RAJARSHI SHAHU MAHAVIDYALAYA, LATUR

(Autonomous)

(BoS in ZOOLOGY)

CHOICE BASED CREDIT SYSTEM
(CBCS)
SEMESTER PATTERN
(W.e.f. Academic Year 2019-20)

SYLLABUS FOR M.Sc.-IEXAMINATION
M.Sc. ZOOLOGY

JUNE -2019

Rajarshi Shahu Mahavidyalaya, (Autonomous), Latur
Department of Zoology and Fishery Science
Syllabus outline of M. Sc. Zoology First Year
Effective from Academic Year 2019-20

Semester - I

Semester	Course Code	Course Name	Marks		Total	
			Internal	End Semester	Marks	Credits
Semester - I	**Core Course (CC) (Compulsory Course)**					
	P-SFI- 181	Structure and Function in Invertebrates	40	60	100	4
	P-TTB-182	Tools and Techniques in Biology	40	60	100	4
	P-CBI -183	Cell Biology	40	60	100	4
	P-BIO-184	Biochemistry	40	60	100	4
	Practical / Lab Course					
	P-LC-185	Lab Course I Based on P-SFI- 181	20	30	50	2
	P-LC-186	Lab Course II Based on P-TTB-182	20	30	50	2
	P-LC-187	Lab Course III Based on P-CBI-183	20	30	50	2
	P-LC-188	Lab Course IV Based on P-BIO-184	20	30	50	2
	P-TP-189	Seminars	25	-	-	1
		Total(I)			625	25

Semester – II

Semester	Course Code	Course Name	Marks		Total	
			Internal	End Semester	Marks	Credits
Semester - II	**Core Course (CC) (Compulsory Course)**					
	P-CAV-281	Comparative Anatomy of Vertebrates	40	60	100	4
	P-MBI-282	Molecular Biology	40	60	100	4
	P-GRD-283	Genetics and r-DNA Technology	40	60	100	4
	P-BTA-284	Biosystematics and Taxonomy	40	60	100	4
	Practical / Lab Course					
	P-LC-285	Lab Course V Based on P-CAV-281	20	30	50	2
	P-LC-286	Lab Course VI Based on P-MBI-282	20	30	50	2
	P-LC-287	Lab Course VII Based on P-GRD-283	20	30	50	2
	P-LC-288	Lab Course VIII Based on P-BTA-284	20	30	50	2
	P-SEM-289	Seminars	25	-	-	1
		Total(II)			625	25
		Total (Sem I + Sem II)			1250	50

M. Sc. ZOOLOGY-I (SEM-I)

Course Code: P-SFI- 181

Course: Structure and functions in invertebrates

Total Teaching hours: 60 **Marks: 100**

Learning Objectives

- To understand the systematic position, functional morphology, mode of life of invertebrates.
- To understand evolution and origin of invertebrates.
- To understand biodiversity and affinity of invertebrates.

Learning Outcomes:

After completion of this course students should be able to:

- Classify Protista to phylum Echinodermata by using examples.
- Describe characters of protista to phylum Echinodermata.
- Explain origin and evolution of different phyla of invertebrates.
- Describe life cycles of different invertebrates.

UNIT I: Protista, Parazoa, Metazoa and Porifera

- General characteristics and Classification up to classes
- Study of Euglena, Amoeba and Paramecium
- Life cycle and pathogen city of Plasmodium vivax and Entamoeba histolytica
- Locomotion and Reproduction in Protista
- Evolution of symmetry and segmentation of Metazoa
- Canal system and Spicules in sponges

UNIT II: Cnidaria, Ctenophora and Platyhelminthes

- General characteristics and Classification up to classes
- Metagenesis in Obelia
- Polymorphism in Cnidaria
- Corals and coral reefs
- Life cycle and pathogenicity of Fasciola hepatica ,Taenia solium
- Parasitic adaptations in helminthes
- Introduction to Coelomates
- Evolution of coelom and metamerism

UNIT III: Nematohelminthes, Annelida, Arthropoda and Onychophora

- General characteristics and Classification up to classes
- Life cycle and pathogen city of Ascaris lumbricoides and Wuchereria bancrofti
- Excretion in Annelida
- Vision and Respiration in Arthropoda
- Metamorphosis in Insects Social life in bees and termites
- Evolutionary significance of Onychophora

UNIT IV: Mollusca and Echinodermata

- General characteristics and Classification up to classes
- Respiration in Mollusca Torsion and distortion in Gastropod
- Pearl formation in bivalves
- Evolutionary significance of trochophore larva
- Water-vascular system in Asteroidea
- Larval forms in Echinodermata
- Affinities with Chordates

