

**Ramniranjan Jhunjhunwala College of Arts,
Science and Commerce**

(Autonomous affiliated to University of Mumbai)

Syllabus for F.Y.B.Sc

Semester I & II

Program: B.Sc

Course: Zoology

F.Y.B.Sc. Zoology Syllabus

Semester I

Course code	Unit	Topic
RJSZOOSI01	I	Levels of organization and classification of animal kingdom-I
	II	Ecology-I
	II	Biodiversity and Conservation
RJSZOOSI02	I	Biomolecules-I
	II	Basic Biotechnology
	II	Laboratory safety, Units and Measurement
RJSZOOSIP01		Practicals based on Paper I and II

Semester II

Course code	Unit	Topic
RJSZOOSII01	I	Classification of animal kingdom-II
	II	Ecology-II
	II	Basics of ethology
RJSZOOSII02	I	Biomolecules-II
	II	Health, Hygiene and Health hazards
	II	Instrumentation
RJSZOOSIIP02		Practicals based on Paper I and II

**F.Y.B.Sc ZOOLOGY THEORY
SEMESTER I**

**PAPER-I
COURSE CODE: RJSZOOSI01**

UNIT I: Levels of organization and classification of animal kingdom-I

1.1: Levels of organization

- 1.1.1: Unicellularity vs. multicellularity: Colonization and organization of germ layers (diploblastic and triploblastic condition).
- 1.1.2: Division of labour and organization of tissues (Brief fate of ectoderm, mesoderm and endoderm).
- 1.1.3: Development of coelome: Acoelomate, Pseudocoelomate and Eucoelomate organization.
- 1.1.4: Radial and bilateral symmetry.
- 1.1.5: Segmentation and cephalization.

1.2: Unicellular and multicellular organization (Salient features with examples of phyla, subphyla and classes mentioned below)

- 1.2.1: Unicellular organization: Phylum Protozoa.
- 1.2.2: Multicellular organization: Colonization level- Phylum Porifera.
- 1.2.3: Multicellular organization: Division of labour (Cell differentiation)-Phylum Coelenterata.
- 1.2.4: Acoelomate organization - Phylum Platyhelminthes.
- 1.2.5: Pseudo coelomate organization – Phylum Nematoda.
- 1.2.6: Triploblastic coelomate organization
 - 1.2.6 (A):** Animals with metameric segmentation- Phylum Annelida.
 - 1.2.6 (B):** Animals with jointed appendages- Phylum Arthropoda.
 - 1.2.6 (C):** Animals with mantle: Phylum Mollusca.
 - 1.2.6 (D):** Animals with enterocoel: Phylum Echinodermata.

UNIT II: Ecology-I

2.1 Overview of Ecology

2.2 Physical Factors:

- 2.2.1 Edaphic: Soil formation, Components of Soil, Types of soil and Soil Profile.
- 2.2.2 Light: Relation to terrestrial and aquatic habitat, photoperiodism, diurnal migrations, Adaptation of animals to dark.
- 2.2.3 Temperature: Range, tolerance, Bergman's principle, Allen's Rule, Effects of temperature on living organisms.
- 2.2.4 Biogeochemical Cycles: Oxygen, Carbon dioxide, sulphur, nitrogen, phosphorus, Human activities affecting biogeochemical cycles.

UNIT III: Biodiversity and Conservation

- 3.1: Introduction to Biodiversity - Definition, Concepts and Scope.
- 3.2: Levels of Biodiversity -Genetic, Species and Ecosystem Biodiversity.
- 3.3: Biodiversity Hotspots- Western Ghats and Indo-Burma Border.
- 3.4: Threats to Biodiversity - Habitat loss and Man-Wildlife conflict.
- 3.5: Biodiversity conservation and management:
 - 3. 5.1: Conservation strategies: in situ, ex-situ, National parks, Sanctuaries and Biosphere reserves.
 - 3.5.2: International efforts : Convention on Biological Diversity (CBD), International Union for Conservation of Nature and Natural Resources (IUCN), United Nations Environment Program - World Conservation Monitoring Centre (UNEP-WCMC)
 - 3.5.3: Introduction to Indian Wildlife (Protection) Act, 1972 and Convention for International Trade of endangered species (CITES).

PAPER II

COURSE CODE: RJSZOOSI02

UNIT I: Biomolecules-I

- 1.1- Basic biochemistry: Concept of monomers & polymers, Role and significance of carbon, types of chemical bonds. Water- role as universal solvent, properties of water.
- 1.2- Carbohydrates:
 - 1.2.1- Nomenclature and isomerism.
 - 1.2.2- Glycosidic bond.
 - 1.2.3- Classification of carbohydrates;
 - a) Monosaccharides- Galactose& fructose
 - b) Disaccharides- Sucrose & lactose
 - c) Polysaccharides- Starch, cellulose, glycogen, chitin
 - 1.2.4- Biological role of carbohydrates
- 1.3- Nucleic Acids:
 - 1.3.1: Structure (Structure of Purine &Pyrimidine Bases, Hydrogen Bonding between Nitrogenous bases in DNA, Structure of Nucleosides, Nucleotides and Polynucleotides) & functions of Nucleic Acids.
 - 1.3.2: Properties and Types of DNA (A, B, & Z) & RNA.
 - 1.3.3: Differences between DNA and RNA.

UNIT II: Basic Biotechnology

2.1: Concept of Biotechnology

- 2.1.1: Definition
- 2.1.2: An overview of achievements and scope (fishery, animal husbandry, medical, industrial, agriculture).

2.2 Transgenesis and cloning

- 2.2.1 Methods of transgenesis: Retroviral method, nuclear transplantation method, DNA micro injection method and embryonic stem cell method.

- 2.2.2. Animal Cloning (Dolly experiment).
- 2.2.3 Ethical issues of transgenic and cloned animals.

2.3 Applications of Biotechnology

- 2.3.1 Forensic biotechnology: DNA fingerprinting; Technique in brief and its application in forensic science (Crime Investigation).
- 2.3.2: Enzyme Technology;
 - a) Bio-detergents
 - b) Concept of enzyme immobilization.
 - c) Enzymes as meat tenderizer.
- 2.3.3: Medical biotechnology;
 - a) Recombinant DNA in medicines (recombinant insulin).
 - b) Gene therapy: Ex-vivo and *In vivo*, Severe Combined Immunodeficiency (SCID), Cystic Fibrosis.
- 2.3.4: Environmental Biotechnology;
 - a) Bioremediation: Concepts and applications.
 - b) Biodegradation of polycyclic aromatic hydrocarbons (PAHs) and Petrochemicals.

UNIT III: Laboratory safety, Units and Measurement

- 1.1: Introduction to good laboratory practices.
- 1.2: Use of safety symbols: meaning, types of hazards and precautions.
- 1.3: Units of measurement:
 - 1.3.1: Calculations and related conversions of each: Metric system- length (meter to micrometer); weight (gram to microgram), Volumetric (Cubic measures)
 - 1.3.2: Temperature: Celsius, Fahrenheit, Kelvin.
 - 1.3.3: Concentrations: Percent solutions, ppt, ppm, ppb dilutions, Normality, Molarity and Molality.
- 1.4: Biostatistics: Introduction and scope, Sampling and its types, Central Tendencies (mean, median, and mode) Tabulation, Graphical representations (Histograms, bar diagrams, pie diagrams).

