmental Analysis. 2004. Conklin, A.R.Jr. CRC Press.
6. Principles and Standards for Measuring Primary Production. 2007. Fahey, T.J. and Knapp , A.K. Oxford University Press, UK.
7. Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
8. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford University Press, UK.
9. Principles of Terrestrial Ecosystem Ecology. 2011. Chaplin, F.S., Matson, P.A. and Vitousek, P.M. Springer.
10. Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
11. Freshwater Ecology: A Scientific Introduction. 2004.Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.

Practicals

A. Habitat studies:

1. Physical and chemical characteristics of soil.
2. Physico-chemical properties of water.

B. Community/ecosystem studies:

1. Assessment of density, frequency and abundance of plants/ animals in a community using various techniques i.e. transect, quadrate etc.
2. Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro- and macro-fauna in decomposition.
3. Understanding ecosystem succession by studying various stages of vegetation/community assemblages development.
4. Application of molecular techniques in ecological study.
5. Insect diversity in soil.
6. Identification of aquatic organisms of different trophic levels and construction of food chain and food web.

C. Landscape studies:

1. Principles of GIS, GPS and RS technology.
2. Interpretation (visual and automated) of remote sensing information for landscape differentiation.

Outcomes:

- Knowledge of evolution would facilitate in assessing the potential disease
- causing organisms and thus be able to design effective disease control strategies.
- The students would be able to suggest beneficial alterations in agricultural crops and livestock through variability studies.
- The students would be able to take up functional studies of many organisms.
- Students will be exposed to the fundamental aspects of ecology.
- They will get idea about the impact of anthropogenic activities on the environment.
- Students will get idea about the natural resources and their conservation.
- The students will be able to understand the impact of climatic factors on the distribution of organisms and how the animals cope up with extreme climatic changes to survive and propagate.
- The students will be able to understand the role of species in the food web particularly those which help in maintaining the stability and diversity of ecosystem.
- The students will know about the key features required for simulating and developing an artificial ecosystem.
- The students will be able to understand the impact of climate on the population growth of species, the r- and k-selection strategies in animals and how civilization and industrialization have distanced man from nature thus resulting in environmental degradation.
- The students will be able to learn how the populations of species are regulated due to predation and parasitism, how the species with overlapping niches tend to shrink their niche size to coexist and how the biodiversity can be conserved and mapped using GPS, GIS and remote sensing methods

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Course Name: Cell Biology

Objectives: This course will provide knowledge about the complex organization in the eukaryotic cell and the molecular mechanisms of the cellular processes that exist in all cell types.

Unit I: Techniques in Cell Biology & Cellular Division
Advanced Microscopy: Confocal and immunofluorescence microscopy, FISH. Scanning and transmission microscopes, fixation and staining techniques for EM. Techniques for detection of Cancer, Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis. Cell death: different modes of cell death and their regulation. Cell Cycle misregulation and cancer. Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, virus-induced cancer,metastasis

Unit II: Interaction of the cell with its environment
General principles of cell communication: cell-cell communications, cell-environment communications. Role of different adhesion molecules: Desmosomes, Hemi-desmosomes, Gap junctions, Tight Junctions, Plasmodesmata . Organelle Interconnectivity and communications.

Unit III: Cell Organelles
Structure of cell membranes and concepts related to compartmentalization in eukaryotic cells;endoplasmic reticulum and Golgi apparatus, lysosomes, cellular cytoskeleton, mitochondria, and chloroplasts. Nucleus, nucleolus and chromosomes. Organelle Interconnectivity and communication of Mitochondria with the endomembrane system.

Unit IV: Cellular signaling
Signalling in normal cells: G-protein mediated signalling, RTK signalling, Ca++ signalling, Insulin Signalling, Ras-MAPK signalling, Wnt signalling. Hedgehog signalling, Toll-like receptor signaling Signalling pathways in Apoptosis and Cancer.

Text Books:
Cell biology C.B. Panwar
Alberts et al., Molecular Biology of the Cell, Garland Publishing, Inc., 2002, 4th ed.

Suggested Readings:
Lodish et al., Molecular Cell Biology, W.H. Freeman & Company, New York, 2007, 6th edition.

Outcomes: The students will:

- Be able to understand how the cell functions as a unit of life.
- Gain knowledge about the techniques and experiments that contributed to the understanding of molecular mechanisms of the cellular processes.
- Be able to draw parallels between the physiological processes at the cellular and organismic levels.
- Appreciate the importance of cell-cell adhesion and the extracellular matrix in the evolution of multicellular organisms.

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Course Name: Microbiology and Human Health Awareness

Objectives: The course will provide knowledge about different microbes living in specific niche, their interaction with each other and other living organisms. Student will learn the world microbes and modern microbiology as a subject with great impact in medicine, food science, biochemistry and molecular biology. Students will recognize the agents causing infectious diseases in animals and humans and also study the ways in which microorganisms cause disease and can suggest measures for prevention and cure of infectious diseases.

Unit I: Microbial characteristics and Microbial diversity

Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; antimicrobial resistance. Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes.

Unit II: Control of microorganisms

Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms. Ecological impact of microbes; microbes and nutrient cycles; microbial fuel cells.

Unit III: Virology and Host-microbes interaction

Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions. Host-pathogen interaction; symbiosis (Nitrogen fixation and ruminant symbiosis); microbial communication system; bacterial quorum sensing; microbial biofilm; prebiotics and probiotics, microbiome.

UNIT-IV Health and modern life style diseases

Health and modern life style diseases. Obesity, Diabetes mellitus type 1 and 2, Stroke and Hypertension – classification, effects on health, causes, pathophysiology, epidemiology,history, society and culture, diagnosis, prevention and management. Depression andstress – causes, assessment and treatment; Tobacco use and diseases – forms of tobacco use, Chemicals and carcinogens present in tobacco, Role of tobacco in cardiovascular and dental diseases, Cancer- oral, breast,\stomach and lung, Alcoholism: addiction and treatment, Drug abuse and addiction, Drug rehabilitation.

Suggested readings:

1. Peter Gluckman and Mark Hanson. 2008. Mismatch: The lifestyle diseases timebomb. Kindle Edition)
2. World Health Organization (WHO) (2000). Technical report series 894: Obesity: Preventing and managing the global epidemic. Geneva: World Health Organization
3. Centers for Disease Control and Prevention (CDC). 2010. How Tobacco Smoke Causes DiseaseThe Biology and Behavioral Basisfor Smoking-Attributable Disease. U.S. department of health and human servicespublic health service.
4. Microbiology by Pelczar- M.J.Chan ECS & Krieg NR-Tata Mcgraw Hill,
5. Microbiology- Prescott.
6. Pelczar, M. J., Reid, R. D., & Chan, E. C. (2001). Microbiology (5th ed.). New York: McGraw-Hill.
7. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). Prescott's Microbiology. New York: McGraw-Hill.
8. Matthai, W., Berg, C. Y., & Black, J. G. (2005). Microbiology, Principles and Explorations. Boston, MA: John Wiley & Sons.

Reference Books:

1. General Microbiology by Brock.
2. Microbial Physiology 4th ed. By Alber G.Moat & John W.Foster Wileyliss.
3. Foundation in Microbiology-by Talaro K, Talaro A, Cassida Pelzar and Reid
4. W.C.Brown Pub.
5. General Microbiology by R.Y.Stanier

Outcomes:

It the completion of this course, the students will be able to:

- Identify and classify different members of microbial world
- Understand the origin and evolution of microorganisms and major microbial habitats
- Recognize the relationship between microorganisms and disease
- Reveal catabolic and anabolic process of micro organisms
- Predict how virus and microorganisms interact with host cells and the way in which diseases arise
- Classify different agents causing infectious diseases and understand the mode of infection, biology and life cycle of different infectious agents.
- Understand host-parasite interaction from cellular and immunological view point.
- Have a detail understanding about the epidemiology and preventive methods of different infectious diseases.
- Plan and carry out laboratory experiments in order to address scientific hypothesis.
- Obtain an overview on the current challenges such as drug resistance and immune evasion for treating infectious diseases.
- Explain the basic concept of interaction of different pathogens with their corresponding hosts.
- Understand different strategies of pathogen to overcome host immune system.
- Learn to design novel therapeutics for pathogens targeting to the host pathogen interaction.

