S.P Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Program: M.Sc.

Course: Zoology

(Credit Based Semester and Grading System with effect from the academic year 2019-2020)

M.Sc. Zoology Syllabus Semester I and Semester II
Credit Based and Grading System
To be implemented from the Academic year 2019-2020
SEMESTER I

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
RPSZOO101	I	Phylogeny Systematics of non-chordates and assorted topics- I	4	1
	II	Phylogeny, systematics of non-chordates, Hemichordata & Assorted Topics		1
	III	Phylogeny, systematic of chordates and Assorted topics -I		1
	IV	Comparative vertebrate osteology- I		1
RPSZOO102	I	Biomolecules- a structural and functional approach- I	4	1
	II	Biochemical Thermodynamics		1
	III	Metabolic Pathways and integration of Metabolism- I		1
	IV	Regulation of metabolism		1
RPSZOO103	I	Genetics -Chromosome theory of inheritance and Mendelism- I	4	1
	II	Genetics- Extension of Mendelian Genetics and Non-Mendelian inheritance- I		1
	III	Evolution- I		1
	IV	Developmental Biology- I		1
RPSZOO104	I	Principles and applications of Microtomy, microscopy, centrifugation	4	1
	II	Principle and applications of radioisotopes & extraction techniques		1
	III	Principles and applications of spectroscopy		1
	IV	Good laboratory practices & research methodology- I		1
RPSZOP101	Non-chordates, Chordates and their Phylogeny -I		2	1
RPSZOP102	Biochemistry and Metabolism - I		2	1
RPSZOP103	Genetics, Evolution and Developmental Biology- I		2	1
RPSZOP104	Tools and Techniques in Biology - I		2	1

SEMESTER II

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
RPSZOO201	I	Phylogeny,systematics of non-chordates and assorted topics -II	4	1
	II	Phylogeny of Protochordates, Agnatha& Assorted Topics		1
	III	Phylogeny, systematics of chordates and assorted topics- II		1
	IV	Comparative vertebrate osteology- II		1
RPSZOO202	I	Biomolecules- a structural and functional approach- II	4	1
	II	Enzymes and Enzyme kinetics		1
	III	Metabolic Pathways and integration of Metabolism- II		1
	IV	Inborn errors of Metabolism		1
RPSZOO203	I	Genetics -Chromosome theory of inheritance and Mendelism- II	4	1
	II	Genetics- Extension of Mendelian Genetics and Non-Mendelian inheritance- II		1
	III	Evolution- II		1
	IV	Developmental Biology- II		1
RPSZOO204	I	Principles and applications of chromatography- I	4	1
	II	Principles and applications of chromatography-II(Gel chromatography and affinity chromatography)		1
	III	Principles and applications of chromatography & Electrophoresis (GC, HPTLC, Electrophoresis)		1
	IV	Good laboratory practices & Research methodology- II		1
RPSZOP201	Non-chordates, Chordates and their Phylogeny -II		2	1
RPSZOP202	Biochemistry and Metabolism - II		2	1
RPSZOP203	Genetics, Evolution and Developmental Biology- II		2	1
RPSZOP204	Tools and Techniques in Biology - II		2	1

M. Sc. Zoology Syllabus

Credit and Grading System

To be implemented from the Academic year 2019-2020

Semester I - THEORY

RPSZOO101: Non-chordates, chordates and their phylogeny -I **60 L**

Learning Objectives: To revise the basic concepts i.e.systematics, salient features and phylogeny of all phyla. It's also important for students to know about osteology of different animals.
Learning Outcomes: Students can compare the characteristics of different phyla and can know about the comparative study of different bones in different animals

Unit I: Phylogeny, Systematics of non-chordates and assorted topics-I **15 L**

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

Unit II: Phylogeny, Systematics of non-chordates, Hemichordata& assorted topics **15 L**

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.

Unit III: Phylogeny, Systematics of Chordates and Assorted topics- I **15 L**

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.

Unit IV: Comparative Vertebrate Osteology- I **15 L**

4.1. Embryonic development of- a) neurocranium, b) splanchnocraniuc)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.

Topics for Assignments & Essays

RPSZOO102: Biochemistry and Metabolism – I60L

Learning objective: It aims on understanding about structure and function of majorclass of biomolecules. It gives knowledge at molecular level of all chemical processes associated with living cells and its thermodynamics. It also gives understanding of central metabolic pathways and diseases associated.

