SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar, Gujarat
(Reaccredited with 'A' Grade by NAAC (CGPA 3.25)
Syllabus with effect from the Academic Year 2022-2023

PROGRAMME STRUCTURE

M.Sc. Zoology Semester: III

Programme Outcome (PO) - For M.Sc. Zoology Programme	Upon successful completion of Masters of Science in Zoology students will be able to : ● Develop an understanding to associate theoretical concepts and practical skills of Zoological Sciences in day-to-day life ● Gain the expertise in operating laboratory instruments with their basic mechanisms and applications ● Analyze critically, think holistically and apply the knowledge of various dimensions of Animal Sciences in teaching and research ● Correlate the impact of dynamics of ecology with evolution, embryology and development of specific behavior patterns in animals and humans ● Accomplish different specialized tasks devotedly suiting to the needs to wildlife conservation, industry, research laboratories and academic institutions
Programme Specific Outcome (PSO) - For MSc Zoology Semester - III	● To learn about different cytological and molecular level processes in both prokaryotes and eukaryotes including its regulation. ● To correlate various level adaptations, variations and speciation using stratigraphy

To Pass	(1) At least 40% marks in each paper at the University Examination and 40% aggregate marks in Internal and External Assessment. (2) At least 33% Marks in each paper in Internal Assessment.

Course Type	Course Code	Name Of Course	Theory/ Practical	Credit	Exam Duration in hrs	Component of Marks		
						Internal	External	Total
						Total	Total	Total
Core Course	PS03CZOO51	Clinical Physiology	T	4	3	30	70	100
	PS03CZOO52	Developmental Biology	T	4	3	30	70	100
	PS03CZOO53	Toxicology	T	4	3	30	70	100
	PS03CZOO54	Practical	P	4	3	30	70	100
	PS03CZOO55	Practical	P	4	3	30	70	100
Elective Course (Any One)	PS03EZOO51	Biological Chemistry	T	4	3	30	70	100
	PS03EZOO52	Aquaculture Technologies	T	4	3	30	70	100
	PS03EZOO53	Bioinformatics	T	4	3	30	70	100

Master of Science Zoology
M.Sc. Zoology Semester (III)

Course Code	PS03CZOO51	Title of the Course	Clinical Physiology
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	Student should be able to: i. Correlate various systems of the human body with homeostasis. ii. Understand pathophysiological conditions occurring in humans.

Course Content		
Unit	Description	Weightage* (%)
1.	Homeostasis and the organization of body fluids, Control of Homeostasis, Positive and negative Feedback systems, Homeostatic Imbalances. An overview of human circulatory system. Disorders of circulatory system: respiratory acidosis and alkalosis, metabolic acidosis and alkalosis, Hypoxia, coagulation disorders, hypertension, thalassaemias and anemias.	25
2.	An overview of digestive system. Hormonal and neural regulation of GIT, Gastritis, GIT obstruction, ulcers An overview of Muscular System. Disorders of muscular system: Myasthenia Gravis, muscular dystrophy, fibromyalgia, muscular atrophy and hypertrophy, Rigor Mortis.	25
3.	An overview of Nervous System. Disorders of nervous system: multiple sclerosis,epilepsy, neuropathy, Guillain-Barre syndrome. Neurotoxicity: neurotoxins, anaesthetics, neuro-transmission inhibitors. An overview of Respiratory System. Disorders of respiratory system: Asthama, Chronic Obstructive Pulmonary Disease, Cystic fibrosis, Pnumonia, Pulmonary edema.	25
4.	An overview of human urinary system. Role of kidney in body water, electrolyte and acid-base balance. Renal malfunctions and hemodialysis. Nephrotic syndrome, Kidney stone, UTI Disorders of reproductive systems: prostate disorders, cryptorchidism and hernias, PMS, PMDD. Birth control: Physiology of birth control methods.	25

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Students should be able to read and understand diagnostic reports.
2.	Student should be able to understand, how to maintain health

Suggested References:	
Sr. No.	References
1.	Hall, J. E., & Guyton, A. C. (2016). Textbook of medical physiology (13th Edn.). Elsevier, Philadelphia.
2.	Barrett, K. E., & Ganong, W. F. (2019). Ganong's review of medical physiology (26th Edn.) McGraw-Hill Medical, New York.
3.	Tortora, G. J., & Grabowski, S. R. (2017). Principles of Anatomy and Physiology (15th Edn). HarperCollins College, New York.