Course Name: Animal Physiology & Metabolism

Objectives: Animal physiology is the study of animal structure and function. This course on 'Comparative Animal Physiology' helps understand how animals work at all levels, ranging from individual cells to the whole integrated organism. The scope of physiology includes elucidation of the function of all cells in all organs and all animals related to nervous, respiratory, circulatory and other physiological systems. This course especially focuses on the modifications/adaptations found in different physiological systems of various organisms across the animal kingdom. The course also has a strong lab component, where certain classical and interesting exercises will be conducted to answer various practical queries in animal physiology.

The paper Metabolism: Concept and Regulation is designed as an advance course for understanding the interaction, network and regulation of certain important metabolic pathways and their roles in health and diseases. In the present context, manifestations of all non-communicable diseases, such as Cancer, Cardio Vascular disorder, Diabetes, Arthritis, Alzheimer's, even aging etc. are due to metabolic failure and reprogramming of metabolic pathways. The course also explains the interplay and energetics, catalysis and design of living systems. It is designed for students who have already taken up the courses and elementary biochemistry and macromolecular structures at the undergraduate level.

UNIT I Digestion & Respiration

Structure of salivary glands, Mechanism of salivary secretion, composition and functions of saliva. Structure of stomach, mechanism of secretion of gastric juice, composition and functions of gastric juice.Structure of pancreas, mechanism of pancreatic secretion, composition and functions of pancreatic juice. Structure of liver, bile secretion, its composition and functions.Digestion and absorption of proteins, carbohydrates and fats in the gastrointestinal tract.

Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

UNIT II Functional anatomy of kidney

Functional anatomy of kidney. Mechanism of formation of urine. Normal and abnormal constituents of urine. Mechanism of concentration and dilution of urine –The Counter current system.Regulation of urine and body fluid concentration and volume, hormonal mechanism of Antidiuratic hormone, Aldosterone and Renin –Angiotensin system in renal physiology. Regulation of water, electrolytes and acid base, renal clearance.Physiology of nitrogen excretion, renal failure.

UNIT III Physiology of Circulation

Physiology of Circulation Types of heart (Myogenic and Neurogenic).Anatomy, histology and nerve innervation of the heart, heart valves.Pace maker and specialized conducting fibers.Blood pressure and factors affecting blood pressure. Cardiac cycle, Electrocardiogram (ECG).Cardiac output, heart sound.Haemodynamics,Cardiac Failure. Cellular composition and functions of blood. Blood groups and Blood transfusion.Blood sugars –Causes and control of hypoglycemia and hyperglycemia,Cascade of biochemical reactions involved in coagulation of blood.

Unit-IV Energetic & Catalysis and Metabolic Pathways

Energetics and Design of Living Systems:The living state, metabolism as the defining characteristic of living organisms, molecular approach to understanding life forms and living processes, Energetics (second law of thermodynamics, Free Energy and standard free energy change), synthesis of ATP, structure and function of electron transport chain and synthesis of ATP through Fo-F1 ATP synthase. Catalysis and its Regulation:Nature of enzymes – kinetics, reaction mechanism of chymotrypsin and lysozyme, Inhibition of Enzymeactivity, regulation of enzyme activity: Metabolic Pathways and its Network:A broad outline of metabolic pathways and their linkage, metabolism of primary metabolites –monosaccharaides, lipids, essential amino acids and nucleotides.

Recommended text Books:

1. Enzymology by Palmer.

Suggested Readings:

1. Enzymatic reaction mechanisms by C. Walsh. WH Freeman, San Francisco (1979).
2. Fundamentals of Enzyme Kinetics by A. Cornish-Bowden 3rd Edition, Portland Press, London (2004).

Practicals

1. Effect of pH, temperature and incubation on human salivary amylase activity
2. Determination of a) clotting time, bleeding time
3. Total leukocyte count and differential leukocyte count
4. Estimation of blood Glucose
5. Estimation of blood proteins
6. Estimation of blood cholesterol
7. Estimation of blood alkaline & acid phosphates.
8. Blood amino-acid separation by TLC / Paper chromatography
9. Preparation and study of haemin crystals

Outcomes: After going through this course on 'Comparative Animal Physiology', the students have a good understanding of how invertebrate and vertebrate animals work and how these animals' biology is influenced by the different environments of their niches. The students will be able to explore an original query in animal physiology. The students will appreciate evolutionary changes and environmental adaptations in different taxa of invertebrates and vertebrates. It is expected that a student after taking up this course would acquire the knowledge and understanding of evolutionary design of each metabolic pathways and its intermediates. The student would be able to predict the futuristic outcome of failure of metabolic pathways. Consequently, a scheme of intervention for metabolic failure through life style management can be predicted and which may also result into design of drugs.

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Course Name: Animal Behaviour and Chronobiology

Objectives: Behavior is one of the most important and interesting aspects of animal biology. Behaviors permit flexibility that allows animals to respond rapidly to environmental changes. This course exposes students to the broad field of animal behavior. Students will come to understand the historical foundations of the field, as well as current theories and evidence for a broad range of behavioral topics. We will also focus on how the science underlying our theoretical understanding of behavior is conducted, and how behavioral hypotheses at all levels of analysis can be tested experimentally. Students also participate in practical exercises to learn some fundamental techniques used to study behavior, and will practice reading and analyzing current scientific literature. Behavioral ecology and the evolution of behaviors as adaptations will be recurring themes interwoven through all topics discussed. The purpose of the Animal Behavior Laboratory is for students to have hands-on experiences designing and implementing experiments that concern a variety of behavior. The course is open to students having Undergraduate degreee with Zoology as a subject and having background of Physiology or Neuroscience. The aim of this course is to enable students understand the importance of internal timing in regulation of daily and seasonal processes in organisms.

UNIT I Introduction & Patterns of animal behavior

Introduction-definition, historical out line Objectives and mechanism of behaviours, Types of reflexes, characteristics of reflexes and complex behavior, Orientation: Primary and Secondary Orientation, Sun-Compass Orientation, Kinesis: Orthokinesis and Klinokinesis, Taxis: Different kind of taxis; Development of behaviour: Genetic basis of behaviour, Hormone brain relationship; Neural basis of behaviour: Key stimuli, Stimulus filtering, Supernormal stimuli, Open and closed IRM, Biological rhythms; Learning Definition, Types of learning, Neural mechanism of learning; Communication : Types of communications-Auditory communication ; Infrasound communication among Elephants and Whales; Sonar, Navigation, and communications; Vocalization in nonhuman primates; Ecolocation in Bats; Visual communication; Chemical signals; Functions of scent in vertebrates; Tactile communications.

Unit II Innate mechanism

Innate releasing mechanisms: key stimuli, stimulus filtering, supernormal stimuli, open and closed IRM, mimetic releaser, code breakers. Homeostasis and behaviour: motivational system, physiological basis of motivation, control of hunger drive in blow fly and thirst drive in goat, role of hormone, motivational conflict and decision making, displacement activity, models of motivation, measuring motivation. Hormones and pheromones influencing behaviour of animals. Motivational system: Physiological basis of motivation, control of hunger drive and thirst drive in animals. Motivational conflict and decision making, displacement activity, models of motivation, measuring motivation, hormones and pheromones influencing behaviour of animals.

Unit III Sociobiology& Selection

Sociobiology: major social behaviours; Altruism: Reciprocal altruism, group selection, kin selection and concept of inclusive fitness, cooperation , reciprocation, alarm call, Selfishness; Eusociality: social organization in honey bee, polyphenism and its neural control, flower recognition, displacement and translocation experiment, various type of communications, production of new queen and hive, swarming, honey bee as super organism. Fixed action pattern: mechanism, deprivation experiment, controversies. FAP-characteristics and evolutionary features. Learning and instincts: conditioning, habituation, sensitization, reasoning.