Learning Outcomes: They will get an idea about research work in biochemistry and drug discovery. It will help them to prepare for exams like NET,SET etc.

Unit I: Biomolecules- a structural and functionalapproach-I **15 L**

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.
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.

Unit II: Biochemical Thermodynamics **15 L**

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.

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.

Unit III: Metabolic pathways and Integration of metabolism-I **15 L**

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 TG-lipase, 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.

Unit IV: Regulation of metabolism **15 L**

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.

RPSZOO103: Genetics, Evolution and Developmental Biology - I 60L

Learning objective: The syllabus aims to provide a fundamental knowledge of genetics. The objective of the syllabus is to acquaint students with mapping techniques in prokaryotes and eukaryotes. Developmental biology will help to understand the concept of cell commitment and cell fate in earlier stages of development.

Learning outcomes: The syllabus will provide students the opportunity to carry out research work related to developmental biology..

Comprehensive, detailed understanding of the chemical basis of heredity and the role of genetic mechanisms in evolution.

Unit I: Genetics- Chromosome theory of inheritance and Mendelism -I **15 L**

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 and salivary gland chromosome

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 allele

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

1.3.Genetics of cancer:

1.3.1. Relationship of cell cycle to cancer

1.3.2.Oncogenes

1.3.3.Tumour suppressor genes

1.3.4.Mutator genes

1.3.5.Chemicals and radiations as carcinogenes

Unit II: **Genetics- Extension of Mendelian genetics and non-Mendelian inheritance -I** **15 L**

2.1. Alleles and phenotypes:

2.1.1. Incomplete or partial dominance and co-dominance

2.1.2. Epistasis – Dominant and Recessive

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

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

Unit III Evolution -I **15 L**

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)

Unit IV: Developmental Biology-I **15 L**

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

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

*** Topics for Assignments & Essays**

RPSZOO104: Tools and Techniques in Biology - I 60L

Learning Objectives: The objective of the syllabus is to provide a general knowledge of basic principles and working of various instruments used in biological work. They will have an idea about different types of research and statistical methods used to analyse them.

Learning Outcomes: The knowledge gained will help students to handle the instruments .They will also learn to calibarate and take care of it hence increasing thier shelf life. Through research methodology they will develop idea regarding desertation.

Unit I: Microtomy, microscopy, centrifugation **15 L**

1.1.1Microtomy: Tissue fixation, dehydration, clearing, infiltration, embedding for paraffin method, sectioning, mounting, staining- differential and specific.

1.1.2 Cryopreservation

1.2.Principles and applications of microscopy: *Light microscopy, phase contrast microscopy, fluorescence microscopy, polarization microscopy, confocal scanning microscopy, transmission electron microscopy, specimen preparation for electron microscopy, scanning electron microscopy.

1.3. Principles and applications of centrifugation: Basic principles of centrifugation, Low speed and high speed centrifuges, ultracentrifuge, application of centrifugation-preparative techniques, analytical measurements; care of centrifuges and rotors.

Unit II: Radioisotopes and extraction techniques **15 L**

2.1. Principles and applications of radioisotopes: *Use of isotopes in biological sciences; units of radioactivity, detection and measurement of radioactivity by scintillation counting, 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.

Unit III Principle instrumentation **and application of Spectroscopy** **15 L**

3.1. Spectroscopy

3.1.1. Ultraviolet and visible absorption spectroscopy

3.1. 2. Fluorescence spectroscopy

3.1.3. Nuclear magnetic resonance spectroscopy

3.1.4. Mass spectroscopy

3.1.5. Atomic absorption spectrophotometer

Unit IV Good Laboratory Practices and Research Methodology- I 15 L

4.1. Safety in laboratories, Use, Care and Maintenance of common laboratory equipments: Microscope, pH meter,colorimeter/ spectrophotometer, analytical balance, centrifuge, electrophoresis apparatus, glassware; general safety measures; personal protection; chemical hazards; spillage and waste disposal; first aid.

4.2. Research methodology: Meaning of research; objective of research; motivation in research; types of research; research approaches; significance of research; research methods versus methodology; Research and scientific methods; Importance of knowing how research is done; Research process; Criteria for good research.

4.3. Research problem and research design: Selecting research problem; necessity of defining a problem; techniques involved in defining the problem; meaning of research design; need for research design; important concepts related to research design; different research designs; basic principles of experimental design; important experimental designs.