Reference books

1. Hyman L.H. 'The Invertebrates. Vol I-Protozoa through Ctenophora', McGraw Hill Co, New York.
2. Hyman, L.H. 'The Invertebrates Vol-II', McGraw Hill Co., New York.
3. Hyman, L.H. 'The Invertebrates. Vol-VIII', McGraw Hill Co., New York and London.
4. Barnes, R.D. 'Invertebrate Zoology, 3rd edition', W.B. Saunders Co., Philadelphia.
5. Barrington, E.J.W. 'Invertebrate Structure and Function', Thomas Nelson and Sons Ltd., London.
6. Sedgwick, A.A. 'Students Text Book of Zoology', Vol. I, II and III. Central Book Depot, Allahabad.
7. Parker, T.J., Haswell, W.A. 'Text Book of Zoology', Macmillan Co., Lon

M. Sc. ZOOLOGY-I(SEM-I)

Course code: P-TTB-182

Course : Tools and Techniques in Biology

Total Teaching Hours: 60 **Total Marks: 100**

Learning Objectives:

- To understand Microscopes and Microscopic Techniques
- To understand chromatography and spectroscopy.
- To understand Electrophoretic technique, Centrifugation, Microtomy and Cry technique

Learning Outcomes:

After completion of this course students should be able to:

- Explain the concepts of microscopy and different types of microscopes.
- Describe various separation techniques
- Describe the basic principle of spectrometry and radiography.
- Explain the electrophoresis, Microtomy and Cry technique and centrifugation.

UNIT I: Microscopes and Microscopic Techniques

- **Fundamentals of optical microscopy:**
- Introduction to optics scales of magnification and limits of resolution,
- Microscope designs and types, imaging components and image formation
- Abbe's theory of microscopic resolution.
- **Contrast in Microscopy:**
- Fundamentals of contrast modulation in bright-field and dark-field, Concept of phase differences, Phase contrast microscopy, Applications
- **Light Microscope :**
- Compound and Inverted microscope, Florescence microscopy in brief
- **Electron Microscopy:**
- SEM, and TEM
- Microscopic image documentation in brief

UNIT II: Chromatography

- Adsorption chromatography
- Partition chromatography
- Ion-exchange chromatography
- Affinity chromatography
- Molecular exclusion chromatography
- Thin layer chromatography
- HPLC, FPLC, selection of chromatographic system.

UNIT III: Spectrophotometry

- UV-visible light spectroscopy
- Spectroflourimetry
- Infrared and Raman spectroscopy
- Nuclear magnetic resonance spectroscopy
- Applications in biology
- Radioisotopes Technique:
- Nature of radioactivity, detection and measurement of radioactivity, counting radioactivity, applications of radioisotopes in biology.

UNIT IV: Electrophoretic technique, Centrifugation, Microtomy and Cry technique

- General principles, Support media, electrophoresis of proteins and nucleic acids, Capillary electrophoresis.
- Centrifugation: Basic principles of sedimentation, Types of centrifuges, Analytical Centrifugation, Preparative centrifugation.
- Microtome: Types and applications. Collection & preservation of animal tissue – fixation, embedding, Sectioning, Staining, Identification of deferent components. Tissue preparation for light microscopy. Cry techniques: History and applications of Cry techniques, Cryoultramicrotomy.

Reference books

1. Principles and Techniques in biochemistry and molecular biology Wilson & Walker
2. Sharma V.K. (1991), Techniques in microscopy and cell Virology, Tata-Mc Craw Hill.
3. Robert Braun Introduction to instrumental analysis Mc.Crew.Hill
4. Bisen & Mathew. Tools and Techniques in Life Sciences, CBS Publishers & distributors.

M. Sc. ZOOLOGY-I(SEM-I)

Course code: P-TTB-182

Course : Cell Biology

Total Teaching Hours: 60 **Total Marks: 100**

Learning Objectives:

The learning objectives of this course are:

- To understand types of cells, cell membrane and membrane transportation.
- To understand intracellular compartment and protein sorting.
- To understand cell signaling, cell interactions and cytoskeleton.
- To understand cell cycle, apoptosis and cancer

Learning Outcomes:

After completion of this course students should be able to:

- Describe ultra structure of prokaryotic and eukaryotic cells
- Describe cellular membrane structure membrane transport.
- Explain intracellular compartments and protein sorting.
- Describe cell Signaling, cell interactions and cytoskeleton.
- Explain cell cycle, apoptosis and cancer

UNIT I: Introduction to Cell biology and Bio membranes.

- Discovery of cell, cell theory, prokaryotes and eukaryotes, evolution of eukaryotic cell.
- **Structural organization :** of virus, bacteria and eukaryotic cell- ultra structure of animal cell.
- **Bio membranes:** chemical composition and molecular arrangement (lipid bilayer, membrane proteins and carbohydrates), models of membranes (fluid mosaic).
- **Membrane Transport:** Diffusion (simple and facilitated) and active transport (primary and secondary), carrier proteins (uni, sym and antiporters), channel proteins (voltage and ligand gated). Bulk transport-Pinocytosis Phagocytosis and exocytosis, Receptor mediated endocytosis.