Reproductive strategies: Sexual selection, intrasexual selection (male rivalry), intersexual selection (female choice), infanticide, mate guarding; consequences of mate choice for female fitness, monogamous verses polygamous sexual conflict. Parental Behaviour: Care before birth; Care after birth; Early parental care;Types of parental care ;Factors affecting parental care; Care and attachment; Parent offspring conflict.

Unit IV Basics of Chronobiology

Biological clock; Significance of Biological time keeping; Biological rhythms: Types of rhythms- Circadian, Circatidal, Circalunar, Circannual; Centres of biological rhythms- Suprachiasmatic nuclei, Pineal gland, Optic lobes; Factors influencing biological rhythms- Environmental, Photoperiod, Temperature, Other Zeitgebers; Methods of measurement: Entrainment, Re-entrainment, Phase angle difference, Free- run, Phase shift, Phase response curve, Arrhythmia; Molecular bases of circadian rhythms: Clock genes: Drosophila and Mouse; Applied Chronobiology: Human circadian rhythms, Application of circadian rhythms and principles; Jet-lag/shift work; Depression and sleep disorders; Chronopharmacology and Chronotherapy.

Practicals

1. To study the geotaxis, phototaxis, chemotaxis and hydrotaxi of earthworm.
2. To study the response of woodlice to hygrostimuli.
3. Fixed action pattern in spider.
4. Habituation in snail.
5. Behaviour observations in a primitive eusocial wasp.
6. Courtship and mating behaviour in Drosophila.
7. Foraging behaviour in a (Myna bird).
8. Behavioural profiling of a primate Macacamuletta.
9. Territorial behaviour in stray dogs.
10. Assay of circadian rhythms using animal model systems.
11. Assay of circadian activity rhythms in human.
12. Ambulatory blood pressure monitoring and circadian analysis.
13. Quantifying oscillations: phase, period and amplitude.
14. Dry lab exercises on the previously recorded data.
15. Recording of body temperature (Tb) of human.
16. Experiments demonstrating the photoperiodic clock

Suggested Books:

1. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA
2 Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK
3 Animal Behaviour, John Alcock, Sinauer Associate Inc., USA
4 Perspective on Animal Behaviour, Goodenough, McGuire and Wallace, John Wiley & Sons, USA
5 Exploring Animal Behaviour, Paul W. Sherman & John Alcock, Sinauer Associate Inc. ,Massachusetts, USA
6 An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press, UK
7. Alcock : Animal Behaviour- An Evolutionary Approach. (7th ed.) Sinaur Associates, Inc. 2001.
8. Drickamer & Vessey: Animal Behaviour –Concepts, Processes and Methods (2nd ed.), Wadsworth, 1986.
9. Gadagkar: Survival Strategies-Cooperation and Conflict in Animal Societies. Universities Press,1998.
10. Grier : Biology of Animal Behaviour, Mosby, 1984.
11. Hallidy and Slater : Animal Behaviour(vols. I-3) Blackwell Scientific Publ., 1983.
12 Krebs & Davis : Behavioural Ecology. (3rd ed.) Blackwell, 1993.
13. Lehner : Hand Book of Ethological Methods.(2nd ed.) Garland, 1996.
14. Slater & Halliday : Behaviour and Evolution,(1st ed.) Cambridge Univ. Press, 1994.Nelson, R.J. (2000). An introduction to behavioural Endocrinology, 2nd edition.
15. Binkley, S. (1990). The clockwork sparrow: time, clocks and calendars in biological organisms.
16. Chadrashekaran, M.K. (1985). Biological rhythms. Madras science foundation, Chennai.

Outcomes: At the completion of their Animal Behavior and Chronobiology course, students will be able to:

- Exhibit critical and integrative thinking skills
- Demonstrate ability to communicate scientific information in both oral and written formats
- Demonstrate knowledge of key concepts in animal behavior
- Exhibit quantitative research skills (or demonstrate ability to perform all parts of the scientific method)
- Demonstrate ability to think flexibly and apply knowledge to new problem
- Conceptualize how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
- Understand the molecular, cellular and system levels the generation and coordination of internal timing.
- Develop a critical viewpoint and to interpret observations from experiments on biological rhythms regulating daily and seasonal biology.
- Plan studies on biological rhythms in both human and non-human species.
- Understand the consequence of the disruption of internal rhythms on work performance and health in the modern world.

II Semester

Reproductive Biology and Embryology

Objectives: The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences. The relevance of Developmental Biology to the study of human disease will be exemplified throughout using different model organisms. This course is designed to impart knowledge to students on the fertility and contraception. The knowledge of the two sexes and their gametes will help the students to understand the process of fertilizations and the intricacies involved in the maintenance of fertility. Gamete preservation in cancer patients, and in the case of infertile partner makes it an essential for assisted reproductive technologies to be successful.

UNIT I Basic concepts of developmental biology

Testis: Spermatogenesis and hormonal regulation, Sertoli cell, Leydig cell, Cell – cell interactions; Male accessory sex glands, Functions of accessory sex glands.Regulation of ovarian function: Follicular development and selection, Regulation of steroidogenesis, Factors involved in follicular rupture, Follicular atresia.

UNIT II Early embryonic development of vertebrates

Control of male fertility: Suppression of spermatogenesis, Chemicals acting directly on the testis, asectomy; Male sterility: Parameters of male sterility, Origin and cause of male sterility, Azoospermia, Oligozoospermia. Control of female fertility: oral contraceptives, intrauterine devices, Female sterility:Tubal factors Premature ovarian failure,Polycystic ovarian syndrome,Primer pheromones: Estrous cycle disruption, Whitten effect, Bruce effect.

UNIT- III Hormone as mediators of Development

Gametogenesis: Spermatogenesis - formation of spermatids and spermiogenesis; oogenesis-oocyte growth, maturation and vitellogenesis, types of eggs; Ovulation and ovum transport in mammals; Fertilization: molecular events during pre- and post-fertilization, prevention of polyspermy, egg activation, embryo sac development. Cleavage- patterns and mechanisms; reorganization of embryonic cells – gastrulation and fate of germinal layers.

UNIT- IV General Concepts of organogenesis

Morphogenesis and Organogenesis: Morphogenesis, cell aggregation and differentiation in Dictyostellium, Dentalium and sea urchin. Neural tube formation; organogenesis – development of brain and eye; concepts of embryonic induction, competence and organizer. Vulva formation in Caenorhabditis elegans. Metamorphosis. Environmental regulation of normal development; Developmental genetics: Differential gene expression: Drosophila-maternal genes, pattern and axis formation, homeotic genes, segmentation genes, origin of anteriorposterior and dorsal-ventral polarities. Vertebrates; organization and role of Hox gene and other pattern forming genes, formation of limb; Sex determination: Details of sex determination in Drosophila and mammals.

Practicals:

1. Preparation of permanent slides of reproductive organs: testis and ovary.
2. Biochemical estimation of 3β-hydroxyl steroid dehydrogenase
3. Study of oestrous cycle of rat by vaginal smear preparation.
4. Study of sperm motility, sperm morphology, and sperm count.
5. Experiments demonstrating the photoperiodic clock.
6. Melatonin measurement from seasonal breeders

Suggested Readings:

1. Balinsky, B. I (1981) Introduction to Embryology. Hall Saunders, Philadelphia (5th ed.)
2. Alberts et al: Molecular Biology of the Cell (5th ed 2007, Garland)
3. Gilbert: Developmental Biology (8th ed 2006, Sinauer Associated Inc.)
4. Wolpert: Principles of Development (3rd ed 2007, Oxford)
5. Lewin: Genes IX (2008, Jones and Bartlett)
6. Snustad& Simmons: Principles of Genetics (2003, John Wiley)
7. Leung and Adashi: The Ovary (2004, Raven Press)
8. Adashi et al: Reproductive Endocrinology, Surgery and Technology (1996, Lippincott-Ravenpublishers)
9. Mann &Lutwak-Mann: The Male Reproductive Function and Semen (1998, Springer)

Outcomes:

• Developmental Biology enquires about the fundamental processes that underpin the fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism.
• Students learn best by doing and by having the opportunity to put what they have learned into practice. Therefore, using various model organism as a learning tool in Developmental Biology, students will learn how a cell behaves in response to an autonomous determinant or an external signal depends on the combination of transcriptional and posttranscriptional regulators, signaling pathway components, cytoskeletal elements, and other proteins and RNAs that it has synthesized earlier: i.e., on its developmental history.
• Students will also understand that cells only express a proportion of their genome, and that differential gene expression underlies cell differentiation and any alteration in the entire process of development leads to devastating diseases.
• Students studying this course will be able to understand the structure and function of gametes like eggs and sperms, their maintenance so the reproductive health in human and animals is maintained in good condition. This course will make themsuitably knowledgeable to undertake the jobs in the assisted reproductive technology clinics in the hospitals in addition to the teaching institutions.