F.Y.B.Sc SYLLABUS FOR PRACTICAL SEMESTER I

COURSE CODE: RJSZOOSIP01

PRACTICAL I (Based on Paper I)

- 1. Levels of organization in Animal kingdom
 - A) Symmetry: i) Asymmetric organization: Amoeba ii) Radial symmetry: Sea anemone, Aurelia iii) Bilateral symmetry: Planaria / liver fluke
 - B) Acoelomate: T.S. of Planaria / liver fluke
 - C) Pseudocoelomate: T.S. of Ascaris
 - D) Coelomate : T.S. of Earthworm

E) Segmentation i) Pseudosegmentation: Tapeworm ii) Metamerism: Earthworm iii) Specialization of body parts for division of labour: Head, thorax and abdomen - Insect

F) Cephalization i) Cockroach – Head ii) Prawn/ crab – Cephalothorax

2. Animal Diversity -I

Protozoa : Amoeba, Paramecium, Euglena, Plasmodium

Porifera: Leucosolenia, bath sponge

Coelenterate: Hydra, obelia colony, Aurelia, sea anemone and any one coral

Platyhelminthes: Planaria, liver fluke and tapeworm

Nemathelminthes: Ascaris- male and female

Annelida: Nereis, earthworm and leech

Arthropoda: Crab, lobster, Lepisma, beetle, dragonfly, butterfly, moth, spider, centipede, millipede

Mollusca: Chiton, Dentalium, Pila, bivalve, Sepia and Nautilus

Echinodermata: Starfish, brittle star, sea urchin, sea cucumber, feather star.

3. Determination of soil pH; by pH meter, universal indicator, pH paper.

4. Estimation of salinity by Argentometry/refractometer

5. Study of Biodiversity hotspots using world map.

6. Study of peculiar animals found in the world biodiversity hotspots.

7. Field visit and report submission.

PRACTICAL II (Based on Paper II)

1. Qualitative tests for carbohydrates.

2. Extraction and qualitative detection of nucleic acids:

DNA (SDS-NaCl extraction),

RNA (Phenol extraction)

3. Aseptic techniques: Packaging of test tubes, pipettes, petriplates, conical flask.

4. Aseptic transfer of liquids between burners.

5. Assay of immobilized amylase or invertase from immobilised yeast cells by DNSA method (visual observation for comparative colour intensity in test tube)

6. To demonstrate fermentation of grape juice/sugar cane juice or any fruit juice – (Detection of alcohol generated during fermentation by benzoic acid).

7. Effect of Papain (raw papaya extract) as a meat tenderizer

8. Study of Central tendencies and plotting of Bar diagram, histogram and pie diagram.
9. Problem based on concentrations: percent solutions, normality ,molarity.

**F.Y.B.Sc ZOOLOGY THEORY
SEMESTER II**

**PAPER-I
COURSE CODE: RJSZOOSII01**

UNIT I: Classification of animal kingdom-II

1.1: Phylum Hemichordata.

1.2: Phylum Chordata;

1.2.1: Subphylum: Urochordata

1.2.2: Subphylum: Cephalochordata

1.2.3: Subplylum: Vertebrata

A. Division: AgnathaClass Cyclostomata

B. Division: Gnathostomata

Super class: Pisces

i. Class Chondrichthyes

ii. Class Oestichthyes

Super class: Tetrapoda

iii. Class Amphibia

iv. Class Reptilia

v. Class Aves

vi. Class Mammalia

UNIT II: Ecology-II

2.1: Population Ecology: Concept, Factors influencing Population dynamics: Natality, Mortality, Growth curves, Survivorship curves, Migration, Density, age structure and sex ratio, fecundity.

2.2 Animal Interactions: Concept, Positive and negative interactions, ecological significance.

2.3 Concepts of Ecosystem: Components of ecosystem, energy flow in ecosystem, food chain and food web, Energy pyramids.

UNIT III: Basics of ethology

3.1: Development of behaviour: Ontogeny of behaviour, sensitive periods during development e.g bird song development.

3.2: Innate behaviour: Fixed Action Plan, Orientation, Taxes, Irritability.

3.3: Learned behaviour: Conditioned reflex, habituation, sensitization, instrumental learning and operant behaviour.

3.4: Protective behaviour: Camouflage, Warning colouration, Mimicry- Batesian&Mullerian, Adaptive &evolutionary significance of mimicry

PAPER-II
COURSE CODE: RJSZOOSII02

UNIT I: Biomolecules-II

1.1 Lipids:

- 1.1.1: Classification of Lipids
- 1.1.2: Types of Fatty Acids (Saturated & Unsaturated)
- 1.1.3: Biological roles of lipids
- 1.1.4: Overview of Phospholipids, Glycerides (Mono, Di & Tri)

1.2 -Proteins:

- 1.2.1- Amino acids- Basic structure, Types based on carboxylic, amino & aromatic groups, essential, Semi- essential & non- essential amino acids, Amino acid pool.
- 1.2.2- Peptide bond.
- 1.2.3- Structure of protein- primary, secondary, tertiary and quaternary
- 1.2.4- Biological role of proteins

1.3 Vitamins:

- 1.3.1: Types & Classification (Water soluble & Lipid soluble),
- 1.3.2: Functions of vitamins.

UNIT II: Health, Hygiene & Health Hazard

2.1: Health

- 2.1.1: Definition of Health, need for health education.
- 2.1.2: Physical, psychological and social health issues.
- 2.1.3: Water and water supply, standards of potable water.
- 2.1.4: Purification of water: small scale, medium scale and large scale (rapid sand filters)
- 2.1.5: Water footprint: concept, brief account and significance.

2.2: Hygiene:

- 2.2.1: Hygiene and health factors at home.
- 2.2.2: Personal hygiene, oral hygiene and sex hygiene.

2.3 Health Hazards:

- 2.3.1: WHO and its programmes: Polio, Small pox, Malaria and T.B, Outcome with respect to India.
- 2.3.2: Radiation risk: Mobile cell tower and electronic gadgets (data of recommended level, effects and precaution).
- 2.3.3: Ill-effects of self-medication.

UNIT III: Instrumentation

- 3.1 Microscopy (dissecting and compound), Analytical balance: Principle, SOP and applications.
- 3.2 Colorimetry and spectroscopy: Principle, SOP and applications.
- 3.3 pH meter: Principle, SOP and applications.
- 3.4 Centrifuge (clinical and ultra-centrifuge): Principle, SOP and applications.
- 3.5 Electrophoresis (AGE, PAGE): Principle, SOP and applications.
- 3.6 Instrument for sterilization techniques: Autoclave, Incubator, Laminar overflow- Principle, SOP and applications.
- 3.7 Chromatography (paper, TLC, adsorption): Principle and applications.