UNIT II: Intracellular Compartments and Protein sorting

- Synthesis of proteins on free and bound ribosomes, signals for protein sorting.
- Nucleus: components, nuclear pore complex, organization of chromatin- nucleosomes, chromosomes, export and import of proteins
- Mitochondria structure and functions
- Endoplasmic reticulum (types): signal peptide hypothesis, insertion of membrane proteins and glycosylation.
- Golgi (cis and Trans): secretory and lysosomal proteins. Glycosylation of proteins.

UNIT III: Cell Signaling, Cell interactions and Cytoskeleton.

- Cell surface receptors: G-protein linked receptors, signal transduction, second messengers, receptor tyrosine kinases and intracellular receptors.
- Cell junctions: tight junction, desmosome, hemi desmosome and gap junctions.
- Cell adhesion molecules: cadherin, Immunoglobulin like molecules, integrin and selectins. Cytoskeleton: Microtubules, microfilaments and their dynamics. Centrosome, cilia, flagella.
- Mitotic apparatus and movement of chromosomes.

UNIT IV: Cell cycle, Apoptosis and Cancer

- Phases of cell cycle. Regulation of cell cycle: Discovery of MPF, cyclins and cyclin dependent kinases, Check points- role of Rb and p53.
- Cancer. Types and stages. Tumor suppressor genes and proto-oncogenes.
- Molecular basis of cancer.
- Apoptosis: Neurotropic factors, caspases, Pathways of apoptosis.
- Cell senescence, telomerase

Reference books

1. Molecular all biology: Lodish, etal.
2. Molecular all biology: Bruce Alberts, etal
3. Cell Biology: De Roberts.
4. Cell and molecular biology: Gerald karp
5. Molecular cell biology : David Baltimore.
6. Cell Biology : Rostogi

M. Sc. ZOOLOGY-I (SEM-I)

P-CBI -184

Biochemistry

Total Teaching Hours: 60 **Total Marks: 100**

Learning Objectives:

- To understand the structure and biological significance of carbohydrates, amino acids,• proteins, lipids and nucleic acids.
- To understand Carbohydrate, Lipid, protein and nucleic acid metabolism and its regulation.
- To understand the concept of enzyme, its mechanism of action and regulation.
- To understand classification, mechanism, coenzyme, Isoenzyme and factor affecting on enzyme action.

Learning Outcomes:

After completion of this course students should be able to:

- Comprehended the energy source, chemical bonds and the principles of thermodynamic
- Attained the knowledge of macromolecule such as carbohydrates, protein and fat, their types and functions.
- Understood the knowledge of cholesterol and its biological significance
- Enable the students to illustrate various Biochemical pathways.
- Described the enzymes, mechanism of enzyme action and factors affecting the enzyme Activity

UNIT I: Biomolecules

- **Characteristic features**: Water, structure of liquid water, water as ideal biological solvent. Problems and concepts related to mole, molarity, normality, buffers etc. Thermodynamics: Laws of thermodynamics, free energy, entropy, high energy bonds.
- **Amino acids, peptides and polypeptides**: The three dimensional structures of proteins, the Ramachandran plot, α helix, β sheet. Structure of collagen, domain – basic unit of tertiary structure, quaternary structure, Functional diversity of proteins.
- **Carbohydrates:** Monosaccharides, disaccharides and polysaccharides, structure and function
- **Lipids**: Chemistry of triglycerides, sterols, quinones and prostaglandins.
- **Nucleotides**: Structure, function, properties and types of Nucleic acid. The RNA world.

UNIT II: Carbohydrate and Lipid metabolism

- Glycolysis, glycogenolysis, gluconeogenesis, pentose phosphate pathway, glucoronic acid pathway (emphasis on regulation)
- **Citric acid cycle**: Cyclic overview and reactions. Metabolic sources of acetyl CoA. Regulation and amphibolic nature of the cycle. Glyoxylate cycle
- **Dark reactions of Photosynthesis**: CO2 fixation: C3, C4 and CAM pathways.

UNIT III: Lipid and protein metabolism

- **Lipid Metabolism**: β oxidation of unsaturated and saturated fatty acid and its regulation.
- Propoinyl CoA metabolism, significance of ketone bodies, Biosynthesis of palmitate and its regulation. Mitochondrial and microsomal pathways of chain elongation, long term dietary changes and enzyme level.
- **Metabolism of cholesterol**: Biosynthesis of cholesterol and its regulation, lipoprotein metabolism, chylomicrons, LDL, HDL, VLDHL.
- **Amino acid metabolism**: Transamination, deamination, Fate of amino acid skeleton, urea cycle, precursors for compounds other than proteins, Genetic diseases.