On-line resources to be used if available as reference material

On-line Resources
Relevant review articles/research papers/handouts of latest development in the subject

Master of Science (Zoology)
M.Sc. Zoology Semester III

Course Code	PS03CZOO52	Title of the Course	Developmental Biology
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To understand the abnormalities in gametes and defects in embryo 2. To learn about early and late development of model animals including humans with reference to growth patterns of embryo and their role in developmental obstructions. 3. To impart knowledge of axis formation in normal and abnormal conditions 4. To provide the information on the role of environment and other epigentic factors like estrogenic agents, pollutants 5. To strengthen the comprehensive views of evolution and developmental processes

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction, gametogenesis, fertilization and molecular aspects of development: Introduction to animal development. Fertilization: Structure of gametes, Egg Differential gene expression and cell gene transcription, RNA processing, Control of gene expression at translation, Cell adhesion and cell signalling	25
2.	Early and late development: Early development in invertebrates and vertebrates: Cleavage and pattern of embryonic cleavage; Comparative account of gastrulation; Early development in Sea urchin, C. elegans; Drosophila; Amphibia; Birds; Mammals. Later embryonic development: Development of ectoderm, Neurulation and Central Nervous system. Neural crest cell; Development of mesoderm: Paraxial mesoderm, Intermediate mesoderm, Lateral plate mesoderm. Development of endoderm	25
3.	Body Axes: Establishment of body axes in C. elegans, Birds and Mammals, Tetrapod limb development: Proximo-distal, Anterior-Posterior, Dorsal-ventral; Cell death pathway Drosophila axis specification: Dorso-ventral pattern, Segmentation and Anterior-Posterior body plan, Maternal gradient, Segmentation genes	25

4.	Hormones and environment- regulators of development: Hormones as mediators of development: Amphibian metamorphosis: Morphological and biochemical changes, Hormonal control. Insect metamorphosis: Imaginal discs-- Determination of axes in wing/leg imaginal discs. Hormonal control, and Molecular mechanism of action of ecdysone. Birth defects, Endocrine disruptors and cancer. Environment as a normal agent in producing phenotype: Polyphenisms and Plasticity, Temperature and sex, Environmental induction of behavioural phenotypes and Learning,	25

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern

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1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to

1.	Understand of gametogenesis and evolving inadequacies
2.	Know about germ layer formation, late development and associated irregularities
3.	Correlate axis specification and congential abnormalities
4.	Get information about role of environment in growth and development
5.	Understand relationship between ontogeny and phylogeny

Suggested References:

Sr. No.	References
1.	Barresi, M., J., F., Gilbert, S., F., (2019). Developmental biology. 12th Edn. Sunderland, Mass: Sinauer Associates, United States
2.	Berrill,N., J., Karp, G., (1981). Development. McGraw Hill Inc. New York
3.	Balinsky, B. I., (2012). An introduction to Embryology. 5th Edn. Cenage Learning, India
4.	Wolpert, L., Tickle, C., Arias, A., M., (2015). Principles of Development, Current Biology Ltd., London, New York.

On-line resources to be used if available as reference material
On-line Resources
Relevant review articles/research papers/handouts of latest development in the subject

Master of Science (Zoology)
M.Sc. Zoology Semester III

Course Code	PS03CZOO53	Title of the Course	Toxicology
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To learn about the dose-response relationships and understand the tocixity of various substances 2. To comprehend the knowledge of absorption, distribution, metabolism and elimination of xenobiotics 3. To provide an overview on legislative measures in the field of food, drugs and environmental toxciants