F.Y.B.Sc SYLLABUS FOR PRACTICAL SEMESTER II

COURSE CODE: RJSZOOSIIP02

PRACTICAL I (Based on Paper 1)

1. ANIMAL DIVERSITY-II
 - a) Hemichordata: Balanoglossus
 - b) Urochordata: Herdmania
 - c) Cephalochordata: Amphioxus
 - d) Cyclostomata: Petromyzon/Myxine
 - e) Pisces: Chondrichthyes: Shark, skates, sting ray/electric ray
 - f) Osteichthyes: Sciaena, flying fish
 - g) Amphibia: Frog, toad, caecilian, salamander
 - h) Reptalia: Chameleon, Calotes, turtle/tortoise, snake, alligator/crocodile.
 - i) Aves: Kite, kingfisher, duck
 - j) Mammalia: Shrew, hedgehog, guinea pig, bat
2. Determination of population density;
 - a. Subsampling method using *Daphnia*.
 - b. Capture-recapture method using Rice Weevil.
3. Interpretation of the given graphs/ tables and comment on pattern of population nature:
 - a) Survivorship curve
 - b) Age structure
 - c) Sex ratio
4. Calculation of Natality, Mortality, fecundity w.r.t. population studies.
5. Interpretation of Growth curves (Sigmoid and J shaped)
6. Study of animal interaction:
 - a) Commensalism: Hermit crab and sea anemone, Echinus and shark
 - b) Mutualism: Termite and Trichonympha
 - c) Antibiosis: Effect of antibiotic on bacterial growth on a petri plate
 - d) Parasitism: Ectoparasite – head louse and bed bug
 - e) Endoparasite: Trichinella spiralis
 - f) Predation: Praying mantis and spider
7. Study of Mimicry: Leaf insect, stick insect, stick worm (caterpillar), Kallima butterfly, Monarch butterfly and common tiger butterfly (Danids)

8. Study of Warning Colouration in animals: Coral snake, strawberry poison frog, chameleon, honey badger, blue ring octopus.

PRACTICAL II (Based on Paper 2)

1. Qualitative tests for proteins.
2. Separation of amino acids by paper chromatography.
3. Thin layer chromatography of lipids
4. Qualitative tests for lipids.
5. Qualitative estimation of Vitamin C by Iodometric method
6. Study of Microscope: Use, care and functions of its components.
7. Study of microbial flora of water by Gram's staining.
8. Handling of common laboratory equipment: Burner, balance, homogenizer, colorimeter, pH meter, centrifuge.
9. Sterilization techniques: Autoclave, Oven, Laminar air flow.
10. Electrophoresis apparatus: AGE, PAGE.
11. Adsorption chromatography using chalk to separate mixture of dye.

SCHEME OF EXAMINATION (FOR BOTH SEMESTERS)

Internal examination

The first internal class test comprising of 20 marks shall consist of 20 multiple choice questions with equal weightage.

The second class test will comprise of three short notes- one from each unit of 4 marks each and eight questions of one mark each from all units.

External theory paper pattern

Total: 60 marks

Q.1 Based on Unit I..... 15M

- a. 8 M
- b. 7 M

OR

- a. 5 M
- b. 5M
- c. 5M

Q.2 Based on Unit II.....15M

- a. 8 M
- b. 7 M

OR

- a. 5 M
- b. 5M
- c. 5M

Q.3 Based on Unit III.....15M

- a. 8 M
- b. 7 M

OR

- a. 5 M
- b. 5M
- c. 5M

Q.4 Short notes (mixed on all units).....15M (5marks each)

- a or a (Unit I)
- b or b (Unit II)

c or c (Unit III)

QUESTION PAPER FOR PRACTICAL EXAMINATION

SEMESTER I

PRACTICAL I

Total marks: 50

Q.1 Major experiment- Soil pH/ Salinity of water	12M
Q.2 Identify and comment on the level of organization. (symmetry/coelom/segmentation/cephalization)	03M
Q.3 Identify and Classify with reasons.	15M
a. One specimen from Protozoa/Porifera	
b. One specimen from Coelenterata	
c. One specimen from Platyhelminthes/Nemathelminthes	
d. One specimen from Annelida/Arthropoda	
e. One specimen from Mollusca/Echinodermata	
Q.4 Field report	10M
Q.5 Viva	5M
Q.6 Journal	5M

PRACTICAL II

Total marks: 50

Q.1 Major experiment- Extraction of DNA/RNA/ Assay of immobilized enzyme	12M
Q.2 Minor experiment- Fermentation/Papain as meat tenderizer/aseptic techniques	8M
Q.3 Problems based on biostatistics	10M
a. Central tendency	
b. Graphical presentation of data	

Q.4 Problems based on concentration calculations	10M
a. % solutions	
b. Normality/ Molarity	
Q.5 Viva	5M
Q.6 Journal	5M

QUESTION PAPER FOR PRACTICAL EXAMINATION

SEMESTER I

PRACTICAL I

Total marks: 50

Q.1 Major experiment	12M
Estimation of population density of Daphnia/ Rice weevil	
Q.2 Identify and classify with reasons.	12M
a. Any one specimen from Hemichordata/Urochordata/Cephalochordata	
b. Any one specimen from Cyclostomata/ Pisces	
c. Any one specimen from Amphibia/ Reptiles	
d. Any one specimen from Aves/Mammals	
Q.3 Identify and Comment on	6M
a. One specimen from Mimicry	
b. One specimen from warning colouration	
Q.4 Problems based on population ecology (2 problems)	10M
(Natality/Mortality/Fecundity/Sex ratio)	
Q.5 Viva	5M
Q.6 Journal	5M

PRACTICAL II

Total marks: 50

Q.1 Major experiment – Paper chromatography/ Grams staining	12M
Q.2 Minor experiment	8M
a. Chromatography (Adsorption/TLC)	
b. Qualitative tests (Lipids/Vitamin C/Proteins)	

Q.3 Identify and describe the principle/working/uses. a, b, c & d (Any 4 instruments studied in practical)	16M
Q.4 Viva	05M
Q.5 Journal	05M

REFERENCES:

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Syllabus for S.Y.B.Sc

Semester III & IV

Program: B.Sc

Course: Zoology

S.Y.B.Sc. Zoology Syllabus

Semester III

Course code	Unit	Topic
RJSZOOSIII01	I	Type study Earthworm
	II	Life processes-I
	III	Developmental Biology
RJSZOOSIII02	I	Biochemistry- I
	II	Genetics
	III	Molecular Biology
RJSZOOSIII03	I	Ecosystem ecology and community dynamics
	II	Fishery Biology
	III	Economic entomology
RJSZOOSIIP03		Practicals based on Paper I, II & III

Semester IV

Course code	Unit	Topic
RJSZOOSIV01	I	Type study-Cockroach
	II	Life processes-II
	II	Cell biology
RJSZOOSIV02	I	Biochemistry-II
	II	Chromosomes and heredity
	III	Evolution
RJSZOOSIV03	I	Parasitology
	II	Animal husbandry

	III	Behavioural ethology
RJSZOOSIVP04		Practicals based on Paper I, II & III

S.Y.B.Sc ZOOLOGY Semester III

PAPER I

Course code: RJSZOOSIII01

UNIT I: Type study; Earthworm

- 1.1 Classification and Salient features.
- 1.2 Digestive system
- 1.3 Circulatory system
- 1.4 Excretory system
- 1.5 Nervous system
- 1.6 Reproductive system, copulation, cocoon formation and development.
- 1.7 Locomotion
- 1.8 Economic importance

UNIT II: Life processes-I

2.1 Study of Nutrition and Excretion

- 2.1.1 Comparative study of Nutritional Apparatus (structure and function): Amoeba, Hydra, Amphioxus, Pigeon, Ruminants.
- 2.1.2 Physiology of digestion in man
- 2.1.3 Comparative study of Excretory and Osmoregulatory structures and function
 - a. Amoeba -contractile vacuoles
 - b. Planaria -Flame cells
 - c. Earthworm -Nephridia
 - d. Cockroach-Malphigian tubules and green gland
- 2.1.4 Categorization of animals based on principle nitrogenous excretory products
- 2.1.5 Structure of kidney, Uriniferous tubule and physiology of urine formation in man.