UNIT IV: Nucleotide Metabolism and Enzymology

- **Nucleotide Metabolism**: Salvage and de novo pathways of purine and pyrimidine nucleotide biosynthesis. Formation of deoxyribonucleotides, origin of thymine.
- **Enzymology**:
- Classification, Units, Specific Activity, Coenzymes.
- Kinetics of enzyme catalyzed reactions, Effect of pH, Inhibitor, Activator.
- Regulation of enzyme activities. , Isoenzyme: structure and function

- Isoenzyme: structure and function

Reference Books:

1. Biochemistry, 3rd Ed. (2005), Voet Donald and Voet Judith G. John, Publisher: Wiley & sons, New York. 2. Biochemistry 6th Ed, (2007) Berg Jeremy, Tymoczko John, Stryer Lubert, Publisher: W. H. Freeman, New York.
3. Lehninger's Principles of Biochemistry, 4th edition, (2005) Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY.
4. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
5. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.

M. Sc. ZOOLOGY-I (SEM-I)

Course Code: P-LC -185

Lab. Course : Structure and Function in Invertebrates

Total Teaching Hours: 30 **Total Marks: 50**

Learning Objectives:

- To understand the mounting techniques to identify the microscopic organism.
- To enable the students to identify and study about different species of Invertebrates and their phylogenetic, morphological, ecological and pathological significance.
- To understand the helminthes and coral diversity

Learning Outcomes:

After completion of this course students should be able to:

- Perform staining and mounting technique for identification of microscopic organisms.
- Identify protista diversity of pond.
- Identify and classify of different invertebrates

PRACTICALS

1. Study of whole mount of Euglena, Amoeba and Paramecium, Binary fission and Conjugation in Paramecium
2. Examination of pond water collected from different places for diversity in protista
3. Study of Sycon (T.S. and L.S.), Hyalonema, Euplectella, Spongilla
4. Study of Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora
5. One specimen/slide of any ctenophore
6. Study of adult Fasciola hepatica, Taenia solium and their life cycles (Slides/microphotographs)
7. Study of adult Ascaris lumbricoides and its life stages (Slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

M. Sc. ZOOLOGY-I (SEM-I)

Course Code: P-LC -186

Lab. Course: Tools and Techniques in Biology

Total Teaching Hours: 30 **Total Marks: 50**

Learning Objectives:

- To understand the handling of different types of Microscope .
- To understand various analytical techniques like chromatography , electrophoresis and ,colorimeter, spectroscopy.
- To understand the helminthes and coral diversity

Learning Outcomes:

After completion of this course students should be able to:

- Perform staining and mounting technique for identification of microscopic organisms.
- Identify protista diversity of pond.
- Identify and classify of different invertebrates

Practicals of Tools and Techniques in Biology:

1. Components of light microscopy, upright and inverted microscopes, episcopic and Diascopic microscopic alignment. Different types of lenses, Numerical apertures
2. Handling and adjustment of microscopic components, Method of Koehler illumination, Interpupillary and diopter adjustment. Microscopic image documentation techniques. Other techniques related practical
3. Study of pH of a solution/sample by using pH meter
4 .Gel filtration
5 .Ion exchange chromatography
6 .Density gradient centrifugation
7 .Thin layer chromatography
8 .Radioactivity based problems
9. Separation and analysis of DNA by using agarose gel electrophoresis.
9. Separation of protein by electrophoresis (native and SDS page)
10. Spectroscopy based practicals about study of biomolecules
    Colorimeter, UV-Visible spectrophotometer, FTIR
11. Study of histology of animal tissues by using microtome techniques.

M. Sc. ZOOLOGY-I (SEM-I)
Course Code: P-LC -187
Lab. Course: Cell Biology

Total Teaching Hours: 30 **Total Marks: 50**

Learning Objectives:

- To understand the microtechniques like squash preparation ,Smear preparation etc .
- To understand various cytological techniques like fractionation
- To understand the different functions of plasma membrane like Phagocytosis and pinocytosis etc.
- To understand the Percent Hemolysis and the Osmotic Fragility of Erythrocytes

Learning Outcomes:

After completion of this course students should be able to:

- Differentiate the cells of various living organisms and get awareness of physiological processes of cell e.g. cell divisions.
- Students will be able to observe and correctly identify different cell types, cellular structures using different microscopic techniques.
- Perform staining and mounting technique for identification of different stages of cell Division
- Describe cellular membrane structure membrane transport.

Practicals:

1. Observation of a Eukaryotic cell under higher microscope.
2. Preparation of mitotic chromosomes from roots tips.
3. Preparation of meiotic Chromosomes from testis of grasshopper/fresh onion buds
4. Membrane fragility as a measure of osmotic tolerance
6. Isolation and determination of number of mitochondria
7. Subcelluar fractionation: nuclei, mitochondria Cytosol and assaying functional identification of mitochondria. (2P)
8. Mitosis: Effect of colchicines on mitosis and polyploidy. (1P)
9. Meiosis I and II. (1P)
10. Preparation of blood smears: Cell type identification and differential counts. (1P)
11. Study of Phagocytosis / Pinocytosis. (1P)
12. EM – interpretation of cellular ultra-structure. (1P)
13. To study lipid solubility of membrane. (1P)
14. Determination of Absorption spectrum of hemoglobin (Hb) in Fe2+ and Fe3+ state. (1P)
15. Determination of Percent Hemolysis and the Osmotic Fragility of Erythrocytes. (1P)

M. Sc. ZOOLOGY-I (SEM-I)

Course Code: P-LC -188

Lab. Course: Biochemistry

Total Teaching Hours: 30 **Total Marks: 50**

Learning Objectives:

- To understand the preparation of acid and alkali solution, and measuring pH.
- To understand the concepts of preparation of buffers.
- Determine presence of macrmolecules like carbohydrates, proteins, lipids, etc. in known and unknown samples.
- To estimate micromolecules such as glucose, Amino acids, Nitrogenous bases from unknown samples.