***Topics for Assignments & Essays**

Semester I- PRACTICAL

RPSZOP101

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)

Demonstration practical/Dissection/Virtual dissection/Model (2D 0r 3D)/Chart of the animal system as per UGC guidelines.

RPSZOP102

1. 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.
2. Determination of glucose by Benedict's method (volumetric).
3. Determination of reducing sugars by 3,5-dinitrosalicylic acid (colorimetric) method.
4. Determination of glycogen in the given tissue (liver/ skeletal muscle/ kidney/ brain).
5. Acid and enzyme hydrolysis of glycogen and colorimetric estimation of the products by 3,5-DNSA method.
6. Isolation of starch from potato.
7. Determination of acid value of fats/ oils.
8. Determination of saponification value of fats/ oils.
9. Reichert-Meissl (RM) number of fat.

RPSZOP103

1. Temporary squash preparation of onion/garlic root tip cells to study stages of mitosis.
2. Temporary squash preparation of testis of cockroach/ grasshopper/ Tradescantia pollen to study stages of meiosis.
3. Demonstration of inter-chromosomal connections in the cells of Tradescantia buds.
4. Temporary preparation of polytene chromosomes from salivary gland cells of Drosophila/ Chironomus.
5. Study of chromosome structures in human karyotype.
6. Study of different types of chromosome banding techniques.
7. Temporary preparation of buccal smear to study sex chromatin in human

RPSZOP104

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. Colorimeter: Selection of filter and determination of unknown concentration of solute.

==========

Semester II - THEORY

RPSZOO201: Non-chordates, chordates and their phylogeny - II **60L**

Learning objectives: students will know the salient features of minor and major phyla, their classification and their phylogeny with other phyla. They will have an idea about structures of different bones in different animals.
Learning outcomes: The students can correlate similarities and differences in different phyla, and different girdles. Construction of phylogenic tree will help them to remember the origin and divergence of different animals

Unit I: Phylogeny, Systematics of non-chordates and assorted topic-II **15 L**

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.

Unit II: Phylogeny of Protochordates, Agnatha and assorted topics II **15 L**

2.1. Urochordata and its similarities with other subphyla.

2.2. Cephalochordata and itssimilarities with other subphyla

2.3. Vertebrate ancestry and origin of Vertebrates.

2.4. Changes leading to first vertebrates.

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.

Unit III: Phylogeny, Systematics of Chordates and Assorted topics- II **15 L**

3.1. Warm blooded reptiles.Archaeopteryx- a connecting link between Reptiles and Aves.

3.2. Salient features of classAves 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)

Unit IV: Comparative Vertebrate Osteology- II **15 L**

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.

*** Topics for Assignments & Essays**

RPSZOO202: Biochemistry and Metabolism- II **60L**

Learning objectives: The course content will help the students to gain about about structure and function of different biomolecules, enzyme kinetics ,the associated metabolic pathways their regulation and the disease caused due to inborn errors of metabolism.

Learning outcomes: The knowledge obtained will provide students opportunities to enter in areas dealing with different types of enzymes related work. And also the syllabus will help them to face competitive exams.

Unit I: Biomolecules- a structural and functionalapproach-II **15 L**

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.

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.

1.1.5 Ramachandran plot

Unit II: Enzymes and Enzyme kinetics **15 L**

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)

Unit III: Metabolic pathways and Integration of metabolism **15 L**

3.1. Protein Metabolism:

3.1.1. Metabolism of amino acids: Amino acid pool, transamination; oxidative and non-oxidative 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.

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

Unit IV: Regulation of metabolism and inborn errors of metabolism **15 L**

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, Cysteinurea

4.1.4. Purine metabolism: Primary Gout

4.2. Mineral metabolism and diseases : Hypocalcimia, Hypercalcimia and osteoporosis

RPSZOO203: Genetics, Evolution and Developmental Biology -II **60L**

Learning Objectives: The objective is to develop and understanding of genetics inheritance pattern, terminologies used, environmental influence on sex determination, perspective of how genetics plays a role in evolution and the various developmental changes associated with amphibians, insects, hydra.

Learning Outcomes:Students will understand the following how gene expression is regulated, relationship between genotype and phenotype in human traits, statistical approach towards genetics and influence of particular allele on population.

Unit I: Genetics- Chromosome theory of inheritance and Mendelism-II **15 L**

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- Bacterial and eukaryotes

1.2.7.Pseudoalleles

Unit II: **Genetics- Extension of Mendelian genetics and non-Mendelian inheritance -II** **15 L**

2.1. Determination of sex

2.1.1. Environmental control of sex (*Bonellia, Crepedula*); temperature dependent sex determination (TSD) in reptiles.

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.