2. 2 Study of Respiration

- 2.2.1 Comparative study of Respiratory organs (structure & function): Earthworm, Spider, Fish, Frog and Pigeon.
- 2.2.2 Structure of lungs and physiology of respiration in man

2.3 Study of Reproduction

- 2.3.1 Asexual Reproduction- Fission, fragmentation, gemmule formation, budding.
- 2.3.2 Sexual reproduction;
 - i. Gametogenesis
 - ii. Structure of male and female gametes in human

UNIT III: Developmental Biology

3.1. Fertilization

- i. Types of fertilization
- ii. Oviparity, viviparity, ovo-viviparity

3.2 Eggs and Cleavage

- A] Types of Eggs
- B] Types of Cleavage

3.3 Types of Blastulae: Amphibia, Bird and Mammal

3.4 Gastrulation: Epiboly, Emboly, invagination, involution and infiltration

3.5 Fate of three Germinal Layers and Coelom formation

PAPER II

Course code:RJSZOOSIII02

UNIT I: Biochemistry I

1.1 Fundamentals of Biochemistry.

- 1.1.1: Buffer, pKa, Henderson-Hasselbach equation.
- 1.1.2: Thermodynamics in Biochemistry, Concept of Bioenergetics.
- 1.1.3: Introduction to metabolism: Concept of metabolic pathways, anabolism, catabolism.

1.2 Carbohydrate metabolism.

- 1.2.1 Carbohydrate metabolism-an overview.
- 1.2.2 Glycolysis, TCA cycle, anaerobic pathway.
- 1.2.3 Electron transport and oxidative phosphorylation.
- 1.2.4 Gluconeogenesis, HMP.
- 1.2.5 Disorders: Diabetes mellitus, Fructose intolerance, Glycogen storage diseases.

UNIT II: Genetics

2.1 Introduction to genetics

- 2.1.1 Definition, scope and importance of genetics.
- 2.1.2 Classical and Modern concept of Gene (Cistron, muton, recon).
- 2.1.3 Brief explanation of the following terms: Allele, wild type and mutant alleles, locus, dominant and recessive traits, homozygous and heterozygous, genotype and phenotype.

2.2 Mendelian Genetics

- 2.2.1 Mendelian Genetics: Mendel's laws of Inheritance, Monohybrid cross, Dihybrid cross, test cross, back cross, Mendelian traits in man.
- 2.2.2 Exceptions to Mendelian Inheritance: Incomplete dominance, Co-dominance, Epistasis - Recessive, Double recessive, dominant and double dominant.
- 2.2.3 Pedigree analysis: Autosomal; dominant and recessive, X-linked; dominant and recessive.

2.3 Multiple Alleles and Multiple Genes (Polygenes)

- 2.3.1 Concept of multiple alleles, Coat colour in rabbit, ABO and Rh blood group systems in man.
- 2.3.2 Polygenic inheritance with reference to skin colour and eye colour in man.

2.4 Linkage and Crossing Over

- 2.4.1 Concept of Linkage and crossing over.
- 2.4.2 Mechanism and types of crossing over.

UNIT III: Molecular Biology

3.1 Genetic material.

3.1.1 Experiments for proving DNA as genetic material in living organisms: Griffith's transformation experiment, Avery-Macleod and McCarty experiment, Hershey-Chase experiment.

3.1.2 RNA as genetic material: Singer & Conrat experiment.

3.1.3 Prokaryotes: Chromosomal DNA (Nucleoid) and plasmid (extrachromosomal DNA)

3.1.4 Eukaryotes: Extra-nuclear DNA in Mitochondria & Chloroplast.

3.2 Genetic code: History, concept & properties.

3.3 Flow of genetic information in prokaryotes: DNA replication, Transcription, Translation.

3.4 Operon: Concept of Operon, Structure & regulation of lac operon.

Paper III

Course code:RJSZOOSIII03

UNIT I: Ecosystem ecology and community dynamics.

1.1 Types of ecosystems;

- 1.1.1 Terrestrial ecosystem- Forest, grassland, desert and tundra
- 1.1.2 Aquatic ecosystem- Freshwater, estuarine and marine

1.2 Amazing ecosystems- Coral reef, Amazon Rainforest and Sunderbans

1.3 Ecological succession

- 1.3.1 Concept of succession.
- 1.3.2 Types of succession: Hydrosere and Xerosere.
- 1.3.3 Climax concept in succession.

UNIT II: Fishery biology

2.1- Geographical and morphological features of coastline & fishing communities in India.

2.2- Brief classification of fisheries;

- a) Marine: coastal, offshore & deep sea fisheries
- b) Brackish water fisheries
- c) Fresh water fisheries

2.3- Important fisheries of India

- 2.3.1- Fin fish- Oil sardine, Mackerel, Bombay duck, Pomfret.
- 2.3.2- Crustacean fisheries- Prawns & lobsters.
- 2.3.3- Molluscan fisheries- Clams, edible oysters, loligo.

2.4- Methods of fish preservation.

2.5- Nutritive value of fish & fish products

UNIT III: Economic Entomology

- 3.1 Honey bee: Social life and communication, life history, Apiculture, Economic Importance
- 3.2 Lac insect: Life history, lac culture, composition of lac & its uses.
- 3.3 Silk moth: Life history, Sericulture, Economic Importance, types of silk.
- 3.4 Life history and control measures of Locust (*Schistocerca gregaria*), Aphids, Rice Weevil (*Sitophilus oryzae*), flour beetle (*Tribolium confusum*).
- 3.5 Methods of insect control: Chemical control by synthetic and natural chemicals.
- 3.6 Biological control- *Bacillus thuringiensis*.

S.Y.B.Sc SYLLABUS FOR PRACTICAL SEMESTER III

COURSE CODE: RJSZOOSIIP03

PRACTICAL I (Based on Paper I)

1. Study of earthworm
 - a. External characters
 - b. Digestive system
 - c. Nervous system
 - d. Reproductive system
 - e. Mounting- Septal nephridia, spermatheca, setae.
2. Urine analysis—Normal and abnormal constituents.
3. Detection of ammonia in water excreted by fish.
4. Detection of uric acid from excreta of birds.
5. Study of nutritional Apparatus (Amoeba, Hydra, Pigeon, Ruminant stomach)
6. Study of respiratory structures:
Gills of Bony fish and Cartilaginous fish, Lungs of Frog, Lungs of Mammal, Air sacs of Pigeon.
7. Study of permanent slides on topic of Reproduction: Sponge gemmules, Hydra budding, T.S. of mammalian testis, T.S. of mammalian ovary.
8. Study of Egg types –Fish eggs, Frog eggs, Hen's egg.
9. Study of Cleavage, blastula and gastrula (Amphioxus, Frog and Bird).

PRACTICAL II (Based on Paper II)

1. Preparation of buffer of different pH using Henderson-Hasselbalch equation
2. Preparation of titration curve for strong acid and strong base with the help of pH meter
3. Determination of pKa for weak acid
4. Colorimetry:
 - a) Selection of ideal filters
 - b) Determination of unknown concentration.
5. Study of drosophila: Phenotypic traits (eye colour, wing length, sexual dimorphism)
6. Problems in Genetics-monohybrid cross, dihybrid cross, multiple allelism.