Genetics and Evolution

Objectives:

Genetics and Cytogenetics is offered as a core course that provides fundamental knowledge of how organisms, populations and species evolve. Apart from Mendel's laws and basic genetics, at Master's level, this course will provide some of the most incisive analytical approaches that are now being used across the spectrum of the biological disciplines. Cytogenetics will impart knowledge about the human chromosome constitution that would help in applying basic principles of chromosome behavior to disease context. Overall, this course will highlight extension of Mendelian Genetics, dosage compensation, evolution of the concept of gene and its amalgamation with molecular biology and study of genetic diseases. To effectively complete this paper, students should have a desire for deeper understanding of molecular genetics and molecular cell biology. The course is design to impart knowledge and understanding of this rapidly changing field of modern biology and fast evolving tools for whole genome analysis, high throughput genome, transcriptome and proteome sequencing. The course will focus on comparison between genomes, its advantages and implications in evolution and provide students thought-provoking platform to deduce functional relationships at all macromolecular levels i.e. DNA, RNA and proteins across animal kingdom.

UNIT – I Evolutionary Concept

Concept of evolution, Origin of life, Theories of evolution, Population genetics: Hardy-Weinberg Law, Rate of change of gene frequency through natural selection, migration, random genetic drift, Speciation (Allopatricity and sympatricity), Molecular evolution: gene and gene family, gene duplication and divergence, molecular clock.

UNIT – II Basic principles of Genetics and Mendelian Concept

Mendelian principles: Dominance, segregation, independent assortment. Extensions of Mendelian principles: Codominance, incomplete dominance, penetrance and expressivity linkage and crossing over, sex limited and sex influenced characters. Human genetics: Inheritance patterns, Pedigree analysis, Anticipation, Consanguinity and its measurement, Gene mapping methods: Genetic mapping and physical mapping.

UNIT – III Human Genetics

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sexduction, fine structure analysis of genes, karyotyping. Quantitative genetics: Polygenic inheritance, heritability and its measurements, Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes.

UNIT – IV Genetic disorder diseases

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, polyploidy and their genetic implications, Genetic disorders: Molecular, biochemical and chromosomal.

Lab Course:

1. Pedigree analysis
2. Phylogenetic analysis.
3. Handling of Drosophila and study of its life cycle

Suggested Readings:

1. Brooker: Genetics- Analysis and Principles, Benjamin
2. Hartl: Essential Genetics: A Genomic Perspective (3rd ed, Jones Blackett)
3. Dobzhansky: Genetics and the Origin of Species (1964, Columbia)
4. Dobzhansky: Evolution (1976, Surjeet Publ.
5. Freeman and Herron: Evolutionary Analysis (1998, Prentice Hall)
6. Futuyma: Evolutionary Biology (1998, Sinauer)
7. Hartl and Clark: Principles of Population Genetics (1989 & 1997, Sinauer)
8. Li Wen-Hsiung and Dan Graur: Fundamentals of Molecular Evolution (1991, Sinauer)

Outcomes:

• Genetics and Cytogenetics course will open up several avenues for students in terms of research and employability.

• Genetics has made extensive use of model organisms, many of which will be used to teach this course. By observing genetic mutations in Drosophila, students can correlate phenotype with genotype, understand genetic interaction and their molecular basis.

• Students will be able to set hands on genetic crosses to understand recessive and dominant, segregation, pattern of inheritance and finally evaluating statistical significance by counting the progeny as statistical analysis provides crucial. Insight into many biological processes.

• Students will learn how genetic information is passed on in eukaryotes and prokaryotes, how genes work together in a complex manner in biological system and any alteration can lead to major phenotypic change.

• Students will appreciate the concept of epigenetics as a key mechanism of regulation of gene expression steering development and cell fate that can ultimately be affected in disease condition.

• After successful completion of the course the student should be able to design and comprehend experimental strategies for whole genome, transcriptome and proteome analysis. The student should be able to appropriately access and utilize various online and offline tools and databases related to genomic analysis.

Molecular Biology

Objectives:-

The course aims to bring a direct linkage between chemical structure of nucleic acids and their known functions. It is often elusive in the minds of students that why and how the specialized roles for the two nucleic acids (DNA & RNA) would have evolved, and the course aims to discuss the possible mechanisms for the functions of these two informational macromolecules. Biological properties and emergent in nature, and in the terms of gene regulation, it is defined as emergent behavior of cis-acting elements (a DNA or RNA sequence) with a trans-acting factor (a diffusible molecule that could be a protein or RNA). Therefore, it is also planned to cover the design of a transcription unit that is often used to annotate a gene from genomics data. The problems of accuracy during information-transfer (replication, transcription and translation) and the mechanism to solve the transmission of misinformation will also be discussed. The course is designed as an elective course for a student who has interest to study genes, genomics and epigenetics at advance level and has already studied the basic genetics and biochemistry of macromolecules.

Unit-1 Genome organization

C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence, Cot ½ and Rot ½ values, Pseudogenes , Gene families, Gene clusters, Super-families Organelle genome Structure of chromatin, nucleosome, chromatin organization and remodeling, higher order organization - chromosome, centromere, telomere Histone and its effect on structure and function of chromatin

Unit-2 DNA Replication

DNA replication in E. coli, Origin of replication, , types of E. coli DNA polymerases, details of replication process, regulation of replication, connection of replication to cell cycle. Different models of replication for linear and circular DNA, replication features of single stranded phages. Eukaryotic DNA replication, multiple replicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC), regulation of replication

Unit-3 DNA damage and repair

Different types in DNA damages, Different DNA repair systems: Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, Double strand break repair, transcriptional coupled repair

Unit-4 Recombination

Homologous and site specific recombination Models for homologous recombination: The Hollliday model, double strand break repair model Proteins involved in recombination: RecA, RuvA,B,C Gene conversion

Unit-5 Mobile DNA elements

Transposable elements in bacteria, IS elements, composite transposons, replicative, non-replicative transposons, Mu transposition Controlling elements in Tn A and Tn 10 transposition, SINES and LINES. Retroviruses and retrotransposon.

Lab Course:

1. Spectrophotometric analysis of nucleotides and amino acids. (2P)
2. Purification of DNA from bacterial cells. (1P)
3. Quantitation of DNA and Agarose gel electrophoresis. (1P)
4. Denaturing agarose gel electrophoresis. (1P)
5. Purification of RNA from bacterial cells. (1P)
6. Quantitation of RNA and agarose gel electrophoresis. (1P)
7. Demonstration of plasmid DNA in E. coli. (1P)
8. Transformation of E. coli with plasmid DNA. (1P)
9. Purification of plasmid DNA. (1P)
10. Restriction Endonuclease digestion and mapping. (1P)
11. Protein gel electrophoresis (2P x 5 H=10 H)

a) SDS-Polyacrylamide gel electrophoresis.

b) Native Polyacrylamide gel electrophoresis.

Reference books:-

•Genes IX, 9th edition (2008), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc.
•Molecular Biology of the Gene, 5th Edition (2004), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher - Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
Molecular Biology, 4th Edition (2007), Weaver R., Publisher-McGrew Hill Science.
•Molecular Biology of the Cell, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
•Essential Cell Biology, 2nd Edition (2003) Bruce Albert, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
•Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press.

