AC 25.04.24 ITEM NO: 26.4

Deccan Education Society's

Kirti M. Doongursee College of Arts, Science and Commerce (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for
Program: Masters of Science
Course: _MSc Part 1 NEP__
Subject: __Zoology__

Choice Based Credit System (CBCS)
with effect from
Academic Year 2024-2025

PROGRAM OUTCOMES

PO	Description
	A student completing Master's Degree in **Science** Program will be able to
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate Programme. Execute strong theoretical and practical understanding generated from the specific graduate Programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioral skills needed for successful social adaptation, work in groups, exhibits thoughts and ideas effectively in writing and orally.
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Performing dependently and collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

Deccan Education Society's

Kirti M. Doongursee College (autonomous)

Proposed Curriculum as per NEP 2020

Year of implementation- 2024-25

Name of the Department: MSc .Part 1
Zoology

Semester	Course Code	Course Title	Vertical	Credit
I	K24PSZOOMJ111	Non-chordates, chordates and their phylogeny – I	Major	4
	K24PSZOOMJ112	Biochemistry and Metabolism – I	Major	4
	K24PSZOOMJ113	Genetics and evolution-1	Major	4
	K24PSZOOMJP11	Non-chordates, chordates and their phylogeny I AND Biochemistry and Metabolism – I and Genetics and evolution-1	Practical	2
	K24PSZOOOEL131	Tools and Techniques in Biology - I	Elective	2
	K24PSZOOEP131	Practicals based on Tools and Techniques in Biology - I & Genetics and evolution-I	Elective Practical	2
	K24PSZOORM141	Research Methodology	RM	4

II	K24PSZOOMJ211	Non-chordates, chordates and their phylogeny - II	Major	4
	K24PSZOOMJ212	Biochemistry and Metabolism- II	Major	4
	K24PSZOOMJ213	Genetics and evolution-II	Major	4
	K24PSZOOMJP21	Non-chordates, chordates and their phylogeny and Biochemistry and Metabolism- II	Practical	2
	K24PSZOOOEL231	Tools and Techniques in Biology-II	Elective	2
	K24PSZOOEP231	Practicals based on Tools and Techniques in Biology - II & Genetics and evolution-II	Elective Practical	2
	K24PSZOOOJ251	FP/OJT	Project	4

Course Code	Major SEM – I	Credits	Lectures/Week
K24PSZOOMJ111	**Paper I Non-chordates, chordates and their phylogeny –I**	**4**	**4**

Course Outcomes:

After successful completion of this course, students would be able to

- Knowledge of characteristics of organisms mentioned
- Segregate the role of characteristics in placing the organisms in specific taxonomic classification
- The learner will be well versed with the knowledge of application of characteristics for taxonomic hierarchy
- Analysis of given animal to place them in appropriate taxonomic hierarchy and their roles in evolution
- Critically assess the effectiveness of conservation strategies or management practices for animal populations.
- Develop conservation plans or strategies to protect endangered animal species or habitats.

Unit	**Topics**	No of Lectures
I	**Phylogeny, Systematics of non-chordates and assorted topics-I** 1.1. Principles of systematic, importance of taxonomic studies in Biology, use of morphometric studies, Osteological studies, use of homologous organs. 1.1. Taxonomic keys: Different kinds of taxonomic keys, their merits and demerits. 1.2. Phylogeny, salient features, classification up to classes (wherever applicable) of the following phyla- 1.3.1 Protista (Protozoa) 1.3.2 Porifera 1.3.3 Coelenterata 1.3.4 Ctenophora	15

II	**Phylogeny, Systematics of non-chordates, Hemichordata & assorted topics** 2.1. Phylogeny, salient features, classification (wherever applicable) up to classes of the following phyla- 2.1.1Mollusca 2.1.2 Bryozoa 2.1.3 Brachiopoda 2.1.4 Echinodermata 2.1.5 Chaetognatha 2.2 Systematic position and affinities of Hemichordata. 2.3 Assorted Topics: 2.3.1 Economic importance of Protozoa. 2.3.2. Mesenteries in Coelenterata. 2.3.3 Economic importance of Arthropoda. 2.3.4 Sense organs in Arthropoda. 2.3.5 Spines and Pedicellariae in Echinodermata. 2.3.6 Invertebrate larvae- larval forms of free living invertebrates, larval forms of parasites, Strategies and evolutionary significance of larval forms.	15
III	**Phylogeny, Systematics of Chordates and Assorted topics- I** 3.1. Discovery of Coelacanth. 3.2. Overview of fish phylogeny. 3.3. Primitive tetrapods- Labrynthodonts. 3.4. Crossopterigians- A blue print. 3.5. Dipnoi- a group that has failed to evolve as Amphibia. 3.6. Lissamphibia. 3.7. Sphenodon- a living fossil. 3.8. Extinct reptiles. 3.9. Adaptive radiation in Reptilia.	15
IV	**Comparative Vertebrate Osteology- I** 4.1. Embryonic development of- a) neurocranium, b) splanchnocranium	15

	and c) dermatocranium. 4.2. Comparative account of jaw suspension. 4.3. Embryonic development of Vertebra. 4.4. Vertebral column of tetrapods- Atlas, Axis, Typical Vertebra, Thoracic vertebra, Trunk vertebra, Caudal vertebra of Dog fish and Bony fish, Frog, Varanus, Pigeon, and Rabbit**.**	

Textbooks:

- Vertebrate comparative anatomy, Function, Evolution, K.V. Kardong, 3rd Ed. Tata McGraw Hill Publication.
- Vertebrate Life: F.H.Pough, C.M.Janis, J.B.Heiser, 6th Ed. Pearson Education. • Functional Anatomy of Vertebrates.
- An evolutionary perspective. K.F.Liem, W.E.Bemis, W, F.Walker, L.Grande, 3rd Ed. Harcourt College Publishers.
- The Life of Vertebrates: J.Z.Young, ELBS-Oxford Univ. Press.
- A Text Book of Zoology; T.J.Parkar and W.A.Haswell, McMillan.
- Chordate Zoology; E.L.Jordan and P.S.Verma, S. Chand & Company
- Biology of Invertebrates; J.A.Pechenik, 4th Ed, Tata McGraw Hill Publication.
- Analysis of Vertebrate Structure: Milton Hildebrand, Wiley International

Additional References:

- Invertebrate Zoology; E.L.Jordan and P.S.Verma, S. Chand & Company
- Life of Invertebrates; Russell, W.D. Hunter, McMillan
- Invertebrate Zoology: Bares, R.D., Saunders Publication

Course Code	Major SEM – I	Credits	Lectures/Week
K24PS ZOOMJ112	**Paper II- Biochemistry and Metabolism – I**	**4**	**4**

Course Outcomes:

After successful completion of this course, students would be able to

- Knowledge of structures and functions of various biomolecules
- Understanding energy consumptions of various biomolecules in pathways
- To estimate the use of energy in different forms and interaction of biomolecules
- To analyze new molecules and pathways and their energy consumptions
- Evaluate the impact of biochemical processes on human health, disease development, and therapeutic interventions.
- Design experiments or investigations to study specific biochemical processes or metabolic pathways.