Course Content		
Unit	Description	Weightage* (%)
1.	Definition and scope of toxicology: Eco-toxicology and its environmental significance, Biochemical Aspects of Toxicology Toxic effects: Basic for general classification & nature. Measurement of Dose-Response Relationships, Synergism and Antagonism Acute and Chronic exposures, Factors influencing Toxicity. Pharmacodynamics & Chemodynamics, dose conversion between animals and human Diagnosis of toxic changes in liver and kidneys: Metabolism of drugs: paracetamol and aspirin with their toxic effects on tissues.	25
2.	Xenobiotics Metabolism: Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reaction/Conjugation: Methylation, Glutathione and amino acid conjugation. Detoxification. Biochemical basis of toxicity: Metabolism of Toxicity: Disturbances of Excitable membrane function. Altered calcium Homeostasis. Covalent binding of cellular macromolecules & Genotoxicity. Tissue specificity of Toxicity. Toxicity testing: Models for toxicity testing; Acute and Chronic toxicology testing, Experimental design; Genetic toxicity testing & Mutagenesis assays In vitro Test systems – Bacterial Mutation Test, Ames test, *In vivo* Mammalian Mutation tests –DNA repair assays, Chromosome damage test, Evaluation of Apoptosis and necrosis	25
3.	Pesticides: Insecticides: Organochlorines, Anti cholinesterases-Organophosphates and Carbamates, Fungicides: Captan, Di-thio carbamates, Herbicides:2,4 D, Atrazine; Food additives: Preservatives,	25

	Processing aids, Flavor and taste modifiers, Nutritional additives; Role of diet in cardio-vascular disease and cancer. Toxicology of food additives; Metal Toxicity: Toxicology of Arsenic, mercury, lead and cadmium.	
4.	Regulatory Toxicology: Rules and Regulations of Nuclear Regulatory Commission (NRC); Environmental Protection Agency (EPA); Food and Drug Administration (FDA); Drug Enforcement Administration (DEA); Occupational Safety and Health Assessment (OSHA); Committee for Purpose of Control and supervision of experimental on animals (CPCSEA)	25

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Learn the toxicity testing methods and designing of animal experimentations in pharmaceutical and drug industries or research organizations
2.	Correlate concentrations of doses, duration of exposure and animal responses

Suggested References:

Sr. No.	References
1.	Klaassen, C., D., (Ed) (2013). Casarett and Doull's toxicology : the basic science of poisons. McGraw-Hill Education, New York.
2.	Timbrell, J. A., (2008). Principles of biochemical toxicology. Taylor and Francis Ltd., London.
3.	Smart, R. C., Hodgson, E., (Ed.) (2013). Molecular and biochemical toxicology. John Wiley and Sons, Inc.
4.	Barley, F., (2007). Principles of Toxicity testing. CRC Press, New York

On-line resources to be used if available as reference material
On-line Resources
Relevant review articles/research papers/handouts of latest development in the subject

Master of Science Zoology
M.Sc. Zoology Semester (III)

Course Code	PS03CZOO54	Title of the Course	Lab-1
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To learn to determine concentration of blood parameters like glucose, lipid parameters, etc. 2. To correlate the developmental stages in frog and chick 3. To understand the sperm morphology, motility and vitality related aspects

PS03CZOO54 (Lab-1)

1. Determination of serum glucose by GOD/POD method
2. Estimation of total cholesterol, HDL, LDL
3. Demonstration of blood pressure using digital and conventional methods
4. Observation of anatomy slides
5. Comparison of bleeding and clotting time in male and female
6. Determination of Salivary Amylase activity
7. Oxygen saturation measurement using pulse oximeter
8. Measurement of muscle strength
9. Lung capacity measurement using spirometer
10. Observation of permanent slides of developmental stages of frog and chick
11. To study mammalian sperm:
    (a) Morphology and morphological abnormalities
    (b) Live: dead ratio
    (c) vitality
    (d) Acrosomal intactness
    (e) Mitochondrial activity
    (f) hypoosmotic test
    (g) Localization of DNA/RNA
12. Preparation of permanent slide of chick embryo
13. Demonstration of teratogenesis in chick embryo
14. Localization of enzymes in embryo
15. Study of permanent slides of mitosis and meiosis
16. Preparation of slide of Polytene chromosome from Chironomus larva
17. Study of developmental stages of drosophila

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Work with clinical samples and carry out analysis.
2.	Describe cleavage patterns, gastrulation and organogenesis processes

Suggested References:	
Sr. No.	References
1.	Pal, G., K., Pal, P., (2020). Textbook of Practical Physiology. 5th Edn. Universities Press (India) Pvt. Ltd., Hyderabad
2.	Marí-Beffa, M., Knight, J., (2011). Key Experiments in Practical Developmental Biology. 1st Edn. Cambridge University Press, United Kingdom

Master of Science Zoology
M.Sc. Zoology Semester (III)