Outcomes:-

It is expected that a student after completing this course would have fairly good understanding of evolution of genetic material and the design of functional modules (Unit) in the whole genome settings. The student would be able to structurally and functionally annotate a gene from the genomic database. Also, they should be able to design experiments for understanding the advanced functional genomics.

Fish Biology and Toxicology

Objectives:-

Diversity and Behaviour of Fishes introduces the young students to the world of fish diversity. Globally, more than 28000 fish species are available and India has huge fish biodiversity. This course includes the study of Pesticides that are agrochemicals and used for preventing, repelling, mitigating or destroying any pests. It includes insecticides, fungicides, rodenticides and herbicides etc. These insecticides are of chemical or biological origin that control the insect. The course indicates the mechanism of Pest control that may result in the form of killing the insects or otherwise preventing it from its destructive behaviors. Insecticides are either natural or man-made synthesized and are applied to target pests in a myriad of formulations (EC,WP, SP, FP, G etc.) and delivery systems (sprays, baits, slow-release diffusion, dust, etc.). In recent years, the bacterial genes coding for insecticidal proteins have been incorporated into various crops that deal with the mortality of the pests feeding on them.
The course highlights various categories of insecticides and their relative efficacy in relation to other control methods in a particular ecosystem. Use of bio-pesticides and other plant derived pesticides form an important part of IPM (Integrated Pest Management)
The course indicates the biodiversity of insects in different ecosystems and the impact of global climatic changes on insects diversity and their behaviour. Insects are important for the survival of different biota on the earth. Effect of various anthropogenic activities and pollutants on insects is correlated with maintenance of different ecosystems.

UNIT I Origin, Evolution and Distribution

Diversity and characteristic features of freshwater, marine and brackish water habitat. Classification of planktons and planktonic adaptations.Distribution and impact of environment on the aquatic biota. Types, origin and thermal stratification of lakes. Biomagnification. Process of eutrophication and its impact. Water bodies of Rajasthan.

UNIT II Comparative anatomy and Behaviour

Locomotion and locomotory organs in fishes. Respiratory system and accessory respiratory organs in fishes. Physiology of respiration. Urino-genital system. Migration in fishes. Common fish diseases. Fish diversity in Rajasthan

UNIT-III Toxicokinetics

Oxidative stress, non-enzymatic enzymatic and other sources, function and generation of ROS, pathways involved in ROS. pathophysiological role of ROS, antioxidant defense systems (endogenous and exogenous). Role of dietary nutrients, phytochemicals in defense mechanism.

UNIT-IV Toxicodynamics

Organ toxicity: Blood, liver, kidney, respiratory, nervous, cardiovascular, skin, reproductive, eye, endocrine and immune systems.

Practicals

1. Estimation and comparison of free CO2 content of aquatic system.
2. Estimation of total alkalinity/total hardness/ chloride contents in water samples.
3. Qualitative and quantitative analysis of plankton from different aquatic systems.
4. Estimation of lipid peroxidation and antioxidant enzymes.
5. Organ toxicity studies in mice/rats.

Suggested Readings

1. Allan, J.A:(1995) Stream Ecology: Structure and function of running waters. Chapman & Hall.
2. Brown M.E: The Physiology of FishesVol.I&II. Academic Press.
3. Closs G, Downes B, Boulton A (2004) Freshwater Ecology, Blackwell Science Publishing.
4. Davenport J (2003) Aquaculture, Blackwell Science Publication.

Outcomes:-

• Students will learn the identification of fishes using classical morphological method as well as advanced molecular tools (viz. barcoding).
• The students having this course will study various types of insecticides and understand their mode of action to kill/control the insects. Also, the students will learn about novel categories of insecticides that may be compatible with other control strategies.
• The students will come to know about many biorational insecticides and other ecofriendly methods for insect pest control, that may be combined to develop an appropriate IPM which has promising future perspectives.
• The students will learn handling of the pesticides in crop protection and understand the therapy and antidotes at the time of poisoning.
• Further, Insects being the important component of various food chains/ food webs, the students will be understand their crucial role in homeostatic maintenance of ecosystems and their biota. The students will learn about the impact of anthropogenic pollutants and climatic changes on the survival and propagation of insects, and may appreciate the insects as bio-indicators of ecological changes/disturbances.

Entomology and Aquatic Biology

Objectives:

Insect diversity society and evolution attempts to introduce students to the various orders and some of the most important families of insects so that they can distinguish between harmful and beneficial insects, which form the basis of entomology. The course emphasizes on understanding the morphological fundamentals of insects in order to understand their diversity. This is followed by understanding the unique morphological characters of the insects belonging to each of the 29 insect orders and also their biology, natural history and succinct features. Students would also be introduced to the classification and evolution of these 29 orders. Understanding insect societies would empower the student to appreciate their societal implications. Besides many social insects are good candidate biocontrol agents.

Unit 1 General organization of the insect body, head

Introduction to insects and their biology: Morphology: external features and their articulation; Comparative study of head-antennae, mouth parts; thorax – legs, wings; abdominal appendages, genitalia of the different orders of insects; Historical development of classification of insect: basis of insect classification; classification of insects up to sub orders and up to super families in economically important groups; fossil history, origin and evolution of insects.

Unit 2 Social organization and social behavior

Insect Society: group of social insects and their social life. Evolution of sociality;Social organization and social behaviour in honey bee, ants, termites, aphids and wasps. Integumentary system: Structure, function & formation, Growth, Moulting and Metamorphic development, hormonal influence, Sclerotization.

Unit-3 Reproductive physiolog and Endocrinology

Endocrine system: Insect hormones- with reference to metamorphosis & reproduction; Digestive & Excretory system: Alimentary tract, digestive and excretory physiology, Malpighian tubules, osmoregulation. Circulatory system: Open circulatory system, hemolymph, hemocytes, Immunity and thermoregulation; Respiratory system: Tracheal system and physiology of gas exchange. Reproductive system: Female & Male reproductive systems; Usual and unusual modes of reproduction. Nervous system: Components of the nervous system, Sensing the environment - Sensory receptors, vision & acoustics.

Unit-4 Insect Plant Interactions and Aquatic Resources

Classification of class of Insect up to Orders with salient features and common example; Useful insects: Insects and Insect products, Pollinating insects, insect used as food and medicine; Harmful insects: Insect pests, vectors of diseases; Insect's role in ecosystem and nutrient cycle; Insects as environmental indicator; Concept of Pest management; Limnology: Introduction, Definition of limnology, Essential nature of limnology; Aquatic Resources: Characteristic features of fresh water, brackish water and marine water environment; Freshwater Environment: Extent and distribution of freshwater. Lotic environments, ideological classification of fresh water biota. Freshwater communities; Rivers: Origin and characteristics of Rivers, Function and Biological productivity; Major threats to freshwater ecosystem including pollution and sand mining, impact of large dams.

Practical:

1.Estimation of soil parameters: pH, Organic Carbon, phosphate.
2. Estimation of primary productivity by LB-DB Method.
3. Collection and Identification of Plankton, Aquatic Insects, Aquatic Macrophytes.
4. Estimation of turbidity using Secchi-Disc method.
5. Identification of indigenous and exotic ornamental fishes under different families.
6. Identification of insects belonging to different orders.
7. Identification of different types of insect mouth parts, antennae and legs.
8. Salivary gland of honey bee — dissection and temporary mounting.
9. Dissection of sting apparatus in honey bee.
10. Study of prepared slides and museum specimens of selected parasites of representative groups of protozoans, parasites, helminthes and arthropods.
11. Preparation and identification of permanent slide of rectal ciliates in frog.
12. Culture and study of insect parasitoid on an insect host.

Suggested Literature:

1. A general text book of entomology, Imms , A. D., Chapman & Hall, UK
2. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M Saunders College Publication, USA
3. Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
4. The Insect Societies, Wilson, E. O., Harvard Univ. Press, UK .
5. Whitfield, J. B. and A. H. Purcell III. 2014. Daly and Doyen's Introduction to Insect Biology and Diversity. 3rd Edition. Oxford University Press, Oxford, UK. 718 pp

Outcomes:

Following completion of this course, they would acknowledge the value and importance of insects and the students would be able to sight identify most of the 29 orders of insects. They will also know the basic biology and the significant identification characters of the insects belonging to each of the 29 orders. They would also learn the latest ideas of comparing these insects in an evolutionary perspective. Studying insect societies, students would develop an ability to appreciate their implications on societal impacts. They would also be able to identify and use various insects as biocontrol agents.