Unit	**Topics**	No of Lectures
I	**Biomolecules- a structural and functional approach-I** 1.1 Concepts: 1.1.1 Biological Macromolecules. 1.1.2 Polymerization and macromolecules. 1.1.3 Central role of carbon. 1.1.4 Common functional groups. 1.1.5 Common ring structure and isomerization in biological molecules. 1.2. Carbohydrates: 1.2.1. Classification: mono-, oligo- and poly-saccharides. 1. Monosaccharides- structure, classification, D- and L- isomers, Anomers and mutarotation, open chain and ring forms, pyranose and furanose forms, reactions of monosaccharides, glycocydic bonds and nomenclature. 2. Oligosaccharides.	15

	3. Polysaccharides- homo- and hetero-polysaccharides. 1.2.2. Biological functions of carbohydrates. 1.3. Lipids: 1.3.1 Classification: simple and complex lipids. 1.3.2. Fatty acids- Even and odd carbon fatty acids, numbering the carbon atoms, saturated and unsaturated fatty acids, cis- and trans-configuration, nomenclature and short hand representation of fatty acids. 1.3.3. Acylglycerols- Mono-, di- and tri-glycerides, stereospecific numbering of glycerols in glycerides, properties of triacylglycerol. 1.3.4. Complex lipids- Phospholipids, Sphingolipids, Sterols and waxes, Amphipathic lipids: Membrane lipid bilayers. 1.3.5. Biological functions of lipids. 1.4. Nucleic acids: Types- RNA and DNA. 1.4.1. Components: Pentose, Nitrogenous bases, Nucleosides, tautomeric forms of purines and pyrimidines. 1.4.2. Structure of DNA: Watson and Crick model; different forms of DNA double helix. 1.4.3. Structure, types and functions of RNA. 1.5. Complex biomolecules 1.5.1 Glycoproteins: Blood group substances 1.5.2. Glycolipids: Gangliosides. 1.5.3 Lipoproteins: Classification and functions- chilomicrons, VLDL, LDL, HDL, and free fatty acid-albumin complex.	
II	**Biochemical Thermodynamics** 2.1. Biochemical Thermodynamics: 2.1.1 Laws of thermodynamics, free energy, entropy, enthalpy, exergonic and endergonic reactions. 2.1.2 High energy compounds: ATP, ADP, ATP-ADP cycle, ATP-AMP ratio.	15

	2.1.3 Biological oxidation: Electron transport chain and mitochondria; Oxidative phosphorylation- mechanism, uncoupling of oxidative phosphorylation and its significance. 2.1.4 Free radicals, antioxidants and antioxidant system.	
III	**Metabolic pathways and Integration of metabolism-I** 3.1. Metabolism: Concept; Definitions; Catabolism; Anabolism. 3.2. Carbohydrate Metabolism: 3.2.1. Glycolysis: Reaction sequence, flow of carbon, conversion of pyruvate to lactate and Acetyl coenzyme-A, significance of pyruvate-lactate interconversion, aerobic and anaerobic glycolysis and energetic of glycolysis. Regulation of glycolysis. 3.2.2. Gluconeogenesis: Reaction sequence from pyruvate, gluconeogenesis from amino acids, glycerol, propionate, lactate. Regulation of gluconeogenesis. 3.2.3. Glycogen metabolism: Glycogenesis, Glycogenolysis. Regulation of the two pathways. 3.2.4. Significance of following pathways: Hexose monophosphate shunt as a multifunctional pathway; Uronic Acid Pathway; Glyoxalate cycle. 3.3. Lipid Metabolism: 3.3.1. Dynamics of body lipids, mobilization of fats, regulation of hormone sensitive TGlipase, fate of glycerol and free fatty acids. 3.3.2. Fatty acid metabolism: Oxidation of even-carbon and odd-carbon atom fatty acid, oxidation of unsaturated fatty acids, biosynthesis of fatty acids including desaturation, metabolism of phospholipids, cholesterol and *alcohol.	15

IV	**Regulation of metabolism** 4.1. Regulation of metabolism 4.1.1. Concept of homeostasis. 4.1.2. Regulation of metabolic flux by genetic mechanisms: Control of enzyme synthesis, constitutive and inducible enzymes; induction and repression of enzymes (lac operon and trp operon); regulatory proteins- Helix turn Helix, Zinc Fingers, Leucine Zippers, 4.1.3. Regulation of metabolism by extracellular signals: nutrient supply, nutrient transport, endocrine control, neural control.	15

Textbooks:

- Lehninger Principles of Biochemistry 8th Edition by David L. Nelson
- Biochemistry- 2nd Ed. 2002 by U. Satyanarayan, Books and Allied Publ.
- Biochemistry- 2nd Ed. S.C. Rastogi, Tata McGraw Hill.
- Fundamentals of Biochemistry- 3rd Ed. 1988; J.I.Jain, S. Chand and Co. Publ.
- Biochemistry- a Functional Approach; MacGuilver
- www.enzymesIndia.com

Additional References:

- Biochemistry – by Donald Voet (Author) Judith voet and more
- Cell and molecular biology 8th ed- De Robertis E.D.P

Course Code	Sem 1 Major	Credits	Lectures/Week
K24PS ZOOMJ113	**Genetics, Evolution and Developmental Biology - I**	4	4

Course outcomes

- Memorize basic genetics concepts and evolutionary theories and processes
- Explain mechanisms of genetic inheritance and interpret the evolutionary relationships based on molecular data
- Utilize genetic principles to establish phylogenetic trees
- Analyze data for identify inheritance patterns
- Critically evaluate research findings in genetics evolution an developmental biology
- Design experiments to investigate evolutionary phenomena

I	**Genetics- Chromosome theory of inheritance and Mendelism -I** 1.1.Mitosis and Meiosis 1.1.1. Mitosis: *Interphase and cell cycle, genetic control of cell cycle, *stages of mitosis. 1.1.2. Meiosis: An overview of meiosis, the first meiotic division, the second meiotic division, comparison of spermatogenesis and oogenesis in animal cells. 1.1.3. *non-disjunction and its implications. 1.2. Organization of genetic material: 1.2.1. *Structure of chromosomes 1.2.2. *Chromosome number, shape and types 1.2.3. Structural features of eukaryotic chromosomes (chromatids, centromeres and telomeres; significance of telomeres; telomeres and cancer) 1.2.4. Heterochromatin and euchromatin 1.2.5. *In situ* hybridization 1.2.6. *Giant chromosomes: lamp brush and polytene chromosomes	15