Unit III: Evolution-II **15L**

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 naturalselection

Unit IV: Developmental Biology- II **15 L**

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- (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.

Topics for Assignments & Essay

RPSZOO204: Tools and Techniques in Biology- II **60L**

Learning objectives:The subject content will help students to understand the working and application of important techniques like chromatography, electrophoresis. Through research methodology they will get an idea regarding report framing and proposal writing.

Learning outcomes: At the end of the course the student should be able to explain the principles of the most important liquid and gas chromatographic technique. They must have acquired some technical knowledge, some practical experience and will be able to evaluate strengths and limitations of the most important chromatographic separation and detection methods in relation to the properties of the sample and of the analysis task.

Unit I Principles and application of chromatography I **15 L**

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. Column chromatography: Packing and operation of column, loading the column, eluting the column, collection of elluent, detection of elluent, application.

1.1.3. Ion exchange chromatography: Ion exchange resins, selection of ion-exchanger, choice of buffers, preparation and use of ion-exchangers, storage of resins.

Unit II: Principles and application of chromatography II **15 L**

2.1. 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

2.2 Affinity chromatography: Chromatography media, immobilized ligands, attachment of ligands to the matrix, experimental procedures and application.

Unit III: Principles and application of chromatography and Electrophoresis **15 L**

3.1. Gas chromatography

3.1.1. Gas chromatography (GC): Instrumentation, selection of operating conditions, analysis of data and application.

3.1.2. HPLC.

3.2. Electrophoresis

3.2.1. Theory of electrophoresis

3.2.2. Horizontal agarose gel electrophoresis

3.2.3. Vertical polyacrylamide gel electrophoresis

3.2.4. Pulse field electrophoresis

3.2.5. Capillary electrophoresis

3.2.6. Isoelectric focusing of proteins

3.2.7. Two dimensional electrophoresis.

Unit IV: Good Laboratory Practices and Research Methodology- II **15 L**

4.1. Interpretation and report writing: Meaning of interpretation; technique of interpretation; precautions in interpretation; 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.

4.2. 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.

4.3. Writing research proposal: Characteristics of a proposal; content and organization of a proposal; weakness in proposal seeking funding.

*** Topics for Assignments & Essays**

Semester II - PRACTICAL

RPSZOP201

1. Study of animal type*: *Periplanataamericana:* Morphology, digestive system, nervous system, reproductive system and life history. Mountings of- cornea, salivary glands, gonapophyses, spermatheca
3. 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).
4. Study of Larval forms: Larvae of Helminthes- Miracidium, Redia, Cercaria, Metacercaria; Trochophore, Crustacean larvae, Ascidian tadpole.
5. 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)
6. 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.

RPSZOP202

1. Determination of total cholesterol and HDL cholesterol from serum.
2. Qualitative tests for amino acids and Proteins: Ninhydrin test; Xanthoproteic test; Millon's test; Biuret test.
3. Colorimetric estimation of protein by Peterson-Lowry method.
4. Quantitative estimation of amino acids using ninhydrin reagent.
5. Isolation of casein from milk.
6. Detection of conformation of BSA by viscosity measurement and effect of varying concentration of urea on viscosity of BSA.
7. Determination of creatinine in serum and urea.
8. SDH specific activity.

RPSZOP203

1. Problems in genetics.
2. Pedigree analysis.
3. Quantitative estimation of DNA in a suitable tissue by diphenyl amine method.
4. Quantitative estimation of RNA in a suitable tissue by orcinol method.
5. Observation of morphogenetic movements in chick embryo.
6. Isolation of limb bud and its chorioallantoic grafting.

RPSZOP204

1. Identification of lipids in a given sample by TLC.
2. Separation of pigments from leaves or flowers by adsorption column chromatography.
3. Separation of amino acids by ion exchange chromatography using cation exchanger.
4. Separation and identification of amino acids by 2D paper chromatography
5. SDS-polyacrylamide slab gel electrophoresis of proteins.

REFERENCES

RPSZO0101and RPSZOO201

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

RPSZOO102 and RPSZOO202

- 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

RPSZOO103 and RPSZOO203

- 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.

RPSZOO104 and RPSZOO204

- 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.