Learning Outcomes:

After completion of this course students should be able to:

- Prepare acid, alkali solution of different normality, molarity, and concentration.
- Prepare different types of buffer solution.
- Analysis different macromolecules and micromolecules

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1 Basic and standardization Methods. (3P)

- Preparation of Acid and Alkali solutions and acid-base titration.
- Concept of pH. Measuring pH of different solutions
- Preparation of buffers: Acetate, Phosphate and Tris buffers

2 Estimation of micromolecules. (4P)

- Estimation of inorganic phosphate
- Estimation of sugar (glucose)
- Estimation of Amino acid (Tyrosine)
- Estimation of Base (Guanine)

3 Estimation of macromolecules. (3P)

- Determination of Blue Value of Starch
- Estimation of Proteins
- Estimation of nucleic acids (DNA)

4 Separation of micromolecules by paper chromatography. (3P)

- Sugars
- Amino acids
- Nitrogenous Bases

5 Enzyme kinetics. (3P)

- Determination of Units and specific activity of an enzyme
- Determination of Km and Vmax of an

M. Sc. ZOOLOGY-I (SEM-II)

Course Code: P-LC -281

Course: Comparative Anatomy of Vertebrates

Total Teaching Hours: 60 **Total Marks: 100**

Learning Objectives:

- To understand the systematic position, functional morphology, mode of life of Chordata.
- To understand evolution and origin of chordates.
- To understand comparative functional anatomy from Pisces to mammals

Learning Outcomes:

After completion of this course students should be able to:

- Classify Protista to phylum Echinodermata by using examples.
- Develop an understanding of the origin and evolution of chordates thus integrating structure, function and development
- Explain comparative functional anatomy from Pisces to mammals

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UNIT I: **Origin of Chordates**

- **Protochordata:** Hemichordata, Urochordata and Cephalochordata.
- **Amphioxus :** a generalized chordate ,The origin of chordates from filter feeding animals
- The vertebrates without jaws: - Lampreys
- Diversity and classification of vertebrates
- **Fishes:** History of fishes, Diversity and classification, General characteristics of fishes.
- **Amphibians:** History of amphibians, Diversity and classification, General characteristics of Amphibians.

UNIT II: Anatomy of Chordates

- **Reptiles:** History of reptiles, Diversity and classification, General characteristics of Reptiles
- **Aves:** History of birds, Diversity and classification, General classification of birds.
- **Mammals:** History of mammals, Diversity and classification, General characteristics of Mammals.
- **The Human condition:** Rise of the cultural Ape –Rise of primates, Diversity and classification of primates, General characteristic of Primates, Rise of the speaking bipedal tribal ape –Point(S) of origin? Earliest Hominins, Australopithecines, Origin of Homo.

UNIT III: Comparative functional anatomy from Pisces to mammals

- Integumentary system: Integument and its derivatives.
- Skeletal system
- Locomotary organs
- Nervous system: brain, spinal cord and peripheral nerves; cranial nerve sense organs
- Respiratory systems
- Circulatory system: Heart and aortic arches

UNIT IV: **Comparative functional anatomy and adaptation from Pisces to mammals**

- Digestive and excretory system
- Reproductive system comparison of male and female reproductive systems
- Special salient features and adaptations in vertebrates
- Pisces: Locomotion and migration Amphibians: Parental care and Paedomorphosis
- Reptilia: Adaptive radiation in reptiles Aves: Flight adaptation and migration
- Mammalia: Dentition, general features of egg laying mammals, pouched-mammals, Aquatic mammals, Adaptive radiation in mammals

Reference Books:

- Life of vertebrates by J.Z. Young
- An Introduction to Zoology –Investigating the Animal world by Joseph T. Springer and Dennis Holley

- A textbook of zoology Vol. IIby Parker and Haswell (revised by Marshall)
- Comparative vertebrate anatomy by Hyman.
- Vertebrate structure and function by Waterman.
- Evolution of vertebrates by E.H. Colbert. Vertebrates –R. L. Kotpal
- Chordate Zoology E. L. Jordan & P. S. Verma Vertebrate Zoology & Evolution –Yadav B. N. & D. Kumar

M. Sc. ZOOLOGY-I (SEM-II)
Course Code: P-LC -282
Course: Molecular Biology

Total Teaching Hours: 60 **Total Marks: 100**

Learning Objectives:

- To understand the Genome organization and DNA Replication.
- To understand DNA damage and repair:
- To understand transcription and translation regulations in prokaryotes and eukaryotes.
- To understand translational regulation

Learning Outcomes:

After completion of this course students should be able to:

- Describe genome organization
- Explain the molecular events in DNA replication
- Explain the DNA damage and repair.
- Explain the transcription and translation regulations in prokaryotes and eukaryotes.
- Explain the translational regulation

UNIT I: Genome organization and DNA Replication:

- C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence
- Organelle genome- Structure of chromatin, nucleosomes, chromatin organization and remodeling, higher order organization - chromosome, Centromere, telomere Histone and its effect on structure and function of chromatin
- 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.