	1.2.7. *Human chromosomes* 1.2.8. Chromosome banding 1.2.9. *Variations in chromosome structure and chromosome number 1.3. Principles of Mendelian Genetics: 1.3.1. *Mendel's first law-segregation of alleles 1.3.2. *Mendel's second law-independent assortment 1.3.3. Monohybrid and dihybrid crosses 1.3.4. Molecular basis of dominance (genotype, phenotype, dominance, alleles) 1.3.5. The cellular basis of segregation and independent assortment	
II	**Genetics- Extension of Mendelian genetics and non-Mendelian inheritance -I** 2.1. Alleles and phenotypes: 2.1.1. *Incomplete or partial dominance and co-dominance 2.1.2. *Epistasis 2.1.3. Complementation analysis 2.1.4. *Multiple alleles 2.1.5. *Lethal alleles (recessive and dominant lethal alleles) 2.1.6. Penetrance and expressivity 2.2. Quantitative inheritance: 2.2.1. Traits controlled by many loci 2.2.2. Location of polygenes 2.2.3. Heritability: measurement of heritability 2.3. Linkage, crossing over and gene mapping: 2.3.1. Chromosomal theory of linkage 2.3.2. *Mechanism and types of crossing over 2.3.3. Mapping in prokaryotes and bacterial viruses	15

	2.3.4. Gene mapping in eukaryotes (three point cross) 2.3.5. Genetic mapping in humans- a) physical chromosome mapping: deletion mapping, somatic cell hybridization mapping, mapping by *in situ* hybridization; correspondence of genetic and physical maps. B) Practical application of chromosome mapping- tracking the inheritance of an allele with coupled DNA markers	
	Evolution -I 3.1.1. *Concept of evolution & theories of organic evolution (Lamarckism, Darwinism, De Vries mutation theory, Neo-Darwinism) 3.1.2.* Evolution of horse 3.1.3. Human evolution. 3.2. Population and Evolutionary genetics: 3.2.1* Gene pool 3.2.2 Calculating allelic frequencies 3.2.3. The Hardy-Weinberg equilibrium and mating systems (non-random mating, assortative mating, inbreeding, dis-assortative matings)	15
	Developmental Biology-I 4.1. Basic concepts in developmental Biology 4.1.1. Cell fate and commitment 4.1.2. Mechanism of developmental commitment 4.1.3. *Mosaic and regulative development 4.1.4. Pattern formation and compartments 4.1.5. Morphogenesis and cell adhesion: a) Differential cell affinity b) *Cadherins and catenins c) *Sorting out of embryonic tissues and cell recognition	15

	4.2. Cell differentiation and Totipotency 4.2.1. Nucleocytoplasmic interaction 4.2.2. *Mechanism of gene action during cell differentiation 4.2.3. * Factors affecting cellular differentiation 4.2.4. Maintenance of differentiation	
	References Genetics; Daniel J. Fairbanks and W.R. Anderson. Wadsworth Publ. • Prin. Of Genetics; Robert H. Tamarin; 7th Ed. Tata McGraw Hill • Basic Human Genetics; Elaine Johansen Mange and Arthur Mange; Indian Reprint; 1997; Rastogi Publ. • Genes and Evolution: A.P. Jha; MacMillon India • Concepts of Genetics; William S. Kluge;, M.R.Cummings, Pearson Edu. • Developmental Biology; Scott F. Gilbert, Sinauer Associates Inc. • Developmental Biology; T. Subramanian, Narosa Publ. • Biology of Developing System; Philip Grant; Holt Saunders International Ed. • Evolution; M. W. Strikberger, CBS Publ. • Cytology and Genetics; Sumitra Sen and Dipak Kumar Kar, Narosa Publ. • Instant Notes- Developmental Biology; R.M. Twyman, Bios. Scientific Pub. Ltd.	

Course Code	**SEM I - Non-chordates, chordates and their phylogeny I, Biochemistry and Metabolism – I and Genetics and Evolution –**	**Credits**	**Lectures/Week**

	I		
K24PSZOOMJP11	**Practical 1 (Paper 1 + Paper 2)**	**2**	**4**

Course Outcomes:

After successful completion of this course, students would be able to

- Knowledge of characteristics of organisms mentioned structures and functions on various biomolecules,
- Understanding the role of characteristics in placing the organisms in specific taxonomic classification, energy consumptions of various biomolecules in pathways and genetics
- The learner will be well versed with the knowledge of application of characteristics for taxonomic hierarchy and will be able to estimate the use of energy in different forms and interaction of biomolecules
- Analysis of given animal to place them in appropriate taxonomic hierarchy and their roles in evolution and new molecules and pathways and their energy consumptions

Paper 1- Non-chordates, chordates and their phylogeny I

1	Study of animal type*: Sepia: Morphology, digestive system, nervous system, reproductive system, Mounting of: jaws, radula, statocyst and spermatophore
2	Study of systematic and major features of: Protozoa (Amoeba, Volvox, Noctiluca, Paramoecium, Plasmodium); Porifera (Leucosolenia,Grantia, Euplectella, Euspongia); Coelenterata (Obelia colony, Physalia, Porpita, Sea-anemone, Madrepora, Aurelia); Mollusca (Chiton,Dentalium, Patella, Aplysia, Limnea/Achatina, Mytilus, Loligo/Octopus, Nautilus); Echinodermata (Starfish, Brittle star, Sea urchin, Sea cucumber, Feather star); Minor Phyla (Comb jelly, Lingula, Sagitta,); Hemichordata (Balanoglossus).
3	Study of accessory respiratory organs in: Anabas, Clarius, Sacchobranchus and Boleopthalmus,
4	Study of Larval forms: Echinoderm larvae and Tornaria larva
5	Cephalochordata (Amphioxus). Study of systematics and major features of: Agnatha (Petromyzon, Myxine); Pisces (Shark, Sting ray, Electric ray, Hippocampus, Eel, and any lung fish); Amphibia(Caecilian, Salamander, Frog, Toad); Reptilia (Turtle/Terrapin,

	Tortoise, Calotes/ Chameleon, Draco, Phrynosoma, Viper, Rattle snake, Hydrophis, Crocodile/Alligator/Gharial)
6	Mounting of spicules of Holothurian
7	Comparative Osteology: Types of vertebrae (Procoelous, Opisthocoelous, Amphicoelous, Heterocoelous)
Paper 2- Biochemistry and Metabolism – I	
8	Qualitative tests for carbohydrates and identification of the nature of carbohydrates in the given sample: Molisch's test; Anthrone test; Iodine test; Barfoed's test,; Seliwanoff's test; Fehling's test; Benedict's test, Picric acid test; Mucic acid test; and Bial's test
9	Determination of glucose by Benedict's method (volumetric).
10	Determination of reducing sugars by 3,5-dinitrosalicylic acid (colorimetric) method.
11	Determination of glycogen in the given tissue (liver/ skeletal muscle/ kidney/ brain)
12	Acid and enzyme hydrolysis of glycogen and colorimetric estimation of the products by 3,5-DNSA method
13	Isolation of starch from potato
14	Determination of acid value of fats/ oils
15	Determination of saponification value of fats/ oils.