III SEMESTER

Endocrinology and Neurology

Objectives- The course is designed to develop deep understanding on evolution of endocrine physiology.

UNIT – I Introduction, History and Milestones

Introduction, History and Milestones: General organization of central nervous system and brain in mammals,Type and structural characteristics of neurons, The information flow in the brain: connections and synapses, The transmitter systems:Amine neurotransmitters, Amino acid neurotransmitters, Peptide neurotransmitters. Principles and application of techniques used in neuroendocrinology (e.g. immunocytochemistry and in situ hybridization).

UNIT – II The pineal gland

Hormones and human health: Hormones as second messengers: endocrine, paracrine and autocrine hormones. Structure and function of the hypothalamus: hypothalamo – hypophyseal system; feedback mechanism. Biosynthesis and physiological roles of hormones. Stress (Adrenal) and metabolic disorders (Pituitary, Pancreas, Thyroid) - molecular basis and therapeutics; GI tract hormones: Source, composition and functions; Thymic hormones and cell immunity; Pineal gland structure, biosynthesis of melatonin, diurnal variations of pineal gland functions; Pheromones: Classification, chemical nature, structure, functions, relevance in applied fields, clinical applications.

UNIT – III Development and cytology of the pituitary gland

Types of hormone receptors.signal transduction mechanisms. Protein hormones: Membrane receptors G-proteins – cAMP signaling pathway. Thyroid hormones: Mechanism of action of thyroxine, tri-iodothyronine and tetra-iodothyronine. Mechanism of action of steroid hormones (genomic and non-genomic pathway); Ovaries and testis, hormonal control of reproduction. Regulation of gonadal activity: Hypothalamus – hypophyseal – gonadal axis. Oestrous and menstrual cycles and their regulation by hormones.Pineal and photoperiodic regulation of breeding cycle of vertebrates.

UNIT – IV Hypothalamus and internal timing

Life of a neuron - Neurogenesis – role of stem cells, Neuronal ageing and death; Neurophysiology - Neuronal plasticity, Neurotransmitters and receptors, Electrical properties of nerve cells: membrane and action potential. Synaptic transmission and neural integration, Neuromuscular junctions. Neuro-endo-immune circuitry; Aspects of neuronal disorders- Neurotransmitter-related, Structural, Metabolic.

Lab Course:
Endocrinology:

1. Preparation of brain for cryosection: Transcardial perfusion of rat and brain fixation
2. Cresyl violet (CV) staining of rat brain to identify different brain nuclei.
3. Study of important brain areas and hypothalamic nuclei involved in neuroendocrine regulation.
4. Demonstration of hypothalamo-hypophyseal portal system in rat brain
5. Identification of different neuropeptides and area of its localization in brain following immunohistochemical (IHC) methods.
6. Isolation of pituitary cells to study the effect of GnRH and its analogues in culture.
7. Extraction of rat/mice pituitary and study on the anterior pituitary histology.
8. Demonstration of the flow cytometry technique for its uses in the study of neuroendocrinology.
9. Study of endocrine glands in rat.
10. Estimation of hormones by ELISA (LH, FSH, Progesterone).
11. Demonstration of Hypothalamohypophysio gonadal (HPG) axis.
12. Histological preparation and immunocytochemical demonstration of endocrine tissues.

Suggested readings:

1. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
2. Chester-Jones et al: Fundamentals of Comparative Endocrinology (1987, Plenum Press)
3. Gorbman et al: Comparative Endocrinology (1983, John Wiley)
4. Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)
5. Hadley: Endocrinology, Prentice Hall (2000, International Edition)
6. Handbook of Neuroendocrinology: George Fink, Donald W. Pfaff and Jon E. Levine Eds.) 2012. Elsevier Inc.
7. An Introduction to Neuroendocrinology: Michael Wilkinson and Richard E Brown (2015), Cambridge University Press, UK.
8. Neuroscience: Exploring the Brain: 4th edition, Mark F. Bear, Barry W. Coonors and Michael A. Paradiso (2015). Wolters Kluwer.
9. Introduction to Behavioral Neuroendocrinology (5th edition), Randy J. Nelson and Lance J. Kriegsfeld (2016) Oxford University Press.

Outcomes:

This course will help in advancing our knowledge on endocrine pathology employing molecular tools and techniques. Further, Comparative Endocrine Physiology course will equip the students to know how residue of pharmaceuticals, estrogenic compounds coming from indiscriminate use of polythene and other pollutants present in aquatic/terrestrial system are severely affecting the hormone secretion and thereby, terrestrial and aquatic biomes.

Immunology

Objectives-

The primary objective of this course is to help students develop skills necessary for critical analysis of contemporary literature on topics related to health and disease and role of immune system. The course has been divided into two components: 1) lecture and discussion 2) practical demonstration. The lecture-discussion part is conceptualized with the aim that students are taught the basics of immunology so as to develop understanding of the subject, such as howdoes the immune system works? What are the molecular and cellular components and pathways that protect an organism from infectious agents or cancer? This comprehensive course answers these questions as it explores the structure, function and genetics of the components of immune system. The course also emphasizes the research and development opportunities for therapeutic intervention arising from recent advances in immunology. The immunological aspects of disease will also be discussed using case-based studies. Upon completion of the course students have a sound understanding of the essential elements of the immune system, preparing them to engage further in this rapidly evolving field.

Unit 1. Overview of the immune system

Overview of the immune system: Components of the immune system, principles of innate and adaptive immunity, antigen and immunogenicity, clonal selection theory; Evolution of immune system; Antigen recognition by immune cells: Innate Immunity- Pattern recognition in the innate immune system, TLRs and their role in innate immune response; Adaptive immunity-Antibody structure, antigen recognition by B lymphocytes; molecular mechanism behind BCR formation; B lymphocyte development and survival.

Unit2Structure and function of MHC complex and Antigen recognition by immune cells
Structure and function of MHC complex: antigen processing cells, antigen processing and presentation to T lymphocytes, MHC restriction; TCR structure and function: T-cell receptor gene rearrangement; T lymphocyte development and survival; Antigen recognition by T-cells, signaling through TCR and T-cell activation, co- receptors and their role in T –cell functioning; co-stimulation.

Unit 3 Effector mechanisms and regulation of immune responses
Effector mechanisms and regulation of immune responses: Induced innate response to infection, Innate memory, Complement system, NK and NKT cell functions, Humoral immune response, Production of effector T- cells, cytotoxic T- cell effector mechanisms. Regulation of immune response: Leukocyte activation and migration, Cytokines, innate regulation of the immune response, T-cell mediated regulation of immune response, Immunological tolerance. Mucosal immunity.

Unit-4 Immunity in health and disease

Immunity in health and disease: Allergy and hypersensitivity, Autoimmunity, Immunodeficiency diseases, Immunity and Infection, Tumour-immunology, Transplantation, Vaccines; Techniques related to immunology

Practical class:

1. Preparation of single cell suspension from bone marrow and spleen (spleenocytes) of mice.
2. Cell counting and viability testing of the spleenocytes prepared.
3. Preparation and study of phagocytosis by spleenic/peritoneal macrophages and
4. Mactophage functional analysis by: a)Phagocytosis, b) Nitric oxide estimation.
5. Raising polyclonal antibody in mice, serum collection and estimation of antibody titre in serum by following methods: a)Ouchterlony (double diffusion) assay, b) ELISA
6. Antibody purification from the serum collected from immunized mice: a) affinity purification/chromatography, b) Immunoelectrophoresis.
7. Demonstration of Western blotting: a) Protein estimation by Lowry's method /Bradford's method, b) SDS-PAGE, c) Immunoblot analysis.