Modality of Assessment:

A) Internal Assessment- 40%

a) Theory

Sr. No.	Evaluation type	Marks
1.	Two Assignments/Case study/Project/Research paper review	20
2.	One class Test (multiple choice objective questions)	15
3.	Active participation in routine class instructional deliveries (case studies/seminars/presentations)	05
4.	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

b) Practicals

Sr. No.	Evaluation type	Marks
1.	Based on the theory paper	40
2.	Journal	05
3.	Viva	05

B) External examination- 60%

a) Semester End Theory Assessment- 60% **60 Marks**

i) Duration - These examinations shall be of two hours duration for each paper.

ii) Theory Question Paper Pattern:-

- There shall be five questions each of 12 marks. On each unit there will be one question and the last question will be based on entire syllabus.
- All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 20 marks with options.
- Question may be subdivided into sub-questions a, b, c… and the allocation of marks depend on the weightage of the topic.

b) Practicals **50 Marks**

M.Sc. ZOOLOGY
Semester I/Semester II EXAMINATION
2019-20

Coursecode:_____

Maximum Marks: 60
Duration: 2 Hours
Marks Option: 90

Question 1: Unit I

Question 2: Unit II

Question 3: Unit III

Question 4: Unit IV

Question 5: Unit I to Unit IV (Mixed Questions)

Instructions:

i. All questions are compulsory.
ii. All questions carry equal marks.
iii. Draw neat and labeled diagrams wherever necessary.

1. Answer any **two questions** from the following (Based on Unit I)
   a. 06
   b. 06
   c. 06
2. Answer any **two questions** from the following (Based on Unit II)
   a. 06
   b. 06
   c. 06
3. Answer any **two questions** from the following (Based on Unit III)
   a. 06
   b. 06
   c. 06
4. Answer any **two questions** from the following (Based on Unit IV)
   a. 06
   b. 06
   c. 06
5. Answer any **four questions** from the following (Based on entire syllabus)
   a. 03
   b. 03
   c. 03
   d. 03
   e. 03
   f. 03

======= x =======

M.Sc. ZOOLOGY

Semester I

PRACTICAL EXAMINATIONRPSZOP101

Total Marks: 50

1. *Dissect Sepia so as to expose its digestive system/reproductive system/nervous system. 10

2. *Make temporary preparation/mounting (stain if necessary) of - 06

   Jaws/Radula/Spermatophores/Statocyst of Sepia

   Or

   * Spicules of Holothurian.

3. Identify specimen/slide a to h as per instructions. 24

4. Viva 05

5. Journal 05

   • Candidates are required to present certified journal on the day of practical examination.

   (* Demonstration/Dissection/Virtual dissection/Model (2D or 3D)/Chart of animal system as per UGC guidelines)

==========

M.Sc. ZOOLOGY

Semester I

PRACTICAL EXAMINATION RPSZOP102

Total Marks: 50.

1. Estimate the yield of glycogen from skeletal muscles / liver. Show the results to the examiners and submit a report. 20

Or

Demonstrate the enzymatic / acid hydrolysis of glycogen from the given sample. Show the results to the examiners and submit a report.

Or

Identify the nature of carbohydrates in the given sample using qualitative tests (6 tests).

2.From the given material isolate Starch and estimate the yield. Show the results to the examiners and submit a report. 20

Or

Estimate the amount of Glucose by Benedict's volumetric method. Show the results to Examiners and submit a report.

Or

Determine the amount of reducing sugars from the given sample by DNSA method. Show the results to the examiners and submit a report.

Or

Determine the Saponification Value / Acid Value / Reichert-Meissl (RM) number of the given sample of lipid. Show the results to the examiners and submit a report.

3. Viva 05

4. Journal 05

- Candidates are required to present certified journal on the day of practical examination.

==========

M.Sc. ZOOLOGY

Semester I

PRACTICAL EXAMINATION RPSZOP103

Total Marks: 50

1. Make a temporary squash preparation of testis of cockroach/ grasshopper/ Tradescantia young anther to study stages of meiosis. 15

Or

Make a temporary preparation of polytene chromosomes from salivary gland cells of Drosophila/ Chironomus larva.

2. Make a temporary squash preparation of onion/garlic root tip cells to study stages of mitosis. 10

Or

Make a temporary preparation of buccal smear to study sex chromatin in human.

3 Make a karyotype analysis from the given printed material and comment on the numerical or/and structural variations in the chromosomes. 15

Or

Identify and describe different types of chromosome banding techniques.