Textbooks:-

- Invertebrate Zoology; E.L.Jordan and P.S.Verma, S. Chand & Company.
- An introduction to practical biochemistry -Plummer
- Genetics; Daniel J. Fairbanks and W.R. Anderson. Wadsworth Publ.
- Prin. Of Genetics; Robert H. Tamarin; 7th Ed. Tata McGraw Hill
- Basic Human Genetics; Elaine Johansen Mange and Arthur Mange; Indian Reprint; 1997;
- Rastogi Publ.
- Genes and Evolution: A.P. Jha; MacMillon India
- Concepts of Genetics; William S. Kluge;, M.R.Cummings, Pearson Edu.
- Developmental Biology; Scott F. Gilbert, Sinauer Associates Inc.
- Developmental Biology; T. Subramanian, Narosa Publ.
- Biology of Developing System; Philip Grant; Holt Saunders International Ed.
- Evolution; M. W. Strikberger, CBS Publ.
- Cytology and Genetics; Sumitra Sen and Dipak Kumar Kar, Narosa Publ.

- Instant Notes- Developmental Biology; R.M. Twyman, Bios. Scientific Pub. Ltd. Genetics; Daniel J. Fairbanks and W.R. Anderson. Wadsworth Publ.
- Prin. Of Genetics; Robert H. Tamarin; 7th Ed. Tata McGraw Hill
- Basic Human Genetics; Elaine Johansen Mange and Arthur Mange; Indian Reprint; 1997;
- Rastogi Publ.
- Genes and Evolution: A.P. Jha; MacMillon India
- Concepts of Genetics; William S. Kluge;, M.R.Cummings, Pearson Edu.
- Developmental Biology; Scott F. Gilbert, Sinauer Associates Inc.
- Developmental Biology; T. Subramanian, Narosa Publ.
- Biology of Developing System; Philip Grant; Holt Saunders International Ed.
- Evolution; M. W. Strikberger, CBS Publ.
- Cytology and Genetics; Sumitra Sen and Dipak Kumar Kar, Narosa Publ.
- Instant Notes- Developmental Biology; R.M. Twyman, Bios. Scientific Pub. Ltd.

Course Code	Elective SEM – I	Credits	Lectures /Week
K24PSZOOEL131	**Tools and Techniques in Biology - I**	**2**	**2**

Course Outcomes:

After successful completion of this course, students would be able to

- Knowledge of principles of various tools and techniques
- Understanding of working of tools and techniques
- Applications of tools and techniques in research
- Analysis of various topics based on the above areas
- Critically assess the strengths and limitations of different experimental designs or methodologies in biological research.
- Create reports, presentations, or visualizations to effectively communicate research findings and experimental procedures.

Unit	**Topics**	No of Lectures
I	**Principles and application of Spectroscopy & Microscopy** 1. Spectroscopy 1.1. Ultraviolet and visible absorption spectroscopy 1. 2. Fluorescence spectroscopy 1.3. Nuclear magnetic resonance spectroscopy 1.4. Mass spectroscopy 1.5. Atomic absorption spectrophotometer 1.6. Light microscopy 1.7.Phase contrast microscopy, 1.8 .Fluorescence microscopy 1.9 .transmission electron microscopy 1.10 Specimen preparation for electron microscopy, 1.11 Scanning electron microscopy.	15
II	**Radioisotopes and extraction techniques** 2.1. Principles and applications of radioisotopes: Use of isotopes in biological sciences; units of radioactivity, detection and measurement of radioactivity by scintillation counting,	15

	autoradiography, preparation for the experiment, performing the experiment. 2.2 Principles and application of filtration, distillation and extraction: Ordinary filtration under suction pressure, fractional distillation, steam distillation, technique of extraction with solvents.	

Textbooks:

- Modern Experimental Biochemistry; 3rd Ed. Rodney Boyer, Pearson Education.
- Principles and Techniques of Practical Biochemistry. Wilson and Walker, Cambridge Univ. Press.
- Biological Science; 3rd Ed. D.J.Taylor, N.P.O.Green, G.W.Stou, Cambridge Univ. Press
- Cell and Molecular Biology- Concepts and Experiments, Gerald Karp. John Wiley & Co.
- Introductory Practical Biochemistry; S.K.Swahney, Randhir Sing. Narosa Publ.
- An Introduction to Practical Biochemistry; 3rd Ed. David Plummer. Tata McGraw Hill
- Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ.
- Elementary Practical Organic Chemistry Part I: Small Scale Preparations. 2nd Ed. Arthur I. Vogel. CBS Publ. and Distributors.
- Research Methodology. Methods and Techniques; C.R.Kothari. Wiley Eastern Ltd. Mumbai

Course Code	**Elective Practical SEM – I**	**Credits**	**Lectures/Week**
K24PSZOOEP131	**Practicals based on Tools and techniques in Biology –I & Genetics, Evolution and Developmental biology– I**	**2**	**4**

After successful completion of this course, students would be able to

- Knowledge of principles of various tools and techniques
- Understanding of working of tools and techniques
- Applications of tools and techniques in research

- Analysis of various topics based on the above areas
- Critically assess the strengths and limitations of different experimental designs or methodologies in biological research.
- Create reports, presentations, or visualizations to effectively communicate research findings and experimental procedures.