Suggested Literature:

1. Kuby Immunology, Richard, Thomas, Barbara, Janis , W. H. Freeman and Company [Latest edition].
2. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing [Latest edition].
3. Essentials of Immunology, David, Brostoff and Roitt, Mosby & Elsevier Publishing[Latest edition].
4. Fundamentals of Immunology by William E. Paul, Lippincott Williams & Wilkins Publishing[Latest edition].
5. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing [Latest edition].

Outcomes:

At the end of the course, the students should be able to:
• The students will be able to identify the cellular and molecular basis of immune responsiveness and understand how the innate and adaptive immune responses coordinate to fight invading pathogens.
• Understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.
• Learn to review the literature to determine the strengths and weaknesses of the data published in immunology and its novelty.
• Design new methods to improve existing vaccines and other immunotherapeutic strategies.

Cancer and Radiation Biology

Objectives:

This course is formulated to know the fundamental understanding of the molecular and biochemical basis of cancer diseases.

UNIT – I Fundamentals of Cancer Biology

Cell cycle and Cell death: Mitosis, Meiosis, Genetic regulation of cell cycle, Apoptosis and Necrosis. Characteristics of Cancer: Benign tumour, Malignant tumour, Mechanism of metastasis, Tumour angiogenesis, Cancer staging.

UNIT – II Genetic basis of cancer

Genetic basis of cancer: Proto-oncogene and oncogene, Tumour suppressor gene, Tumour viruses and retrotransposons, Growth factors and signal transduction, Animal models of cancer, Cytotoxicity testing, concept of LD50.

Unit-III Radiation Chemistry

Radiolysis of Water, Formation of oxygen reactive species, Oxygen effect, Linear energy transfer and relative biological effectiveness; Chromosomal aberrations, Micronuclei induction, Radiation mutations.

Unit-IV Application of radiation in Medicine

Radiation therapy, Therapeutic nuclear medicine, Management of radiation injuries, Radio-autoradiography, Radioimmunoassay; Radiation syndrome, Radiation induced chromosome damage.

Practicals:

1. Free radical estimation,
2. Trypan Blue dye exclusion,
3. Cytotoxicity (MTT assay) and acute toxicity tests, Tumor transplantation.
4. Apoptosis morphological and DNA ladder.
5. Chromosome aberration.
6. Symbol of Radiation: Trefoil
7. Knowledge and use of various instruments, Geiger-Muller counter.
8. finding out the operating voltage of the G-M tube
9. Cobalt camera. Linear Accelerator.

Suggested readings

1. Lauren Pecorino (2012) Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics (2nd Edition) by Oxford University Press
2. Weinberg, Robert A. (2007) The Biology of Cancer. New York: Garland Science.
3. Raymond W. Ruddon (2007) Cancer Biology. Oxford University Press.
4. L. M. Franks, N. M. Teich (1997) Introduction to the Cellular and Molecular Biology of Cancer. Oxford University Press
5. John Mendelsohn (2008) The molecular basis of cancer. Saunders/Elsevier
6. Eric J. Halland Amato Giaccia (2011) Radiobiology for the Radiologist.7th edition.Lippincott Williams and Wilkins.
7. A.P. Casarett (1968) Radiation Biology .Prentice Hall
8. Forshier Steven (2002) Essentials of Radiation Biology and Protection. Delmar

Outcomes:-

By the end of the completion of this course, students should be able to

- Learn the basic genetic, molecular and biochemical principles of cancer diseases which certainly lead to develop their research projects.
- Know the fundamental differences between non-cancerous and cancerous cells.
- Acquire the biochemistry and biology of cancer incidence, development, progression, and cancer metastasis.
- Gain both merit and short comings of therapy used in cancer treatment.
- Know the basic principles of stem cell therapy which could be used to treat cancer diseases.

Biochemistry

Objectives:-

To introduce the chemistry of biomolecules, classification, structural and functional diversity, physico-chemical properties and their significance in biological system.

Unit I: Chemical basis of life

Composition of living matter; Water properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships; Structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structurefunction relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.

Unit II: Enzyme catalysis

General principles of catalysis; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes, Allosteric enzymes. Two-substrate kinetics and pre-steady state kinetics; Allosteric enzyme kinetics; Enzyme inhibition kinetics; Immobilization of enzymes. Kinetics of immobilization, external mass transfer resistance, Damköhler number, Effectiveness
factor

Unit III: Structure and function of carbohydrates and lipids

Sugars - mono, di, and polysaccharides; Suitability in the context of their different functionscellular structure, energy storage, signaling; Glycosylation of other biomolecules – glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins. Biological membrane transport, membrane dynamics

Unit IV: Bioenergetics

Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism; Introduction to GPCR, Inositol/DAG//PKC and Ca++ signaling pathways; glycolysis and gluconeogenesis; reciprocal regulations and non-carbohydrate sources of glucose; Citric acid cycle, entry to citric acid cycle, citric acid cycle as a source of biosynthetic precursors; Oxidative phosphorylation; importance of electron transfer in oxidative phosphorylation; F1-F0ATP Synthase; shuttles across mitochondria; regulation of oxidative phosphorylation; Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation.

Lab course:

1. Buffer preparations.
2. Quantitative estimation of protein.
3. Estimation of enzymes.
4. Quantitative estimation of Carbohydrate.
5. Estimation of nucleic acid.

Suggested readings

1. Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. D L Nelson and M M Cox, Lehninger Principles of Biochemistry, 7th edition, Macmilan 2017.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
4. Thomas M Devlin (2010) Text of Biochemistry with Clinical Correlations, Wiley-Liss

Outcomes:-

- Upon completion of this course students will be able to understand the structural characteristics and functional role of the macromolecules (Carbohydrates, Proteins, Lipids and Enzymes) and their significance in a biological system.
- Knowledge about the biocatalysts will enable the students to understand the significance of enzymatic reactions and how they can influence the metabolic processes.
- Students will be able to correlate the physiological significance of these molecules in order to maintain homeostasis in an organism.
- Qualitative and quantitative analysis will enhance the technical skills of the learners.

Parasitology

Objectives:-

The course aims to give an overview of biological basis of parasitic lifestyles including host responses and parasite evasion of host defense mechanisms. The students are exposed to parasites that not only infect humans but also those of plants and animals. It emphasizes on the evolutionary aspect of host-pathogen interactions leading to host specificity. The students learn about transmission, epidemiology, diagnosis, clinical manifestations, pathology, treatment and control of major parasites. The course has been structured in a way that the students assimilate the classroom knowledge for applied aspects of parasitological and public health.

Unit 1 General concepts

Animal associations and evolution of host –parasite relationship, Immune response and self-defense mechanisms, immune evasion and biochemical adaptations of parasites, Zoonosis.

Unit 2. Blood parasites

Blood parasites: Malaria: Epidemiology, mode of infection, detection, immunity and immune evasion mechanisms: Coordinated switching for antigenic variation by malaria parasites, drug targets, mechanism of drug resistance, malaria vaccine strategies. Leishmaniasis: Sand fly biology in the life cycle of Leishmania parasites; critical role for sand fly midgut microbiota in Leishmania development and transmission, epidemiology, detection, protective and pathologic immune responses in leishmaniasis, immune evasion mechanisms, drug targets, mechanismof drug resistance, vaccine strategies. Sleeping sickness: Epidemiology, mode of infection, serum resistance in zoonotic trypanosomes, immunity and immune evasion mechanisms, dynamics of antigenic variation and VSG diversification, drug targets, mechanism of drug resistance, vaccine strategies.

Unit 3. Gastro-intestinal and other parasites

Gastro-intestinal and other parasites:Amoebiasis: Epidemiology, detection, immunity and immune evasion mechanisms, drug targets, mechanism of drug resistance, vaccine strategies. Schistosoma, Wuchereria, Brugia, Ancylostoma, Trichinella and Dracanculus: Epidemiology, mode of infection, detection, immunity and immune evasion mechanisms, drug targets, mechanism of drug resistance, vaccine strategies.

Unit 4. Beyond humans

Beyond humans: Parasites of veterinary importance. 11 Parasitic insects, mites and ticks; parasites of insects and their significance; nematode parasites of plants, morphology, biology, lifecycle and infection of crop plants by major plant parasitic nematodes, host parasite interactions.