UNIT II: DNA damage and repair:

- Eukaryotic DNA replication, multiple replicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC), regulation of replication
- Different types in DNA damages,
- Different DNA repair systems: Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair.
- Homologous and site specific recombination
- Transposable DNA elements

UNIT III: Transcription and translation regulations in prokaryotes and eukaryotes.

- **Activating transcription**: Transcription activating factors, Different domains in transcription factors, Mechanism of transcription activation, response elements recognized by activators.
- **RNA processing Splicing**: Nuclear pre-mRNA splicing - spliceosomes, alternative splicing, trans splicing tRNA splicing, rRNA splicing - autosplicing in group I and group II introns. Editing: types of editing gRNA mediated editing, enzyme mediated editing 3'processing: Polyadenylation, PARP, Poly (A) signal,

UNIT IV: Translational regulation

- mRNA stability, half-life- polyadenylation, polysome formation mRNA structure-3' and 5' UTRs CAP mRNA stability 5'Processing: Capping, importance of capping, mechanism of capping independent, CAP dependent translation, IRE sites, multiple ORFs, 5' and 3' structures formed, role of initiation and elongation factors
- Mechanism of global and mRNA specific regulation of translation: Initiation by eIF2, cap binding protein assembly, IRE mediated regulation, mRNPs –as trans regulating proteins, miRNA mediated regulation
- mRNA localization and regulation of translation, protein degradation and regulation of translation

Reference books:

1.Genes IX, 9th edition (2008), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc.
2.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.
3. Molecular Biology, 4th Edition (2007), Weaver R., Publisher-McGrew Hill Science.
4. Molecular Biology of the Cell, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.

M. Sc. ZOOLOGY-I (SEM-II)
Course Code: P-LC -283
Course: Genetics and r-DNA Technology

Total Teaching Hours: 60 **Total Marks: 100**

Learning Objectives:

- To understand the Mendel's Laws of inheritance.
- To understand the function of gene chromosome theory of inheritance
- To understand sex linked genes and chromosomal mutations.
- To understand the principles of recombinant DNA technology
- To understand the methods and applications of rDNA Technology

Learning Outcomes:

After completion of this course students should be able to:

- Apply the principles of Mendelian inheritance.
- Explain the fine structure and molecular aspects of genetic material.
- Understand the cause and effect of alterations in chromosome number and structure.
- Relate the conventional and molecular methods for gene manipulation in other biological systems.
- Discuss and analyse the epigenetic modifications and imprinting and its role in diseases.
- Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, etc.

UNIT I: Transmission Genetics

- History of Genetics, Scope and significance of genetics, Mendel's Experiments, Symbols and terminology, Principle of dominance and segregation, Principle of independent assortment, Mendelian inheritance and probability.
- **Allelic variation and gene function**- Incomplete dominance, co-dominance, multiple alleles
- Gene action-from genotype to phenotype. Gene interaction, penetrance, expressivity, Epistasis, pleiotropic, interaction with environment.Genomic imprinting, Continuous variation, Quantitative traits and significance of polygenic control.
- **Chromosomes** – chromosome number, sex chromosome
- **Chromosome theory of inheritance** - Experimental evidence, non-disjunction as proof of chromosome theory, genic balance theory. Sex chromosome and sex determination - Human, Drosophila, other animals.

Unit II: Sex linked Genes and Chromosomal mutations.

- **Sex linked genes in humans** - Hemophilia, colour blindness.
- **Dosage compensation of X- linked genes**. Hyper activation of X-linked gene in male drosophila, Inactivation of X-linked gene in female.
- **Maternal Inheritance**- Mitochondrial- Snail, poky and petite Chloroplast – leaf variegation in Mirabilis Jalapa, Lojap.
- Morphology of chromosomes, Structural and Numerical Variations
- Linkage, Recombination, Crossing over (Mitotic crossing over), Chromosome mapping (two point and three point test cross).
- Mutation: Mutagens, Spontaneous and induced Mutation, gene mutations-Point Mutations.
- Microbial Genetics: Conjugation, Transformation and transduction Phenomenon and mapping.

Unit III: Principles of Gene Manipulation.