Unit	**Topics**	No of Lectures
1.	Identification of pictograms, symbols and signs of safety in laboratory practice.	
2.	Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation sectioning, staining.	
3.	. Solutions and Buffers: Mode of expressing concentration of solutions- Molarity (M), Molality(M), normality (N), Mass concentration, mass fraction, mass percentage or % (w/w), % by volume (v/v), parts per million (ppm) with practical exercises. Types of solutions- Stock solutions practical exercises	
4.	Preparation of buffers of different pH using Henderson-Hasselbalch equation and its verification using pH meter	
5.	Determination of pKa of weak acid.	
6.	Principles and applications of centrifugation: Basic principles of centrifugation, Low speed and high speed centrifuges, ultracentrifuge, application of centrifugation-preparative techniques,different types of rotors, analytical measurements; care of centrifuges and rotors	
	Paper 3- Genetics and evolution – I	

7.	Temporary squash preparation of onion/garlic root tip cells to study stages of mitosis.	
8.	Temporary preparation of polytene chromosomes from salivary gland cells of Drosophila/Chironomus	
9.	Study of chromosome structures in human karyotyperomosome structures in human karyotype	
10.	Study of different types of chromosome banding techniques.	
11.	Temporary preparation of buccal smear to study sex chromatin in human	

References:
• Modern Experimental Biochemistry; 3rd Ed. Rodney Boyer, Pearson Education.
• Principles and Techniques of Practical Biochemistry. Wilson and Walker, Cambridge Univ.
Press.
• Biological Science; 3rd Ed. D.J.Taylor, N.P.O.Green, G.W.Stou, Cambridge Univ. Press
• Cell and Molecular Biology- Concepts and Experiments, Gerald Karp. John Wiley & Co.
• Introductory Practical Biochemistry; S.K.Swahney, Randhir Sing. Narosa Publ.
• An Introduction to Practical Biochemistry; 3rd Ed. David Plummer. Tata McGraw Hill
• Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ.
• Elementary Practical Organic Chemistry Part I: Small Scale Preparations. 2nd Ed. Arthur I.
Vogel. CBS Publ. and Distributors.

Course Code	**RM SEM – I**	**Credits**	**Lectures /Week**

K24PSZOOR M141	**Research Methodology**	**4**	**4**

Course Outcomes:

After successful completion of this course the learner will be able to:-

- Explain the importance of defining a research problem and the role of research design in conducting a study.
- Use techniques to define research problems effectively and develop a research design suitable for a specific research problem.
- Evaluate the appropriateness of different research designs for different research problems and assess the validity of research designs.
- Critique research designs, identify potential limitations, and propose improvements to enhance the quality of research designs
- Develop research proposals, including the formulation of research questions, design considerations, and anticipated outcomes.

Unit	**Topics**	No of Lectures
I	**Meaning of research and types of research** 1.1Motivation in research; 1.2 Types of research; research approaches; significance of research; research methods versus methodology; 1.3 Research and scientific methods; Importance of knowing how research is done; 1.4 Research process; Criteria for good research	15
II	**Research problem and research design** 2.1 Selecting research problem; necessity of defining a problem; techniques involved in defining the problem; 2.2 Meaning of research design; need for research design; important concepts related to research design; different research	15
III	**Interpretation and report writing**	15

	3.1Interpretation and report writing: Meaning of interpretation; technique of interpretation; precautions in interpretation; 3.2 Significance of report writing; layout of research report; types of reports; *Presentation of research work- oral, poster and writing research paper; Precautions for writing research report	
IV	**Review of related literature and Writing research proposal** 4.1 Review of related literature: Understanding the role of review; how to begin a search for related literature- Library reference, recording and indexing, classification of references, internet sites for biological references; downloading the information through internet; requests for reprints through e-mail and post; classification and filing of reprints. 4.2 Writing research proposal: Characteristics of a proposal; content and organization of a proposal; weakness in proposal seeking funding	15
Textbooks: • Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ • Research Methodology. Methods and Techniques; C.R.Kothari. Wiley Eastern Ltd. Mumbai		

Course Code	Major SEM – II	Credits	Lectures/Week
K24PSZOOMJ211	Paper I- : Non-chordates, chordates and their phylogeny - II	4	4

Course Outcomes:

After successful completion of this course, students would be able to

- Knowledge of characteristics of organisms mentioned
- Understanding the role of characteristics in placing the organisms in specific taxonomic classification
- The learner will be well versed with the knowledge of application of characteristics for taxonomic hierarchy
- Analysis of given animal to place them in appropriate taxonomic hierarchy and their roles in evolution
- Critically assess the scientific literature and research findings related to non-chordate and chordate phylogeny.
- Design and conduct experiments or investigations to study specific aspects of non-chordate or chordate evolution, such as evolutionary developmental biology or molecular phylogenetics.

Unit	Topics	No of Lectures
I	**Phylogeny, Systematics of non-chordates and assorted topic-II** 1.1. Platyhelminthes and Nemethelminthes 1.2. Acanthocephala 1.3. Annelida 1.4. Sipunculoidea 1.5. Arthropoda 1.6 Onychophora – Peripatus, A connecting link between Annelida and Arthropoda.	15
II	**Phylogeny of Protochordates, Agnatha and assorted topics II** 2.1. Urochordata and its affinities. 2.2. Cephalochordata and its affinities 2.3. Vertebrate ancestry and origin of Vertebrates. 2.4. Changes leading to first vertebrates.	15

	2.5. Salient features and phylogeny of Ostracoderms. 2.6. Affinities of Cyclostomes- a) resemblance with Cephalochordates. b) differences from fishes. c) vertebrate characters. d) specialized characters	
III	**Phylogeny, Systematics of Chordates and Assorted topics- II** 3.1. Warm blooded reptiles. Archaeopteryx- a connecting link between Reptiles and Aves. 3.2. Affinities of Aves and classification up to subclass. 3.3. Origin of flight (theory of cursorial & arboreal origin). 3.4. Birds as glorified reptiles. 3.5. Egg laying mammals- connecting link between reptiles and mammals. 3.6. Classification of mammals up to orders. 3.7. Dentition in mammals. 3.8. Walking gait (Plantigrade, Digitigrade, and Unguligrade)	15
IV	**Comparative Vertebrate Osteology- II** 4.1. Pectoral & Pelvic girdles of Dog fish, Bony fish, Frog, Varanus, Pigeon and Rabbit 4.2. Comparative anatomy of limbs of tetrapods. 4.3. Mechanism of support and movements- Running, Jumping and Digging.	15

Textbooks:

- Vertebrate comparative anatomy, Function, Evolution, K.V. Kardong, 3rd Ed. Tata McGraw Hill Publication.
- Vertebrate Life: F.H.Pough, C.M.Janis, J.B.Heiser, 6th Ed. Pearson Education. • Functional Anatomy of Vertebrates.
- An evolutionary perspective. K.F.Liem, W.E.Bemis, W, F.Walker, L.Grande, 3rd Ed. Harcourt College Publishers.
- The Life of Vertebrates: J.Z.Young, ELBS-Oxford Univ. Press. •
- A Text Book of Zoology; T.J.Parkar and W.A.Haswell, McMillan. • Chordate Zoology; E.L.Jordan and P.S.Verma, S. Chand & Company
- Biology of Invertebrates; J.A.Pechenik, 4th Ed, Tata McGraw Hill Publication.