Course Code	PS03CZOO55	Title of the Course	Lab-2
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To understand the basic principles and instrumentation of spectrophotometry 2. To learn the concepts of protein purification and quantification of major biomolecules

PS03CZOO55 (Lab-2 A)

1. To study Beer Lambert's Law using any color solution
2. To determine absorption maxima of a colored solution
3. Standard curve preparations for glucose, cholesterol, protein
4. To calculate isoelectric points of amino acids
5. Qualitative analysis of carbohydrates and proteins
6. Quantitative measurements of: Glycogen and Glucose
7. To analyze protein concentrations
8. To estimate lipids and total cholesterol levels

PS03CZOO55 (Lab-2 B)

Practicals related to elective papers

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%

3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Gain experience of correlating various biochemical solutions based on solubility, alkalinity and quantifications
2.	Describe significance of carbohydrates, proteins and cholesterol levels in biological samples

Suggested References:	
Sr. No.	References
1.	Godkar, P., B., (2020). Textbok of Medical Laboratory Technology. 3rd Edn. Bhalani Publishing House, New Delhi
2.	Marí-Beffa, M., Knight, J., (2011). Key Experiments in Practical Developmental Biology. 1st Edn. Cambridge University Press, United Kingdom

Master of Science (Zoology)
M.Sc. Zoology Semester III

Course Code	PS03EZOO51	Title of the Course	Biological Chemistry
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To understand fundamental aspects of bioenergetics and mechanism of enzymes 2. To learnt about structure and functions of proteins and amino acids 3. To study carbohydrate metabolic pathways and regulatory measurements 4. To gain knowledge related to lipid metabolism and monitoring parameters

Course Content		
Unit	Description	Weightage* (%)
1.	Matter and energy, Atomic structure, ions, electrolytes, free radicals, solutions, colloids, suspensions, chemical reactions, acids, bases, pH. Principles of Bioenergetics: Bioenergetics and Thermodynamics, ATP, Biological oxidation-reduction reactions. Enzymes: Nature, function, classification and nomenclature. Enzyme kinetics, mechanism of action, active sites, substrate binding, Regulation of enzyme activity. Chemistry and functions of Co-enzymes Oxidative phosphorylation and electron transport chain	25%
2.	Protein Metabolism: Proteins- structure, classification, properties, functions and degradation. Types and properties of amino acids. Nitrogen incorporation and excretion (Urea Cycle). Vitamins: Water and Fat-soluble vitamins, chemistry, occurrence and physiological role.	25%
3.	Carbohydrate Metabolism: Glycolysis pathway and regulation. Cori cycle, Gluconeogenesis, glycogenolysis and glycogenesis. Pentose phosphate pathway, Synthesis of complex polysaccharides-glycoproteins and proteoglycans.	25%
4.	Lipid Metabolism: Chemical nature of fatty acids, synthesis of fatty acids. Storage of fatty acids and utilization. Regulation of lipid metabolism. Biochemistry of phospholipids, cholesterol, sphingolipids, prostaglandins, thromboxanes and oxy eicosatetraenoic acids.	25%

Teaching-	Topics will be taught and discussed in interactive sessions using

Learning Methodology	conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to

1.	Explain various metabolic activities leading to synthesis or breakdown of different macromolecules
2.	Learn structural and functional correlations of major building blocks of human body
3.	Understand and explain the process of energy generation in the cell

Suggested References:

Sr. No.	References
1.	Nelson, D., L., Cox, M., (2013). Lehninger Principles of Biochemistry. 6th Edn. W. H. Freeman Publications, New York
2.	Stryer, L., (2002). Biochemistry- clinical companion. 5th Edn. H. Freeman & Co Ltd, New York
3.	Rodwell, V., Bender, D., Weil, A., P., Kennelly, P., Botham, K., (2015). Harper's Illustrated Biochemistry. 30th Edn. McGraw-Hill Education, India
4.	Voet, D., Voet, J., G., (2010). Biochemistry. 4th Edn. John Wiley & Sons, Inc, United States
5.	Zubay, G., (1997). Biochemistry. 4th Edn. Brown (William C.) Company, United States

On-line resources to be used if available as reference material
On-line Resources
Relevant review articles / research papers / handouts of latest development in the subject.