7. Blood grouping
8. Problems based on molecular biology.

PRACTICAL III (Based on Paper III)

1. Study of different biomes and their representative animals.
2. Study of commercially important fishery (Catla, Rohu, Mackerel, Pomfret, Bombay duck, Prawn, Crab, Lobster, Edible oyster)
3. Study of crafts and gears.
4. Study of honey bee:
 - a) Life cycle of honey bee
 - b) Study of bee hive.Mountings of honeybee:-
 - c) Mouth parts,
 - d) Legs of honeybee
 - e) Sting apparatus,
5. Life cycle of Silk Moth
6. Detection of adulterants in honey
7. Study of Insects
 - a. Harmful insect :Locust, Aphids, Rice weevil, Flour beetle
 - b. Entomophagus insect – Dragonfly
 - c. Parasite Insect – Ichneumon wasp.
8. Visit to fish market/docks/fish landing centers and submission of report.

S.Y.B.SC ZOOLOGY SEMESTER IV

PAPER I

Course code: RJSZOOSIV01

UNIT I: TYPE STUDY: COCKROACH

- 1.1 Classification
- 1.2 External characters
- 1.3 Digestive system
- 1.4 Blood vascular system
- 1.5 Respiratory system
- 1.6 Nervous system
- 1.7 Reproductive system, copulation and fertilisation.

UNIT II: LIFE PROCESSES II

- 2.1 Circulation:
 - 2.1.1 Comparative study of circulation: Open and closed - single and double.
 - 2.1.2 Types of circulating fluids- Water, coelomic fluid, haemolymph, lymph and blood.
 - 2.1.3 Comparative study of vertebrate Hearts (Structure and function)
 - 2.1.4 Structure and mechanism of working of heart in man
- 2.2 Locomotory organs -structures and functions.
 - a. Pseudopodia in Amoeba (sol gel theory), Cilia in Paramecium
 - b. Wings and legs in Cockroach
 - c. Tube feet in Starfish
 - d. Fins of fish
 - e. Structure of Striated muscle fibre in human and Sliding filament theory
- 2.3 Control and coordination
 - 2.3.1 Irritability –Paramecium, Nerve net in Hydra, Nerve ring and nerve cord in earthworm
 - 2.3.2 Types of neurons on the basis of structure and function

- 2.3.3 Conduction of nerve impulse: Resting potential, action potential and refractory period
- 2.3.4 Synaptic transmission
- 2.3.5 Endocrine regulation: Hormones as chemical messengers, feedback mechanisms, Movement and Locomotion

UNIT III: CELL BIOLOGY

- 3.1 Cellular Organization: Difference between Prokaryotes and Eukaryotes
- 3.2 Structure and function of Plasma membrane, Importance of membrane fluidity and asymmetry, Membrane Transport, Passive diffusion, facilitated transport, active transport, Exocytosis and endocytosis.
- 3.3 Cytoplasmic Membrane System: Structure and function
 - a) Cytoskeleton: Microtubules and Microfilaments.
 - b) Endoplasmic Reticulum: SER, RER
 - c) Golgi Complex
 - d) Lysosomes: Primary and Secondary Lysosomes
- 3.4 Mitochondria: Structure and function
- 3.5 Structure of nucleus, Nuclear Pore and pore Complex, Nucleolus, Organization of Chromatin and Chromosomes.

PAPER II

Course code: RJSZOOSIV02

Unit- I: Biochemistry II

- 1.1 Lipid Metabolism:**
 - 1.1.1 Overview, Triacylglycerol, β - Oxidation
 - 1.1.2 Disorders: Obesity, Diabetic ketoacidosis, respiratory Distress syndrome
- 1.2 Protein Metabolism:** Overview,
 - 1.2.1 Metabolism of amino acids- transamination, deamination (oxidative and non-oxidative), Urea cycle.
 - 1.2.2 Disorders: Deficiencies of Urea cycle.
- 1.3 Intermediary metabolism:** how major anabolic and catabolic pathways are interconnected. Acetyl – CoA as a common product in metabolism of carbohydrates, proteins and lipids.

UNIT II: Chromosomes and Heredity

2.1 Chromosomes

- 2.1.1 Types of chromosomes–Autosomes and Sex chromosomes
- 2.1.2 Chromosome structure - Heterochromatin, Euchromatin
- 2.1.3 Classification based on the position of centromere

2.1.4 Endomitosis, Giant chromosomes- Polytene and Lamp brush chromosomes and significance of Balbiani rings.

2.2 Sex- determination

2.2.1 Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW.

2.2.2 Sex determination in honey bees- Haplodiploidy,

2.2.3 Sex determination in Drosophila-Genic balance theory, intersex, gynandromorphs.

2.2.4 Hormonal influence on sex determination-Freemartin and sex reversal.

2.2.5 Role of environmental factors- Bonellia and Crocodile

2.2.6 Barr bodies and Lyon hypothesis

2.3 Sex linked, sex influenced and sex limited inheritance.

2.3.1 X-Linked: Colourblindness, Haemophilia

2.3.2 Y-linked: Hypertrichosis

2.3.3 Sex-influenced genes

2.3.4 Sex limited genes

UNIT III: EVOLUTION

3.1: Geological timescale.

3.2 Theories of Evolution

3.3 Origin of life: Emergence of life on primitive earth

3.4: Evolution and adaptations: Microevolution, Role of natural selection in microevolution, Co-evolution.

3.5: Ecological niches and adaptations.

PAPER III

Course code: RJSZOOSIV03

UNIT I: PARASITOLOGY

1.1 Definitions: parasite, parasitism, host, vector-biological and mechanical.

1.3 Types of parasites- Ectoparasites, Endoparasite and their subtypes

1.4 Parasitic adaptations in Ectoparasites and Endoparasites

1.5 Types of hosts: intermediate, definitive and reservoir

1.6 Host-parasite relationship

Host specificity: Definition, structural specificity, physiological specificity and ecological specificity.

1.7 Protozoan and helminth parasites of man and domesticated animals:

Life cycle, pathogenicity, control measures and treatment of;

a) *Entamoeba histolytica*,

b) *Leishmania*,

c) *Toxoplasma gondii*,

d) *Fasciola hepatica*,

e) *Taenia solium*&

f) *Wuchereria bancrofti*

UNIT II: ANIMAL HUSBANDRY

2.1 Introduction: concept of integrated farming.

2.2 Poultry:

2.2.1 Definition and nomenclature.

2.2.2 Breeds of fowl (Aseel, Kadaknath, Leghorn, Rhode Island red),

2.2.3 Factors affecting size of eggs, abnormal eggs, hatching of eggs,

2.2.4 Housing and equipments, Brooding and rearing.

2.2.5 Poultry diseases- Coccidiosis, Avian flu.

2.3 Cattle Farming:

2.3.1 Classification of breeds (Milch breeds, Dual Purpose Breeds, Draught breeds, New breeds).

2.3.2 Various breeds of Cows: Indigenous – Red Sindhi, Sahiwal, Khillari, Haryana. Exotic – Holstein–Friesian, Brown Swiss, Jersey.