- Analysis of Vertebrate Structure: Milton Hildebrand, Wiley International

Additional References:

- Invertebrate Zoology; E.L.Jordan and P.S.Verma, S. Chand & Company
- Life of Invertebrates; Russell, W.D. Hunter, McMillan
- Invertebrate Zoology: Bares, R.D., Saunders Publication

Course Code	**MAJOR SEM – II**	**Credits**	**Lectures /Week**
K24PSZOOMJ212	**Paper II- Biochemistry and Metabolism- II**	**4**	**4**

Course Outcomes:

After successful completion of this course, students would be able to

- Knowledge of structures and functions on various biomolecules
- Understanding energy consumptions of various biomolecules in pathways
- To estimate the use of energy in different forms and interaction of biomolecules
- To analyze new molecules and pathways and their energy consumptions
- Evaluate the impact of biochemical processes on human health, disease development, and therapeutic interventions.
- Create models or simulations to illustrate complex biochemical processes or metabolic networks.

Unit	**Topics**	No of Lectures
I	**Biomolecules- a structural and functional approach-II** 1.1. Proteins as polymers of amino acids 1.1.1. Amino acids: structure, classification based on structure, polarity, nutritional requirement and metabolic fate; properties of amino acids; derivatives of amino acids, non-transcribed amino acids as protein constituents, D-amino acids.	15

	1.1.2. Organization of protein structure: Primary structure and peptide bond, secondary, tertiary and quaternary structure; conjugate proteins- haemoglobin, cytochromes, myoglobin; bonds involved in protein organization. 1.1.3. Properties of proteins: classification, denaturation and protein folding. 1.1.4. Biological functions of proteins. Biologically important peptides: glutathione, octa-, nona-, and deca-peptides.	
II	**Enzymes and Enzyme kinetics** 2.1. Enzymes and Enzyme kinetics. 2.1.1. Enzymes: Nomenclature and classification with numerical code; chemical nature of enzymes. 2.1.2. Mechanism of enzyme action: Fischer's Lock and Key Theory, Koshland's Induced fit model; Mechanism of enzyme catalysis. 2.1.3. Enzyme kinetics: Michaelis Menton equation; Lineweaver-Burk plot; significance of Vmax and Km; factors affecting enzyme activity; enzyme activation and inhibition. 2.1.4. Regulatory enzymes: a) covalently modulated, b) allosteric regulation, c) Isoenzymes (LDH, CK, ALP, ADH) 2.1.5. Non-protein enzymes- Ribozymes. 2.1.6. Advanced enzymes in human healthcare (e.g. fungal lactase, Hemicellulase, Trypsin chymotrypsin mix)	15
III	**Metabolic pathways and Integration of metabolism** 3.1. Protein Metabolism: 3.1.1. Metabolism of amino acids: Amino acid pool, transamination; oxidative and nonoxidative deamination; metabolism of branched chain amino acids; fate of carbon skeleton of amino acids. 3.1.2. Metabolism of ammonia: Urea cycle. 3.2. Metabolism of nucleic acids: 3.2.1 Synthesis of ribonucleotides- a brief idea of *de novo* pathway and salvation pathway. 3.2.2. Conversion of ribonucleotides to deoxyribonucleotides. 3.2.3. Degradation of nucleotides.	15

	3.3. Integration of Metabolism, Energy demand and supply; Integration of major metabolic pathways of energy metabolism; intermediary metabolism; organ specialization and metabolic integration. Metabolism in starvation	
IV	**Regulation of metabolism and inborn errors of metabolism** 4.1. Inborn errors of metabolism 4.1.1. Carbohydrate metabolism: Glycogen storage disease,G-6-PD deficiency 4.1.2. Lipid metabolism: Metabolic disorders of cerebrosides. 4.1.3. Protein metabolism: PKU, Albinism, Cystinuria 4.1.4. Purine metabolism: Primary Gout 4.2. Mineral metabolism and diseases: Hypocalcaemia, Hypercalcaemia and osteoporosis	15

Textbooks:

- Lehninger Principles of Biochemistry 8th Edition by David L. Nelson
- Biochemistry- 2nd Ed. 2002 by U. Satyanarayan, Books and Allied Publ.
- Biochemistry- 2nd Ed. S.C. Rastogi, Tata McGraw Hill.
- Fundamentals of Biochemistry- 3rd Ed. 1988; J.I.Jain, S. Chand and Co. Publ.
- Biochemistry- a Functional Approach; MacGuilver
- www.enzymesIndia.com

Additional References:

- Biochemistry – by Donald Voet (Author) Judith voet and more
- Cell and molecular biology 8th ed- De Robertis E.D.P

Course Code	Sem II Paper 3	Credits	Lectures/Week
K24PSZOOMJ213	**Genetics, Evolution and Developmental Biology -II**	4	4

Course Outcomes

- Recall the basic terminology in genetics evolution and developmental biology
- Understand the effects of various components of genetics and evolution
- Utilize evolutionary theories to analyze the developmental changes across different species
- Analyze evolutionary data to elucidate the genetic basis of developmental pathways
- Critically evaluate research findings in genetics evolution and developmental biology
- Propose hypotheses regarding the evolutionary origins of developmental patterns and structure

Units	Topic	Lectures
I	**Genetics- Chromosome theory of inheritance and Mendelism-II** 1.1. Mendelian genetics, probability and statistics 1.1.1 Combining probabilities (sum rule and product rule) 1.1.2. Chi square test 1.2. Modern concept of gene 1.2.1. * Difference between prokaryotic and eukaryotic gene structure 1.2.2. Properties of genes, gene-enzyme relationship 1.2.3. One gene-one enzyme hypothesis, one gene-one polypeptide concept. 1.2.4. Fine structure of gene, cistron, recon and muton 1.2.5. Split gene- exon and intron 1.2.6. Mobile genes and transposons 1.2.7. Pseudoalleles	15
II	**Genetics- Extension of Mendelian genetics and non-Mendelian inheritance -II** 2.1. Determination of sex *2.1.1. Environmental control of sex (*Bonellia, Crepedula*); temperature dependent sex determination (TSD) in reptiles.	15