Master of Science (Zoology)
M.Sc. Zoology Semester III

Course Code	PS03EZOO52	Title of the Course	Aquaculture Technologies
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To understand culture practices of IMCs and shrimps/ prawns; and to get information on induced breeding techniques and hatchery management 2. To know the major diseases of cultivable fishes as well as shrimps and their management 3. To get the knowledge of fish nutrition and formulation of supplementary feed 4. To learn the importance of different molecular and cytogenetics techniques in aquaculture 5. To acquire information on recent developments in aquaculture

Course Content		
Unit	Description	Weightage* (%)
1.	Culture practices and induced breeding: Culture practices: Indian major carps and exotic carps; Shrimps and prawns. Induced Breeding: Hormonal regulation of gonadal development, Activity of Gonadotropin. releasing hormone, application of hormones in aquaculture. Sex determination and control. Induction of maturation and spawning.	25
2.	Diseases: Fish and Prawn/ Shrimp Diseases: Types of Diseases- viral, bacterial, fungal, protozoan and other parasitic diseases; Diagnosis; Control measures; Water quality parameters, Role of biopesticides; Application of monoclonal antibodies; Vaccines and immunostimulants; Drug resistance	25
3.	Fish nutrition: Aquafeed: Nutrition, Feed formulation, Feed additives, Alternative feed ingredients. Nutritional diseases of fish. Fish products and byproducts, fish processing, production of fish sauce by lactic acid fermentation. Microbial hazards in seafood.	25
4.	Cytogenetics and molecular techniques in fisheries: Comet Assay, Micronuclei Test, Fish Cell Culture, Application of Hybridoma Technology, Transgenesis and Androgenesis and recent developments in marine biotechnology. Inheritance of quantitative traits. Jellyfish Green Fluorescent Proteins and their applications.	25

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Learn culture techniques of economically important fish and shrimp species; and learning hypophysation technique
2.	Understand management of diseases in intensive aquaculture practices
3.	Correlate nutritional aspects of cultivable fish species with formulation of fish feed
4.	Apply the information of recent molecular and cytogenetics techniques for better management of aquaculture
5.	Gain knowledge of therapeutically active molecules in various diseases and other advanced applications

Suggested References:	
Sr. No.	References
1.	Jayaram, K., C., (1981). The fresh water fishes of India, Pakistan, Bangladesh, Burma

	and Sri Lanka. 1st Edn. Zoological Survey of India, Calcutta
2.	Jhingran, V. G. (1991). Fish and Fisheries of India. 3rd Edn. Delhi : Hindustan Publication Corporation, India
3.	Kurian, C., V., Sebastian, V., O., 1986. Prawns and Prawn fisheries of India. 5th Edn., Hindustan Publication Corporation, India
4.	Balakrishna Nair, N. and D.M. Thampy, 1980 A text Book of Marine Ecology, The Macmillan Co. of India Ltd., New Delhi.
5.	Lakra, W., S., Abidi, S., A., H., Mukherjee, S., C., Ayyappan, S., (2004). Fisheries Biotechnology. Narendra Publication House, Jammu.
6.	Pillay, T.,V., R., Kutty, M., N., (2012). Aquaculture – Principles and Practices. 2nd Edn. Blackwell Publishing, New Delhi

On-line resources to be used if available as reference material
On-line Resources
Relevant review articles/research papers/handouts of latest development in the subject

Master of Science (Zoology)
M.Sc. Zoology Semester III

Course Code	PS03EZOO53	Title of the Course	Bioinformatics
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To get knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics 2. To explore existing software effectively to extract information from large databases and to use this information in computer modelling 3. To get problem-solving skills, including the ability to develop new algorithms and analysis methods. 4. To train student for understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries.

Course Content		
Unit	Description	Weightage* (%)
1.	❖ Introduction to Bioinformatics: ▪ Introduction and Bioinformatics Resources: ▪ Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases: ▪ Describe about various approaches in genome sequencing and NGS ▪ Overview of Sequence trace files (or chomatograms) raw data output from sequencer machines, Assembling and storing of the sequencer data files. ▪ Nucleic acid sequence databases: GenBank, EMBL, DDBJ ▪ Protein sequence databases: SWISS-PROT, TrEMBL, PIR, PDB, SCOP, CATH ▪ Genome Databases at NCBI, EBI, TIGR, SANGER ▪ Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources) ❖ Sequence analysis: ▪ Various file formats for bio-molecular sequences: GENBANK, FASTA, GCG, MSF, NBRF-PIR etc. ▪ Basic concepts of sequence similarity, identity and homology, Definitions of homologues, orthologues, paralogues, xenologus. ▪ Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series. ▪ Database Searches: what are sequence-based database	25%

	searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA. ▪ Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA. ▪ Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results.	
2.	❖ Gene prediction: ▪ Gene structure in Prokaryotes and Eukaryotes, Gene prediction methods: Neural Networks, Pattern Discrimination methods, Signal sites Predictions, Evaluation of Gene Prediction methods. ❖ Computational RNA Structure analysis: ▪ Secondary and tertiary structure of RNA. Various algorithms of RNA folding and their analysis. Energy minimization in RNA folding. RNA sequence alignment based on secondary structure and its applications in functional genomics and phylogeny. ❖ Transcriptomics: ▪ Complete transcript cataloguing and gene discovery sequencing ▪ Microarray based technologies and computation based technologies	25%
3.	❖ Genomics: ▪ Concepts and tools for genomics and comparative Genomics ▪ Ancient conserved regions ▪ Horizontal gene transfer ▪ Functional classification of genes ▪ Gene order (synteny) is conserved on chromosomes of related organisms. ▪ Prediction of gene function based on a composite analysis. ▪ Functional genomics. ▪ Putting together all of the information into a genome database. ❖ Phylogenetic analysis: ▪ Definition and description of phylogenetic trees and various types of trees, Molecular basis of evolution, Method of construction of Phylogenetic trees: Distance based method (UPGMA, NJ), Character Based Method (Maximum Parsimony and Maximum Likelihood method).	25%
4.	❖ Proteomics and Protein Computational Biology: ▪ Tools for proteomics: Acquisition of protein structure information, databases and applications.	25%

	▪ Structural classification of proteins, Protein structure analysis structure alignment and comparison, ▪ Secondary structure and evaluation: algorithms of Chou Fasman, GOR methods. ▪ Tertiary Structure: Basic principles and protocols, Methods to study 3D structure; Prediction of specialized structures. Protein folding, Protein modelling, Method of protein structure evaluation; Active site prediction. ▪ Protein-protein and protein-ligand interaction/Docking; Drug Designing, QSAR studies. ❖ Protein structure comparison and classification: ▪ Classes, Folds, Motif, Domain; ▪ Purpose of structure comparison ▪ Algorithms such as FSSP, VAST and DALI. ▪ Principles of protein folding and methods to study protein folding.	

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Know about the basic concepts of Bioinformatics and its significance in Biological data analysis.
2.	Learn the basics and advance of sequence alignment and analysis.
3.	Get overview about biological macromolecular structures and structure prediction methods.

4.	Understand the structural organisation, structural properties and various techniques employed in the structure determination of Biological macromolecules – DNA & Protein.
5.	Exposure to computational methods, tools and algorithms employed for Biological Data Interpretation.
6.	Have hands on training on various computational tools and techniques employed in Biological sequence analysis.
7.	Get exposed to various tools and methodologies used in multiple sequence alignment, phylogenetic analysis and genetic diversity analysis observed in biological sequences.
8.	Knowledge on chemical databases, various advanced techniques and tools like docking, QSAR studies etc employed in computational drug discovery.
9.	Knowledge about various approaches in genome sequencing and NGS.

Suggested References:

Sr. No.	References
1.	Clavarie, J. M., Notredame, C., (2003). Bioinformatics: A Beginners Guide. Wiley India Private Limited. Uttarpradesh
2.	Mount, D., W., (2004). Bioinformatics: Sequence and Genome Analysis. 2nd Edn. Cold Spring Harbor Laboratory Press. United States.
3.	Rastogi, S.C., Mendiratta, N, Rastogi, P., (2013). Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery. 4th Edn. Prentice Hall India Learning Private Limited, New Delhi
4.	Lesk, A., M., (2013). Introduction to Bioinformatics. 4th Edn. Oxford University Publications, India
5.	Ghosh, Z., Mallick, B., (2008). Bioinformatics: Principles and applications. Illustrated Edition. Oxford University Press, India
6.	Orengo, C., Jones, D., Thornton, J., (2002). Bioinformatics: Genes, Proteins and Computers. 1st Edn. Taylor and Francis Publications, United Kingdom
7.	Webster, D., (2000). Protein structure prediction, methods and protocols. 1st Edn. Humana Press, New Jersey