2.3.3 Various breeds of Buffalo: Murrah, Nagpuri, Jaffrabadi.

2.3.4 Dairy Science: Composition of Milk, Methods of Preservation of Milk Products.

UNIT III: BEHAVIORAL ETHOLOGY

3.1 Concept of instincts: Innate release mechanism, significance of instincts.

3.2 Concepts of imprinting: Filial imprinting, sexual imprinting, Functional aspects of imprinting.

3.3 Displacement behaviour: Causes and functional aspects, ritualization of displacement activity.

3.4 Animal communication: Visual, Sound, Chemical (pheromones), Round & Waggle dance in bees.

S.Y.B.Sc SYLLABUS FOR PRACTICAL SEMESTER IV

COURSE CODE: RJSZOOSIIP04

PRACTICAL I (Based on Paper I)

1. Study of cockroach
 - a) External characters
 - b) Digestive system
 - c) Nervous system
 - d) Reproductive system
 - e) Mounting- ommatidia, mouth parts, trachea & spiracles,
2. Study of hearts (Cockroach, Shark, Frog, Calotes, Crocodile, Mammal)
3. Study of locomotory organs (Amoeba, Unio, Cockroach, Starfish, Fish, and Birds)
4. Study of striated and non- striated muscle fibre
5. Ultra structure of cell organelles – (Electron micrographs)
 - a. Nucleus
 - b. Endoplasmic reticulum (Smooth and rough)
 - c. Mitochondria.
 - d. Golgi apparatus
 - e. Lysosomes
6. Study of permeability of cell through plasma membrane (Osmosis in blood cells).

7. Mounting of Polytene chromosome.

PRACTICAL II (Based on Paper II)

1. Estimation of creatinine from serum/urine sample.
2. Estimation on serum cholesterol.
3. Study of mitosis (onion root tip)
4. Mounting of Barr body
5. Problems based on genetics-X-linked inheritance.
6. Pedigree analysis(X-linked- dominant, recessive), Autosomal (dominant, recessive).
7. Study of fossils-trilobite, Ammonite.
8. Study of evidences of evolution:
 - a. Analogy – Leg of grasshopper and leg of mammal, Wing of insect and wing of bird.
 - b. Homology - Fore limb of amphibian and Fore limb of reptile, Wing of bird and forelimb of man.

PRACTICAL III (Based on Paper III)

1. Study of Protozoan parasites:
 - a. *Trypanosoma gambiense*
 - b. *Giardia intestinalis*
2. Study of Helminth parasites:
 - a) *Ancylostoma duodenale*
 - b) *Dracunculus medenensis*
3. Study of Ectoparasites:
 - a) Leech
 - b) Tick
 - c) Mite
4. Poultry – Aseel, Kadaknath, Leghorn, Rhode island red
5. Cattle breeds- a. Cow breeds-Indigenous: Red Sindhi and Sahiwal. Exotic: Jersey, Holstein Friesian,
 - b. Buffalo breeds- Murrah, Nagpuri and Jaffrabadi
6. Estimation of proteins from eggs. (Folin's method).
7. Extraction and qualitative test of casein from milk.
8. Measurement of density of milk samples by Lactometer.
9. Detection of milk adulterants: starch, urea, glucose.
10. To evaluate the quality of milk by methylene blue reduction method.
11. Study of ethological aspects:
 - a) Instincts
 - b) Imprinting
 - c) Communication in animals: Chemical signals and sound signals

d) Displacement activities in animals: Courtship and mating behavior in animals and ritualization.

12. Field visit to a natural ecosystem/dairy industry/apiary/sericulture unit and report submission

SCHEME OF EXAMINATION (FOR BOTH SEMESTERS)

Internal examination

The first internal class test comprising of 20 marks shall consist of 20 multiple choice questions with equal weightage.

The second class test will comprise of three short notes- one from each unit of 4 marks each and eight questions of one mark each from all units.

External theory paper pattern

Total: 60 marks

Q.1 Based on Unit I..... 15M

a. 8 M

b. 7 M

OR

a. 5 M

b. 5M

c. 5M

Q.2 Based on Unit II.....15M

a. 8 M

b. 7 M

OR

a. 5 M

b. 5M

c. 5M

Q.3 Based on Unit III.....15M

a. 8 M

b. 7 M

OR

a. 5 M

b. 5M

c. 5M

Q.4 Short notes (mixed on all units).....15M (5marks each)

- a or a (Unit I)
- b or b (Unit II)
- c or c (Unit III)

QUESTION PAPER FOR PRACTICAL EXAMINATION

SEMESTER III

PRACTICAL I

Total marks: 50

Q.1 Major experiment	12M
Urine analysis/ Dissection of earthworm digestive system	
Q.2 Minor experiment	08M
Detection of ammonia/uric acid	
Q.3 Mounting of septal nephridium/setae/spermatheca (any one)	05M
Q.4 Identify and describe	15M
a. One specimen from nutritional apparatus	
b. One specimen from respiratory structures	
c. One specimen from reproductive structures	
d & e. specimens from types of eggs, cleavage, blastula & gastrula	
Q.5 Viva	5M
Q.6 Journal	5M

PRACTICAL II

Total marks: 50

Q.1 Major experiment	12M
(Titration curve/pKa/Determination of unknown concentration)	
Q.2 Minor experiment	08M
(Preparation of buffer/Blood grouping/ Selection of ideal filter)	

Q.3 Identification (any one Phenotypic trait of Drosophila)	05M
Q.4 a. Problems based on genetics (two problems)	08M
b. Problem based on molecular biology	07M
Q.5 Viva	05M
Q.6 Journal	05M

PRACTICAL III

Total marks: 50

Q.1 Major experiment	12M
Detection of honey adulterants	
Q.2 Mountings of honey bee (Legs/mouth parts/Sting apparatus)	05M
Q.3 Identification	18M
a. One animal from biome study	
b. One specimen from fin fish fishery	
c. One specimen from non fin fish fishery	
d. One specimen from craft/gear	
e. Life cycle of silk moth/honey bee/ beehive	
f. One specimen from economic entomology	
Q.4 Report on fish market visit.	05M
Q.5 Viva	05M
Q.6 Journal	05M

QUESTION PAPER FOR PRACTICAL EXAMINATION

SEMESTER IV

PRACTICAL I

Total marks: 50

Q.1 Major experiment	12M
(Osmosis/Polytene chromosome/Digestive system of cockroach)	
Q.2 Minor experiment	08M
(Mountings of cockroach- Spiracles/ cornea/ mouth parts)	

Q.3 Identification	15M
a. One specimen from study of hearts	
b & c. Specimens from locomotary organs and muscles	
d & e. Electron micrographs of cell organelles	

Q.4 Viva 05M

Q.5 Journal 05M

PRACTICAL II

Total marks: 50

Q.1 Major experiment 12M

 Estimation of creatinine/cholesterol

Q.2 a. Problem based on genetics. 06M

 b. Problem based on pedigree analysis 05M

Q.3 Minor experiment 08M

 Mitosis/ Barr body mounting

Q.4 Identification based on evidences of evolution 09M

 a, b and c (fossils, homology & analogy)

Q.5 Viva 05M

Q.6 Journal 05M

PRACTICAL III

Total marks: 50

Q.1 Major experiment 12M

 Estimation of protein/milk adulterants

Q.2 Minor experiment 08M

 Extraction of casein/MBRT/Lactometer

Q.3 Identification 12M

 a. One example from Protozoan/Helminth parasite

 b. One example from ectoparasites

 c. One example of poultry breed

d. One example of cattle/buffalo breed

e & f. examples from ethology

Q.4 Report on field visit.	08M
Q.5 Viva	05M
Q.6 Journal	05M

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**Ramniranjan Jhunjhunwala College of Arts,
Science and Commerce**

(Autonomous affiliated to University of Mumbai)