	2.1.2. Genic control of sex determination in Maize, *Caenorhabditis elegans* *2.1.3. XX-XO, XX-XY and ZZ-ZW method of sex determination 2.1.4. Genic balance theory of sex determination in *Drosophila* 2.1.5. Gynandromorphs in *Drosophila* 2.1.6. Haplodiploidy in honeybees 2.1.7. Sex chromatin, Lyon hypothesis, X inactivation 2.1.8. SRY and Dax genes *2.1.9. XX males and XY females in human. 2.2. Non-Mendelian Inheritance: *2.2.1. Maternal effects; Shell coiling in snails, pigmentation in moths 2.2.2. Cytoplasmic inheritance: Mitochondria, chloroplasts, plasmids, infective particles.	
III	**Evolution-II** *3.1. Additive gene action and continuous variation 3.2. Heterosis and inbreeding depression: measuring inbreeding, the effects of inbreeding 3.3. Processes that change allelic frequencies: mutation, migration, natural selection, directional selection, stabilizing and disruptive selection, heterozygote advantage, balance between selection and mutation; genetic drift-random genetic drift. 3.4. Environmental variation: causes of environmental variation; genotype by environmental interaction 3.5.Broad sense heritability: a) Effect of dominance, epistasis and environmental variations on selection; b) Quantitative trait loci and DNA markers; c) Realized heritability. 3.6. Limits on selection	15
IV	**Developmental Biology- II** 4.1. Cell specialization: RBC, secretory cell, retinal rod cell 4.2. Organizer and its role in embryonic development 4.3. Primary embryonic induction 4.4. Metamorphosis, Regeneration and Aging 4.4.1. Metamorphosis: *(**a)** Amphibian metamorphosis; **b)** metamorphosis in insects-	15

	(i) Types of insect metamorphosis (ii) Eversion and differentiation of imaginal discs; (iii). Hormonal control of insect metamorphosis; **c)** programmed cell death *4.4.2. Regeneration: (a) Regeneration in Hydra (b) Regeneration of Salamander limbs. *4.4.3. Aging: Senescence, life span and causes of aging.	

Textbooks

- Genetics; Daniel J. Fairbanks and W.R. Anderson. Wadsworth Publ.
- Prin. Of Genetics; Robert H. Tamarin; 7th Ed. Tata McGraw Hill
- Basic Human Genetics; Elaine Johansen Mange and Arthur Mange; Indian Reprint; 1997;
- Rastogi Publ.
- Genes and Evolution: A.P. Jha; MacMillon India
- Concepts of Genetics; William S. Kluge;, M.R.Cummings, Pearson Edu.
- Developmental Biology; Scott F. Gilbert, Sinauer Associates Inc.
- Developmental Biology; T. Subramanian, Narosa Publ.
- Biology of Developing System; Philip Grant; Holt Saunders International Ed.
- Evolution; M. W. Strikberger, CBS Publ.
- Cytology and Genetics; Sumitra Sen and Dipak Kumar Kar, Narosa Publ.
- Instant Notes- Developmental Biology; R.M. Twyman, Bios. Scientific Pub. Ltd.

Course Code	**SEM II - Non-chordates, chordates and their phylogeny and Biochemistry and Metabolism- II**	**Credits**	**Lectures /Week**
K24PSZOOMJP21	**Practical 1 (Paper 1 + Paper 2)**	**4**	**8**

Course Outcomes:

After successful completion of this course, students would be able to

- Knowledge of characteristics of organisms mentioned structures and functions on various biomolecules
- Understanding the role of characteristics in placing the organisms in specific taxonomic classification, energy consumptions of various biomolecules in pathways
- The learner will be well versed with the knowledge of application of characteristics for taxonomic hierarchy and will be able to estimate the use of energy in different forms and interaction of biomolecules

• Analysis of given animal to place them in appropriate taxonomic hierarchy and their roles in evolution.To analyze new molecules and pathways and their energy consumptions	
Paper 1 Non-chordates, chordates and their phylogeny - II	
1	Study of animal type*: Periplanata americana: Morphology, digestive system, nervous system, reproductive system and life history. Mountings of- cornea, salivary glands, gonapophyses, spermatheca
2	Study of systematics and major features of: Helminthes (Planaria, Liverfluke, Tapeworm, Ascaris, Trichinella); Annelida (Nereis, Earthworm, Leech); Sipunculoidea: (Sipunculus), Arthropoda (Lobster, Balanus, Crab, Lepas, Scorpion, Spider, Limulus, Centipede, Millipede, Beetle). Urochordata (Simple Ascidian, Salpa/ Doliolum); Cephalochordata (Amphioxus).
3	Study of Larval forms: Larvae of Helminthes- Miracidium, Redia, Cercaria, Metacercaria; Trochophore, Crustacean larvae, Ascidian tadpole.
4	Study of systematics and major features of: Aves (Ostrich, Kiwi, Kite, Owl, and Duck); Mammals (Duck billed platypus, Echidna, Kangaroo, Shrew, Bat, Loris, Seal/ Walrus, Dolphin, Sea Cow, Tiger, Giant panda, Tapir, Camel, Striped squirrel, Guinea pig, Porcupine, Rabbit)
5	Comparative Osteology: Study of pectoral and pelvic girdles (Shark, Bony fish, Frog, Varanus, Pigeon, Rabbit); Study of comparative anatomy of tetrapod limbs (Frog, Varanus, Pigeon and Rabbit).
	*****Demonstration practical/ Dissection/Virtual dissection/Model (2D or 3D)/Chart of animal system as per UGC guidelines.
Paper 2 Biochemistry and Metabolism- II	
6	Determination of total cholesterol and HDL cholesterol from serum
7	Qualitative tests for amino acids and Proteins: Ninhydrin test; Xanthoproteic test; Millon's test; Biuret test.
8	Colorimetric estimation of protein by Peterson-Lowry method.
9	Quantitative estimation of amino acids using ninhydrin reagent.
10	Isolation of casein from milk
11	Detection of conformation of BSA by viscosity measurement and effect of varying concentration of urea on viscosity of BSA.
12	SDH specific activity.
Textbooks	

- Invertebrate Zoology; E.L.Jordan and P.S.Verma, S. Chand & Company.
- An introduction to practical biochemistry -Plummer
- Genetics; Daniel J. Fairbanks and W.R. Anderson. Wadsworth Publ.
- Prin. Of Genetics; Robert H. Tamarin; 7th Ed. Tata McGraw Hill
- Basic Human Genetics; Elaine Johansen Mange and Arthur Mange; Indian Reprint; 1997;
- Rastogi Publ.
- Genes and Evolution: A.P. Jha; MacMillon India
- Concepts of Genetics; William S. Kluge;, M.R.Cummings, Pearson Edu.
- Developmental Biology; Scott F. Gilbert, Sinauer Associates Inc.
- Developmental Biology; T. Subramanian, Narosa Publ.
- Biology of Developing System; Philip Grant; Holt Saunders International Ed.
- Evolution; M. W. Strikberger, CBS Publ.
- Cytology and Genetics; Sumitra Sen and Dipak Kumar Kar, Narosa Publ.
- **Instant Notes- Developmental Biology; R.M. Twyman, Bios. Scientific Pub. Ltd.**