- Basic recombinant DNA techniques, cutting and joining DNA molecules, restriction modification systems,
- various enzymes used in recombinant DNA technology
- Restriction maps and mapping techniques; nucleic acid probes, blotting techniques, DNA fingerprinting, foot printing, methyl interference assay.
- Polymerase chain reaction: methods and applications.

Unit IV: Methods and Applications of rDNA Technology

- **Basic biology of cloning vectors**: plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, expression vectors and other advanced vectors in use.
- Gene cloning strategies: methods of transforming E. coli and other cells with rDNA; methods of selection and screening of transformed cells; construction of genomic and cDNA libraries;
- **Principles of DNA sequencing** – Sanger and Maxmam Gilbert DNA sequencing, automated sequencing methods; synthesis of oligo-nucleotides, primer design;
- **Changing genes**- gene transfer to animal cells, genetic manipulation of animals, transgenic technology, application of recombinant DNA technology; genetically modifed organisms: gene knockouts, mouse disease models, gene silencing , CRISPRCAS- 9 genome editing

References:

1. Principles of Genetics by Robert H. Tamarin. Tata-McGraw Hill, Seventh Edition 2002).
2. Genetics, Principles and Analysis by Daniel Hartl & E.W. Jones. 4th Edition 1998; Jones & Barlett Publication.
3.The science of Genetics by Atherly, A. G. Girton, J. R & MC Donald, J. F. (1999) Saunders College Publications / Harcourt Brace.
4. Genetics – M.W. Strickberger Macmillan Publications New York. • Snustad D P, M J Simmons and J P Jenkins, 1997. Principles of Genetics. John Wiley and Sons, INC.
5.Griffiths A J F, H. J. Muller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart, 2000. An introduction to genetic analysis. W. H. Greeman. New York
6.genetics: A mendelian approach by russel • Concepts of genetics by klug and cummings

M. Sc. ZOOLOGY-I (SEM-II)

Course Code: P-LC -284

Course: Biosystematics and Taxonomy

Total Teaching Hours: 60 **Total Marks: 100**

Learning Objectives:

- To understand the biosystematics and types of taxonomy
- To understand the dimensions of speciation and species concept and taxonomic procedures.
- To understand classification and nomenclature
- To understand the classification and nomenclature
- To understand the Molecular taxonomy, ethics in taxonomy and taxonomic evaluation

Learning Outcomes:

After completion of this course students should be able to:

- Apply the fundamental principles of systematic in which the animals are how to classify according to their characters
- Differentiating the various concepts of the species.
- Describing the principal theories of taxonomy
- Explaining the process, procedures, and purpose of the scientific classification of animals.
- Discussing the development and nature of the current system of zoological nomenclature.

Unit I: Biosystematics, and types of taxonomy

- Definition and basic concepts of Biosystematics, , Historical perspectives of Biosystematics and Taxonomy, Stages of taxonomic procedures-alpha taxonomy, Beta taxonomy and Gamma taxonomy, Neotaxonomy,
- Approaches/Trends in taxonomy-embryological, ecological, ethological, cytological, Biochemical, and numerical approaches in taxonomy
- Significance/Importance of Taxonomy in – biodiversity and conservation, research, medicine, agriculture and pest management, and fisheries.

Unit II: Dimensions of speciation and species concept and taxonomic procedures.

- Dimensions of speciation and species concept – Biological species concept, evolutionary species concept, polytypic and monotypic species, subspecies, infraspecific groups, super species etc.
- Taxonomic Procedures –
- Methods of collection, Labeling, Preservation and curation of collections, cataloguing collections, Kinds of collections – survey collection, collections for general exhibit, research collections and others.
- Identification using taxonomic keys – simple dichotomous key, Bracket key, Indented key, serial key, branching key, circular key, box key, multi entry key and computer key.
- Comparing the identified specimen with previous description, comparing identified specimen with authenticated specimens, requesting help from specialists and Identification through internet.

Unit III: Classification and nomenclature

- Classification – History of Animal classification, Kinds of classification – Natural classification, cladistics or phylogenetic classification, Phenetic classification and evolutionary classification, biological classification, hierarchical classification.
- Nomenclature – History of nomenclature, the nature of scientific names, Kinds of names-descriptive,ecological,geographical,patronymic names. Meaning of authors names in brackets,
- Six types of zoological nomenclature – holotype,paratype,lectotype,syntype,neotype,allotype,
- Taxonomical publications – Short research papers, revision, monograph, faunal/floral works, synopses and reviews, hanbooks and mannuals, catalouges and checklists, atlases etc.

Unit IV: Molecular taxonomy, Ethics in taxonomy and taxonomic evaluation

- Introduction to molecular taxonomy, DNA barcoding, Molecular Phylogenetics, method in molecular taxonomy and Significance of Molecular taxonomy. Systematics and molecular taxonomy
- Ethics in taxonomy – credit, lending and borrowing specimens, loan of materials, exchange of materials, collaboration and co-operations of researchers, use of language, ethics in taxonomic publications,correspondence,authorship of taxonomic papers, acknowledgement etc.
- Taxonomic evaluation - Evaluation of Biodiversity indices with brief reference to Shannon-Weinner index and dominance index.