Syllabus for T.Y.B.Sc

Semester V & VI

Program: B.Sc

Course: Zoology

T.Y.B.Sc. Zoology Syllabus

Semester V

Course code	Unit	Topic
RJSZOOSV01	I	Principles of taxonomy
	II	Kingdom Animalia I
	III	Kingdom Animalia II
	IV	Type study- Sepia
RJSZOOSV02	I	Basic Haematology
	II	Applied Haematology
	III	Basic Immunology
	IV	Applied Immunology
RJSZOOSVP05		Practicals based on Paper I & II
RJSZOOSV03	I	Mammalian histology
	II	Toxicology
	III	General Pathology
	IV	Biostatistics
RJSZOOSV04	I	Integumentary systems and derivatives
	II	Human osteology
	III	Muscles of long bones of human limbs
	IV	Developmental biology of chick
RJSZOOSVP06		Practicals based on Paper III & IV

Semester VI

Course code	Unit	Topic
RJSZOOSVI01	I	Phylum Chordata: Group Protochordata and Group Euchordata I
	II	Group Euchordata II
	III	Group Euchordata III
	IV	Type study: Shark
RJSZOOSVI02	I	Enzymology
	II	Homeostasis
	III	Endocrinology
	IV	Animal tissue culture
RJSZOOSVIP07		Practicals based on Paper I & II
RJSZOOSVI03	I	Molecular Biology
	II	Genetic engineering
	III	Human genetics
	IV	Bioinformatics
RJSZOOSVI04	I	Environment management
	II	Wildlife management
	III	Bioprospecting & Zoopharmacognosy
	IV	Zoogeography

RJSZOOSVIP06		Practicals based on Paper III & IV

T. Y. B. Sc. Zoology: Semester V (Theory)

Paper I

Course Code: RJSZOOSV01

Taxonomy - Invertebrates and Type Study

Unit I: Principles of Taxonomy

1.1: Levels of Organization:

1.1.1: Unicellularity, colonization of cells, multicellularity

1.1.2: Levels of Organization: Acellular, Cellular, Tissue level, Organ level and 'Organ-system' level

1.2: Symmetry

1.2.1: Basic concept and definition

1.2.2: Types:

a. Asymmetry: e.g. *Amoeba*

b. Radial symmetry: e.g. Starfish

c. Bi-lateral symmetry: e.g. Invertebrate - Planaria Vertebrate - Man

1.2.3: Evolutionary significance of symmetry

1.3: Coelom

1.3.1: Basic concept and definition

1.3.2: Formation of coelom

1.3.3: Types:

a. Acoelomate: Platyhelminthes e.g. Liverfluke

b. Pseudocoelomate: Nematoda e.g. Roundworm

c. Coelomate: e.g. Frog

1.3.4: Evolutionary significance of coelom

1.4: Metamerism

1.4.1: Basic concept and definition

1.4.2: Types:

a. Pseudometamerism: e.g. Tapeworm

b. True metamerism:

i. Homonomous - Annelida e.g. *Nereis*

ii. Heteronomous - Cephalization - Insecta e.g. Dragonfly

Cephalothorax - Crustacean e.g. Lobster

1.4.3: Evolutionary significance of metamerism

1.5: Taxonomy

1.5.1: Basic concept, definition and objectives

1.5.2: Linnaean Hierarchy, Binomial Nomenclature

1.5.3: Six Kingdom classification:

General characters of each Kingdom with examples: Kingdom Archaeobacteria

Kingdom Eubacteria Kingdom Protista Kingdom Fungi Kingdom Plantae Kingdom Animalia

1.6: Kingdom Protista: Animal like Protists: Protozoa

1.6.1: General characters of Protozoa

1.6.2: Classification of Protozoa with distinguishing features and suitable examples: Phylum Sarcomastigophora

Class Sarcodina e.g. *Amoeba*

Class Mastigophora e.g. *Trypanosoma* Phylum Ciliophora

Class Ciliata e.g. *Opalina*

Class Phyllopharyngea e.g. *Dysteria* Phylum Sporozoa

Class Aconoidasida e.g. *Plasmodium* Class Conoidasida e.g. *Toxoplasma*

Unit II: Kingdom Animalia I

2.1: Phylum Porifera

a. General characters

b. Classification up to class with distinguishing features and suitable examples: Class Calcarea e.g. *Leucosolenia* (*Branched sponge*)

Class Hexactinellida e.g. *Hyalonema* (Glass-rope sponge) Class Demospongia e.g. *Euspongia* (Bath sponge)

2.2: Phylum Cnidaria

a. General characters

b. Classification up to class with distinguishing features and examples Class Hydrozoa e.g. *Hydra*

Class Scyphozoa e.g. *Aurelia* (Jelly fish)

Class Anthozoa e.g. *Meandrina* (Maze Coral)

2.3: Phylum Platyhelminthes

a. General characters

b. Classification up to class with distinguishing features and examples Class Turbellaria e.g. *Dugesia* (Planaria)

Class Trematoda e.g. *Schistosoma* (Blood-fluke) Class Cestoda e.g. *Taenia* (Tapeworm)

c. Morphology, life cycle and pathogenicity of *Fasciola hepatica*

2.4: Phylum Nematoda

a. General characters

b. Classification up to class with distinguishing features and examples Class: Aphasmida (Adenophorea) e.g. *Trichinella* (Trichina worm) Class: Phasmida (Secernentea) e.g. *Ascaris* (Roundworm)

Unit III: Kingdom Animalia II

3.1: Phylum Annelida

3.1.1: General characters

3.1.2: Classification up to class with distinguishing features and examples Class Polychaeta e.g. *Neries* (Clamworm)

Class Oligochaeta e.g. *Pheretima* (Earthworm) Class Hirudinea e.g. *Hirudinaria* (Leech)

3.2: Phylum Arthropoda

3.2.1: General characters

3.2.2: Classification up to class with distinguishing features and examples Subphylum Chelicerata

Class Arachnida e.g. *Hottentotta* (Scorpion)

Class Merostomata e.g. *Limulus* (Horse-shoe crab) Class Pycnogonida e.g. *Nymphon* (Sea spider)

Subphylum Crustacea

Class Malacostraca e.g. *Scylla* (Crab)

Class Maxillipoda e.g. *Balanus* (Barnacle) Subphylum Uniramia

Class Chilopoda e.g. *Scolopendra* (Centipede) Class Diplopoda e.g. *Xenobolus* (Millipede)

Class Insecta e.g. *Attacus* (Moth)

3.3: Phylum Mollusca

3.3.1: General characters of the Phylum

3.3.2: Classification up to class with distinguishing features and examples

Class Aplousobranchia e.g. *Chaetoderma* (Glistening worm solenogaster) Class Polyplacophora e.g. *Chiton* (Coat-of-mail shell) Class Monoplacophora e.g. *Neopilina*

Class Gastropoda e.g. *Nerita* (Nerit)

Class Pelecypoda e.g. *Solen* (Razor clam)

Class Scaphopoda e.g. *Dentalium* (Tusk shell)

Class Cephalopoda e.g. *Nautilus* (Pearly nautilus)

3.4: Phylum Echinodermata

3.4.1 General characters

3.4.2 Classification up to class with distinguishing features and examples Class Asterozoa e.g. *Protoreaster* (Starfish)

Class Ophiurozoa e.g. *Ophiothrix* (Brittle star)

Class Echinozoa e.g. *Clypeaster* (Sand dollar)

Class Holothurozoa e.g. *Cucumaria* (Sea cucumber) Class Crinozoa e.g. *Antedon* (Sea lily)

3.5 Minor phyla

3.5.1: General characters along with examples of

Phylum Acanthocephala e.g. *Moniliformis*

Phylum Onychophora e.g. *Peripatus* (Velvet worm) Phylum Chaetognatha e.g. *Sagitta* (Arrow worm)

3.5.2: *Peripatus*, a connecting link - Affinities with Phylum Annelida, Arthropoda and Mollusca.