On-line resources to be used if available as reference material

On-line Resources

Nucleotide Sequence Databases (the principal ones)

- NCBI - National Center for Biotechnology Information
- EBI - European Bioinformatics Institute
- DDBJ - DNA Data Bank of Japan

Protein Sequence Databases

- SWISS-PROT & TrEMBL - Protein sequence database and computer annotated supplement
- **UniProt** - UniProt (Universal Protein Resource) is the world's most comprehensive catalog of information on proteins. It is a central repository of protein sequence and function created by joining the information contained in Swiss-Prot, TrEMBL, and PIR.
- PIR - Protein Information Resource
- MIPS - Munich Information centre for Protein Sequences
- HUPO - HUman Proteome Organization

Database Searching by Sequence Similarity

- BLAST @ NCBI
- PSI-BLAST @ NCBI
- FASTA @ EBI
- BLAT Jim Kent's Blat is just superb in terms of speed and the integrated view you get for viewing the results

Sequence Alignment

- USC Sequence Alignment Server - align 2 sequences with all possible varieties of dynamic programming
- T-COFFEE - multiple sequence alignment
- ClustalW @ EBI - multiple sequence alignment
- MSA 2.1 - optimal multiple sequence alignment using the Carrillo-Lipman method
- BOXSHADE - pretty printing and shading of multiple alignments
- Splign - Splign is a utility for computing cDNA-to-Genomic, or spliced sequence alignments. At the heart of the program is a global alignment algorithm that specifically accounts for introns and splice signals.
- Spidey - an mRNA-to-genomic alignment program

Protein Domains: Databases and Search Tools

- InterPro - integration of Pfam, PRINTS, PROSITE, SWISS-PROT + TrEMBL
- PROSITE - database of protein families and domains
- Pfam - alignments and hidden Markov models covering many common protein domains
- SMART - analysis of domains in proteins
- ProDom - protein domain database
- PRINTS Database - groups of conserved motifs used to characterise protein families
- Blocks - multiply aligned ungapped segments corresponding to the most highly conserved regions of proteins

Protein 3D Structure

- PDB - protein 3D structure database
- RasMol / Protein Explorer - molecule 3D structure viewers
- SCOP - Structural Classification Of Proteins
- UCL BSM CATH classification

- The DALI Domain Database
- FSSP - fold classification based on structure-structure alignment of proteins
- SWISS-MODEL - homology modeling server
- Structure Prediction Meta-server
- K2 - protein structure alignment
- DALI - 3D structure alignment server
- DSSP - defines secondary structure and solvent exposure from 3D coordinates
- HSSP Database - Homology-derived Secondary Structure of Proteins
- PredictProtein & PHD - predict secondary structure, solvent accessibility, transmembrane helices, and other stuff
- Jpred2 - protein secondary structure prediction
- PSIpred (& MEMSAT & GenTHREADER) - protein secondary structure prediction (& transmembrane helix prediction & tertiary structure prediction by threading)

Phylogeny & Taxonomy

- The Tree of Life
- Species 2000 - index of the world's known species
- TreeBASE - a database of phylogenetic knowledge
- PHYLIP - package of programs for inferring phylogenies
- TreeView - user friendly tree displaying for Macs & Windows

Gene Prediction

- Genscan - eukaryotes
- GeneMark
- Genie - eukaryotes
- GLIMMER - prokaryotes
- tRNAscan - SE 1.1 - search for tRNA genes in genomic sequence
- GFF (General Feature Format) Specification - a standard format for genomic sequence annotation

Metabolic, Gene Regulatory & Signal Transduction Network Databases

- KEGG - Kyoto Encyclopedia of Genes and Genomes
- BioCarta
- **DAVID** - **D**atabase for **A**nnotation, **V**isualization and **I**ntegrated **D**iscovery - A useful server to for annotating microarray and other genetic data.
- stke - Signal Transduction Knowledge Environment
- BIND - Biomolecular Interaction Network Database
- EcoCyc
- WIT
- **PathGuide** A very useful collection of resources dealing primarily with pathways
- SPAD - Signaling Pathway Database
- CSNDB - Cell Signalling Networks Database
- PathDB
- Transpath
- DIP - Database of Interacting Proteins
- PFBP - Protein Function and Biochemical Networks