4. Viva 05

5. Journal 05

- Candidates are required to present certified journal on the day of practical examination.

==========

M.Sc. ZOOLOGY

Semester I

PRACTICAL EXAMINATION RPSZOP104

Total Marks: 50

1. Major Experiment: 20

Demonstrate the relationship between absorbance of light and the conc. of the dye in the solution using different wavelengths for five dilutions. Tabulate the readings. Plot the absorbance curves on the same graph paper and explain the choice of ideal filter from your results.

Or

Determine the pKa of the given weak acid.

Or

Using Henderson Hasselbalch equation calculate the p^H of buffer prepared by mixing known volume of either acid and or salt solutions. Check p^H using p^H meter.

2. (a) Identify the pictograms/ signs/symbols a-e and comment on their significance in a scientific laboratory. 10

(b) Prepare a solution of a given molarity/Normality 05

3. Minor Experiment: 05

From the infiltrated tissue prepare blocks, trim and mount it on the holder for section cutting.

Or

Trim the given block, mount it on the block holder, cut the sections and from ribbons prepare slides

Or

Dewax the mounted ribbons and stain the sections with Hematoxylin/Eosin.

4. Viva 05

5. Journal 05

Candidates are required to present certified journal on the day of practical examination.

M.Sc. ZOOLOGY

Semester II

PRACTICAL EXAMINATION RPSZOP201

Total Marks: 50

1. *Dissect Cockroach so as to expose its digestive system/ reproductive system/ nervous system. 12
2. *Make temporary preparation/mounting (stain if necessary) of - Cockroach - cornea/salivary glands/gonapophyses/spermatheca 04
3. Identify specimen/slide a-h as per instructions. 24
4. Viva 05
5. Journal 05

- Candidates are required to present certified journal on the day of practical examination. (*Demonstration/Dissection/Virtual dissection/Model (2D or 3D)/Chart of animal system as per UGC guidelines)

==========

M.Sc. ZOOLOGY

Semester II

PRACTICAL EXAMINATION RPSZOP202

Total Marks: 50

1. Estimate the protein content of the given tissue homogenate by Peterson-Lowry method 20
Show the results to the examiners and submit the report.

Or

Estimate the amino acid content of the given sample by Ninhydrin reagent. Prepare a Standard graph.

Or

Demonstrate the effect of inhibitor on Succinic Dehydrogenase activity. Show the results to the examiners and submit a report.

Or

Demonstrate the effect of variation in Urea concentration on the conformation of Protein by viscosity measurements. Show the results to the examiners and submit a report.

Or

Estimate the concentration of Creatinine in the given serum / urine sample. Show the results to the examiners and submit a report.

2. Isolate Casein from the given sample of milk and determine its yield. Show the results to the 20
examiners and submit a report.

Or

Determine Total / HDL Cholesterol from the given serum sample. Show the results to the examiners and submit a report.

Or

Detect the protein / amino acids in the given sample using qualitative tests (4 tests).

3. Viva 05

4, Journal 05

- Candidates are required to present certified journal on the day of practical examination.

==========

M.Sc. ZOOLOGY

Semester II

PRACTICAL EXAMINATION RPSZOP203

Total Marks: 50

1. Extract and quantitatively estimate the amount of DNA/RNA from the given tissue homogenate. 15

2. Demonstrate the morphogenetic movements in chick embryo and isolate Limb bud from the given chick embryo. 15

Or

Isolate limb bud from the given chick embryo and demonstrate the chorioallontoic grafting from the given chick embryo.

3. (i) Solve the given problem in Genetics. 10

(ii)Solve the given problem related to Pedigree analysis. 05

4. Viva

5. Journal 05

- Candidates are required to present certified journal on the day of practical examination.

==========

M.Sc. ZOOLOGY

Semester II

PRACTICAL EXAMINATION RPSZOP204

Total Marks: 50

1. Demonstrate the technique of two-dimensional paper chromatography to separate the amino acids. Calculate Rf value. 20

Or

Demonstrate the use of adsorption column chromatography to separate the pigments from leaves or flowers.

Or

Demonstrate the technique of ion exchange column chromatography in the separation of amino acids using two buffers.

2 Identification of lipids in a given sample by TLC. 20

Or

Demonstrate SDS-PAGE under reducing conditions for separation of Plasma/Proteins.

3. Viva 05

4. Journal 05

- Candidates are required to present certified journal on the day of practical examination.

==========