Reference books

1. G.G. Simpson, Principle of animal taxonomy. Oxford IBH Publishing Company.
2. E. Mayer. Elements of Taxonomy. Oxford IBH Publishing Company.
3. E.O. Wilson. The diversity of Life (The College edition W.W. Northem & Co.
4. B.K. Tikadar. Threatened Animal of India, ZSI publication Calcutta
5. V.C. Kapoor. Theory and Practice of Animal Taxonomy. Oxford & IBH Publishing Co.
6. J.c. Avise, Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.

M. Sc. ZOOLOGY-I (SEM-I)

Course Code: P-LC -286

Lab. Course: Molecular Biology

Total Teaching Hours: 30 **Total Marks: 50**

Learning Objectives:

- To understand the Spectrophotometric analysis of nucleic acid and amino acids.
- To understand the Gel Electrophoretic analysis of nucleic acid and amino acids.
- To understand the process of preparation of plasmid isolation and furification.
- To understand the process of preparation of plasmids for transfect ion of cultured cells and analyze protein expression

Learning Outcomes:

After completion of this course students should be able to:

- Apply protocols for Spectrophotometric and Gel Electrophoretic analysis of nucleic acid and amino acids.
- Use techniques for process of preparation of plasmid isolation, furification, for transfect ion of cultured cells and analyze protein expression
- Explain ,critically evaluate the discuss experimental result from basic research within the field of molecular biology

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

12. b) Native Polyacrylamide gel electrophoresis

M. Sc. ZOOLOGY-I (SEM-I)

Course Code: P-LC -287

Lab. Course: Genetics and r-DNA Technology

Total Teaching Hours: 30 **Total Marks: 50**

Learning Objectives:

- To understand the problems on pattern of inheritance.
- To understand the problems on pedigree analysis for tracing of ancestral history of organism
- To understand protocol of blood group analysis and karyotyping.
- To understand the principles of recombinant DNA technology
- To understand the methods and applications of rDNA Technology

Learning Outcomes:

After completion of this course students should be able to:

- Solve the problem on monohybrid, dihybrid cross, pedigree analysis to learn pattern of inheritance and tracing of ancestral history of organisms.
- Prepare various types of karyotype
- Study of genetically character of animal , plants and microorganism
- Extraction and estimation of mitochondrial DNA and mapping by restriction endonuclease digestion
- Develop the concept of recombinant DNA technique.

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1. Problems based on monohybrid and dihybrid cross.
2. Problems based on interaction of genes
3. Problems based on pedigree analysis.
4. Problems based on Hardy-Weinberg equilibrium.
5. To study the human blood group by using given blood sample.
6. Study of karyotype.
7. Study of Human traits, Animal traits and plant traits for its diversity in phenotype.
8. To study the transformation of E.coli. Cells with plasmid DNA.
9. To study small scale extraction and purification of plasmid DNA.
10. To set Restriction digestion reaction of pBR322 DNA
11. Extraction and estimation of mitochondrial DNA and mapping by restriction endonuclease digestion
12. Isolation, purification and electrophoresis of RNA
13. To Prepare a passenger DNA by PCR using Taq DNA Polymerase
14. Linearization of T- vector
15. Ligation of PCR product into T-vector
16. Transformation of Ligated T-vector.
17. Quantitative analysis of gene expression using RT- PCR

M. Sc. ZOOLOGY-I (SEM-I)

Course Code: P-LC -288

Lab. Course: Biosystematics and Taxonomy

Total Teaching Hours: 30 **Total Marks: 50**

Learning Objectives:

- To understand techniques of sampling, collection and analysis of soil fauna.
- To understand determination of density and abundance of different taxonomic group of animal community.
- To understand preservation techniques different animals.
- To study diversity of animals.

Learning Outcomes:

After completion of this course students should be able to:

- Apply the knowledge of sampling, collection and analysis of soiland aquatic fauna.
- Determine of density and abundance of different taxonomic group of animal community.
- Preserve different animals.
- Explain diversity of animals.

Practicals

13. Study of soil fauna: sampling, extraction / collection, preservation and analysis.
14. Collection, identification and preservation of various insect orders and arthropod groups (including study of permanent specimens)
15. Study of Freshwater planktons, collection, sorting, identification of samples of zooplanktons: protozoans, rotifers, crustaceans. (Including study of permanent specimens)
16. Study of biodiversity sampling using quadrate method: study of community in an ecosystem by determination of frequency density and abundance of different taxonomic groups (fauna only) present in the community.
17. Study of biotic component of a pond ecosystem and grouping on the basis of their trophic position.
18. Study of water quality and dissolved oxygen content in water samples of an ecosystem
19. Museum preservation techniques of selected vertebrates and invertebrates.
20. Laboratory and field exercises of animal behaviors; Learning, Recognition, Feeding
21. Visit to ZSI Pune and other places.