Suggested Literature:

1. Foundations of Parasitology, Roberts L.S. and Janovy J., McGraw-Hill Publishers, New York, USA.
2. Modern Parasitology: A Textbook of Parasitology, FEG Cox., Wiley-Blackwell, U. K.
3. Parasitology: A Conceptual Approach, Eric S. Loker, Bruce V. Hofkin

Biology of Parasitism [Practicals]

1. Study of prepared slides and museum specimens of selected parasites of representative groups of protozoans, helminths and arthropods.
2. Demonstration of in vitro culture of Plasmodium, infection of mice with Plasmodium, chasing the process of infection by histopathology and immune reactions.
3. Culturing insect parasitic nematode, and chasing the lifecycle of the nematode on the insect host.
4. Culturing an insect parasitoid and studying their infection on an insect host.
5. Studying the infection of tomato plant by root knot nematode.

Outcomes:

Upon successful completion of this course the students would be able to:

- Understand the biology behind host-parasite interactions
- Learn about epidemiological concepts of parasitic infections of global importance
- Trained to diagnose, identify and detect some important parasites
- Learn pathological changes associated with parasite infections
- Discuss the role of vectors and intermediate hosts in parasite transmission

IV SEMESTER

Biostatistics, Computational Biology and Bioinformatics

Objectives:-

This course is meant to impart knowledge to students on the most import skill which is required in this era for any scientific worker. The course is designed in such a way that the students gets the confidence to use computer programs for the daily design of experiments, data collection, and analysis of results. The mandatory hand on practical exercises in the available state of art computer lab in the Department will benefit students to learn all that they require to use their computer for the study of science.

UNIT I Basics of Tabulation of Data & Central Tendency

Biostatistics- population, sample, variable, parameter, primary and secondary data, screening and representation of data, frequency distribution, tabulation, bar diagram, histograms, pie diagram, mean, median, mode, quartiles and percentiles, variance, standard deviation, coefficient of variation; Probability and distributions- definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, examples- bernoulli, binomial, poisson and normal distributions; bivariate data- scatter plot, correlation coefficient (r), properties (without proof), interpretation of r, linear regression: Fitting of lines of regression, regression coefficient, coefficient of determination; hypothesis, critical region, and error probabilities, tests for proportion, equality of proportions, equality of means of normal populations when variances known and when variances are unknown: chi-square test for independence, P- value of the statistic, confidence limits, introduction to one way and two- way analysis of variance.

UNIT II Probability, Correlation, Regression & Sampling

Applications of Biostatistics, Sampling methods: Random sampling, Stratified sampling and Sub-sampling Measurement of variations: Standard error, standard deviation and co-efficient of variation, Quartile and percentiles, probability and distribution, Binomial, poison and normal distributions; Correlation and regression: Linear regression equation and line of best fit, Coefficient of correlation, Coefficient of regression Chi-square test value of statistics, Confidence limit, t-test, Introduction to one way and two ways Anova and F-test; Kruskal-Wallis test, Man-Whitney U test.

UNIT III Basic components of computers

hardware (CPU, input, output, storage devices), Software (operating systems), Application software; Introduction to MSEXCEL- use of worksheet to enter data, edit data, copy data, move data; Use of in- built statistical functions for computations of mean, S. D., correlation, regression coefficients etc., Use of bar diagram, histogram, scatter plots, etc., Graphical tools in EXCEL for presentation of data; Introduction to MS- WORD word processor- editing, copying, moving, formatting, table insertion, drawing flow charts, Introduction to Power Point, image and data handling and software like Endnote.

UNIT IV Statistical application & Software

Hypotheses testing: null and alternative hypothesis, T-test, Chi-square test, goodness of fit test and homogeneity of samples, F-test. ANOVA: one way and two way analysis of variance, Design of experiments. Use of statistical packages for data analysis (SPSS).

UNIT V Bioinformatics

The era of computerized biology information, review of relevant definitionsn in molecular biology, overview of challenges of molecular biology computingintroduction to phylogenetic analysis. Introduction to bioinformatics. Introduction to computational genomics and proteomics, Introduction to genomics and proteomics databases- nucleic acid sequence databases: Genebank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases: Swiss-prot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results) and HMMER, BLAST vs FASTA, file formats- FASTA, GCG and ClustalW. Databank search- data mining, data management and interpretation. Multiple sequence alignment of genes and primer designing. Phylogenetic analysis with the program PHYLIP, DISTANCES, and GROWTREE.

Proteins, secondary structure and folding, RNA secondary structures, protein prediction tools- protein secondary structure, molecular modelling, identification and characterization of protein mass fingerprint, world- wide biological databases.Protein modelling, protein structure analysis, docking, ligplot interactions. Introduction to the latest modern softwares and technologies.

Suggested Literature:

1. Latest software and articlesavailable on University internet sites and subscribed sites.
2. Latest e-books and the text books available in the Department and University Library.
3. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA.
4. Principles of Biostatistics, Pagano M., Gauvreau, K, (2000), Duxbury Press, USA.
5. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, US.

Practicals

1. Introduction to the statistical software like R and SPSS
2. Use of excel sheet and graph pad Prism for data processing.
3. Use of search engines like Pub-Med, Scopus, Science direct for reference material collection and management.
4. Nucleic acid and protein sequence databases.
5. Data mining for sequence analysis by use of Bioinformatics' tools.
6. Web– based tools for sequence searches and homology screening.
7. Primer designing for gene amplification and gene cloning.
8. Annotations: ORF finder, Use of ARTEMIS or any other suitable software.
9. Construction of phylogenetic trees for DNA and proteins.
10. Introduction to microarray technology.
11. Software to study protein structure.
12. Software to estimate the antigenicity of a protein/peptide.
13. Discuss the modern technologies for the subjects taught in theory and their use depending on their availability.
14. Identification of peptide finger print by nano LC- MS/MS and database search.

Outcomes:-

Students studying this course will be able to perform the data analysis using the statistical tools available on any computer such as excel as well the programs for big and complex data. They will be able to handle high throughput proteomic and genetic data. They will be able to understand the maintenance of computers, server and big data files. This course will make them suitably knowledgeable to undertake the computer jobs in the offices in the hospitals, scientific academies, funding agencies in addition to the teaching institutions.

Bioinstrumentation

Objectives:-
The aim of this course is to provide an advanced understanding of standard methodologies in biology that are commonly used in life science research.

Unit-1 Spectroscopic Methods and Proteomics
Microscopy: Principles and applications of phase contrast, Fluorescence and confocal Microscopy; Principles and application of tracer techniques- autoradiography and radio immunoassay; 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, and surface plasma resonance methods; Different types of mass spectrometry and applications in biology.

Unit-2 Separation techniques in Molecular biology
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. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; Immunological techniques: Immunodiffusion, Immunoelectrophoresis, Enzyme linked Immuno-absorbant assay (ELISA); Centrifugation: Density gradient and unit gravity centrifugation, tissue processing and separation of various sub-cellular organelles by centrifugation.

Unit-3 Separation techniques
Molecular separation Techniques: Ion-Exchange, Absorption, partition, gel filtration, and affinity chromatography, GC, GC-MS, TLC, HPLC and HPLC-TLC; Electrophoresis- Principle and applications, Agarose, SDS, SDS-PAGE, Pulsed gel and Disc electrophoresis, determination of molecular weight by SDS-gel electrophoresis.

Unit-4 Modern Genomics Techniques
DNA sequencing methods, strategies for genome sequencing, Methods for analysis of gene expression at RNA and protein level, large scale expression, western blot, such as micro array based techniques Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques; Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Pedigree analysis, lod score for linkage testing. QTL mapping; Cryopreservation: Methods and applications; Southern, Northern and Western Blotting; Principle and application of Nick-translation, in situ-hybridization; Chromosome banding, FISH-chromosome painting technique.

Outcomes:
Student will get acquired with common laboratory techniques and can comfortably handle the instruments. Biotechniques are in high demand in academics, research and industry and play prominent role in biomedical and clinical research.

JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR

IV SEMESTER

DISSERTATION