Course Code	**Elective II SEM – II**	**Credits**	**Lectures/Week**
K24PSZOOOE231	**Tools and Techniques in Biology-II**	**2**	**2**

Course Outcomes:

After successful completion of this course, students would be able to

- Knowledge of principles of various tools and techniques
- Understanding of working of tools and techniques
- Apply various chromatographic methods to separate and analyse complex structures
- Analyse chromatographic data to determine the composition of mixture.
- Assess the limitations and sources of error in chromatographic equipment.
- Design chromatographic experiment to solve analytical problems or optimize separation conditions

Unit	**Topics**	No of Lectures

I	**Principles and application of chromatography I** 1.1. Chromatography 1.1.1. Planar chromatography (Paper and Thin layer): Preparation of stationary support, solvent, detection and measurement of components, applications. 1.1.2. Ion exchange chromatography: Ion exchange resins, selection of ion-exchanger, choice of buffers, preparation and use of ion-exchangers, storage of resins. 1.1.3. Gel chromatography: *Theory of gel filtration; physical characteristics of gel chromatography, chemical properties of gel, selection of gel, gel preparation and storage, operation of gel column, application 1.1.4 Affinity chromatography: Chromatography media, immobilized ligands, attachment of ligands to the matrix, experimental procedures and application	15
II	**Principles and application of chromatography and Electrophoresis 15 L** 2.1. Gas chromatography 2.1.1. Gas chromatography (GC): Instrumentation, selection of operating conditions, analysis of data and application. 2.1.2. HPLC. 2.2. Electrophoresis 2.2.1. Theory of electrophoresis 2.2.2. Horizontal agarose gel electrophoresis 2.2.3. Vertical polyacrylamide gel electrophoresis 2.2.4. Pulse field electrophoresis 2.2.5. Capillary electrophoresis 2.2.6. Isoelectric focusing of proteins 2.2.7. Two dimensional electrophoresis.	15
Textbooks: • Modern Experimental Biochemistry; 3rd Ed. Rodney Boyer, Pearson Education. • Principles and Techniques of Practical Biochemistry. Wilson and Walker, Cambridge Univ. Press. • Biological Science; 3rd Ed. D.J.Taylor, N.P.O.Green, G.W.Stou,		

Cambridge Univ. Press
- Cell and Molecular Biology- Concepts and Experiments, Gerald Karp. John Wiley & Co.
- Introductory Practical Biochemistry; S.K.Swahney, Randhir Sing. Narosa Publ.
- An Introduction to Practical Biochemistry; 3rd Ed. David Plummer. Tata McGraw Hill
- Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ.
- Elementary Practical Organic Chemistry Part I: Small Scale Preparations. 2nd Ed. Arthur I. Vogel. CBS Publ. and Distributors.
- Research Methodology. Methods and Techniques; C.R.Kothari. Wiley Eastern Ltd. Mumbai Data Management and Analysis:
- The practice of statistics in life sciences - Brigitte Baldi and David Moore, W. H. Freeman.

Course Code	**Elective Practical SEM – II**	**Credits**	**Lectures /Week**
K24PSZOOEL223	**Practicals based on Tools and techniques in Biology -II**	**2**	**4**

After successful completion of this course, students would be able to
- Knowledge of principles of various tools and techniques
- Understanding of working of tools and techniques
- Apply various chromatographic methods to separate and analyse complex structures
- Analyse chromatographic data to determine the composition of mixture.
- Assess the limitations and sources of error in chromatographic equipment.
- Design chromatographic experiment to solve analytical problems or optimize separation conditions

Unit	**Topics**	No of Lectures
	1. Identification of lipids in a given sample by TLC. 2. Separation of pigments from leaves or flowers by adsorption column chromatography.	

	3. Separation and identification of amino acids by 2D paper chromatography 4. SDS-polyacrylamide slab gel electrophoresis of proteins	
	Paper 3 Genetics and Evolution- II	
	5.Problems in genetics.	
	6.Pedigree analysis.	
	7.Quantitative estimation of DNA in a suitable tissue by diphenyl amine method.	
	8.Quantitative estimation of RNA in a suitable tissue by orcinol method.	
	9. Observation of morphogenetic movements in chick embryo	.
	10.Isolation of limb bud and its chorioallantoic grafting.	

Textbooks:

- Modern Experimental Biochemistry; 3rd Ed. Rodney Boyer, Pearson Education.
- Principles and Techniques of Practical Biochemistry. Wilson and Walker, Cambridge Univ.
- Press.
- Biological Science; 3rd Ed. D.J.Taylor, N.P.O.Green, G.W.Stou, Cambridge Univ. Press
- Cell and Molecular Biology- Concepts and Experiments, Gerald Karp. John Wiley & Co.
- Introductory Practical Biochemistry; S.K.Swahney, Randhir Sing. Narosa Publ.
- An Introduction to Practical Biochemistry; 3rd Ed. David Plummer. Tata McGraw Hill
- Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ.
- Elementary Practical Organic Chemistry Part I: Small Scale Preparations. 2nd Ed. Arthur I.
- Vogel. CBS Publ. and Distributors.
- Genes and Evolution: A.P. Jha; MacMillon India
- Concepts of Genetics; William S. Kluge;, M.R.Cummings, Pearson Edu.

- Developmental Biology; Scott F. Gilbert, Sinauer Associates Inc.
- Developmental Biology; T. Subramanian, Narosa Publ.
- Biology of Developing System; Philip Grant; Holt Saunders International Ed.
- Evolution; M. W. Strikberger, CBS Publ.
- Cytology and Genetics; Sumitra Sen and Dipak Kumar Kar, Narosa Publ.
- Instant Notes- Developmental Biology; R.M. Twyman, Bios. Scientific Pub. Ltd.

Evaluation Scheme for First Year (PG) under NEP (22 credits)

I. Internal Evaluation for Theory Courses – 40 Marks

1) Continuous Internal Assessment(CIA) Assignment –

Project – 40 marks

II. External Examination for Theory Courses – 60 Marks

Duration: 2 Hours

Theory question paper pattern:

Question	Based on	Marks
Q.1	Unit I	15
Q.2	Unit II	15
Q.3	Unit III	15
Q.4	Unit IV	15

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be sub-divided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.
- RM carries 100 Marks

III. Practical Examination

- Each core subject carries 20+30 Marks
- Internal Practical-20 Marks and external 30 Marks
- Duration: 2 hours for Internal Practical and 3 Hours for external
- Minimum 80% practical from each core subjects are required to be completed.
- Certified Journal is compulsory for appearing at the time of Practical Exam

NOTE: To pass the examination, attendance is compulsory in both Internal & External (Theory + Practical) Examination