3.6 Phylum Hemichordata

3.6.1: General characters, classification with distinguishing features and examples Class Enteropneusta e.g. *Balanoglossus* (Acorn worm)

Class Pterobranchia e.g. *Rhabdopleura*

Class Planctosphaeroidea e.g. *Planctosphaera*

3.7 Basic concepts of phylogeny: Phylogenetic tree of invertebrates

Unit IV: Type study: *Sepia*

4.1: General characters and classification, Habit and habitat, External characters, mantle cavity, locomotion, economic importance

4.2: Digestive system, Respiratory system, Circulatory system, Excretory system, Nervous system and Sense organs, Reproductive system

Paper II

Course Code: RJSZOOSV02

Haematology and Immunology

Unit I: Basic Haematology

1.1: Composition of plasma: Water, respiratory gases, dissolved salts, plasma proteins, nutrients, enzymes, hormones, nitrogenous waste products

1.2: Haematopoiesis: Erythropoiesis, leucopoiesis and thrombopoiesis

1.3: Erythrocytes: Structure and functions, abnormalities in structure, total count, variation in number; ESR; types of anaemia

1.4: Haemoglobin: Structure, formation and degradation; variants of haemoglobin (foetal, adult), abnormalities in haemoglobin (sickle cell and thalassaemia)

1.5: Leucocytes: Types and functions, total count and variation in number; leukaemia and its types

1.6: Thrombocytes: Structure, factors and mechanism of clotting, failure of clotting mechanism

1.7: Blood volume: Total quantity and regulation; haemorrhage

Unit II: Applied Haematology

2.1: Introduction and scope of Applied Haematology: Clinical, microbiological, oncological and forensic haematology

2.2: Clinical significance of Diagnostic Techniques

2.2.1: Microscopic examination of blood:

Blood cancer (lymphoma, myeloma),

Infectious diseases (malaria, leishmaniasis),

Haemoglobinopathies (sickle cell anaemia, thalassaemia)

2.2.2: Coagulopathies: Haemophilia and purpura

2.2.3: Biochemical examination of blood:

Liver function tests: AST, ALT, LDH, Alkaline phosphatase, Total and direct bilirubin
Kidney function test: Serum creatinine, Blood Urea Nitrogen (BUN)
Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated haemoglobin test

Other biochemical tests: Blood hormones - TSH, FSH, LH.

Unit III: Basic Immunology

3.1: Overview of Immunology

3.1.1: Concept of immunity

3.1.2: Innate immunity - Definition, factors affecting innate immunity, Mechanisms of innate immunity - First line of defence - physical and chemical barriers; Second line of defence - phagocytosis, inflammatory responses and fever

3.1.3: Adaptive or Acquired immunity, Antibody mediated and cell mediated immunity;
Active Acquired immunity - Natural and Artificial; Passive Acquired immunity - Natural and Artificial

3.2: Cells and Organs of immune system

3.2.1: Cells of immune system - B cells, T cells and null cells, macrophages, dendritic cells and mast cells

3.2.2: Organs of immune system

Primary: Thymus and bone marrow
Secondary: Lymph nodes and spleen

3.3: Antigens: Definition and properties; haptens

3.4: Antibodies: Definition, basic structure, classes of antibodies - IgG, IgA, IgM, IgD and IgE

3.5: Antigen processing and presentation

3.5.1: Endogenous antigens - cytosolic pathways

3.5.2: Exogenous antigens - endocytic pathways

Unit IV: Applied Immunology

4.1: Antigen-Antibody interaction

4.1.1: General features of antigen-antibody interaction

4.1.2: Precipitation reaction - Definition, characteristics and mechanism. Precipitation in gels (slide test)

Radial immunodiffusion (Mancini method)

Double immunodiffusion (Ouchterlony method)

4.1.3: Immunoelectrophoresis - Counter-current and Laurel's Rocket electrophoresis

4.1.4: Agglutination reaction definition, characteristics and mechanism. Haemagglutination (slide and micro-tray agglutination) Passive agglutination

Coomb's test

4.1.5: Immunoassay - ELISA

4.2: Vaccines and Vaccination

4.2.1: Principles of vaccines - active and passive immunization, Routes of vaccine administration

4.2.2: Classification of vaccines: Live attenuated

Whole-Killed or inactivated

Sub-unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines

4.2.3: Adjuvants used for human vaccines:

Virosomes and Liposomes

Saponins

Water-in-oil emulsions

4.2.4: Vaccines against human pathogens:

Polio

Hepatitis A and B

Tuberculosis (BCG)

4.3: Transplantation Immunology: Introduction to transplantation; Types of grafts; Immunologic basis of graft rejection: MHC compatibility in organ transplantation, Lymphocyte and Antibody mediated graft rejection; Precautionary measures against graft rejection

Paper III

Course Code: RJSZOOSV03

Histology, Toxicology, Pathology and Biostatistics

Unit I: Mammalian Histology

1.1: Vertical section (V.S.) of skin: Layers and cells of epidermis; papillary and reticular layers of dermis; sweat glands, sebaceous glands and skin receptors

1.2: Digestive System

1.2.1: Vertical section (V.S.) of tooth; hard tissue - dentine and enamel; soft tissue - dentinal pulp and periodontal ligaments

1.2.2: Transverse section (T.S.) of tongue - mucosal papillae and taste buds

1.2.3: Alimentary canal - Transverse section (T.S.) of stomach, small intestine, large intestine of mammal.

1.2.4: Glands associated with digestive system - Transverse section (T.S.) of salivary glands, liver.

Unit II: Toxicology

2.1: Basic toxicology

2.1.1: Introduction to toxicology - brief history, different areas of toxicology, principles and scope of toxicology

2.1.2: Toxins and Toxicants - Phytotoxins (caffeine, nicotine), Mycotoxins (aflatoxins), Zootoxins (cnidarian toxin, bee venom, scorpion venom, snake venom)

2.1.3: Characteristics of Exposure - Duration of exposure, Frequency of exposure, Site of exposure and Routes of exposure

2.1.4: Types of Toxicity - Acute toxicity, Sub-acute toxicity, Sub-chronic toxicity and Chronic toxicity

2.1.5: Concept of LD50, LC50, ED50

2.1.6: Dose Response relationship - Individual / Graded dose response, Quantal dose response, shape of dose response curves, Therapeutic index, Margin of safety

2.1.7: Dose translation from animals to human - Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)

2.1.8: Target organ toxicity: Hepatotoxicity: susceptibility of the liver, types of liver injury, examples of hepatotoxicants; Neurotoxicity: vulnerability of nervous system, examples of neurotoxicants; Nephrotoxicity: susceptibility of kidney, examples of nephrotoxicants

2.2: Regulatory toxicology

2.2.1: OECD guidelines for testing of chemicals (an overview)

2.2.2: CPCSEA guidelines for animal testing centre, ethical issues in animal studies

2.2.3: Animal models used in regulatory toxicology studies

2.2.4: Alternative methods in toxicology (*in vitro* tests)

Unit III: General Pathology

3.1: General Pathology: Introduction and scope

3.2: Cell injury: Mechanisms of cell injury: ischemic, hypoxic, free radical mediated and chemical

3.3: Retrogressive changes: Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)

3.4: Disorders of pigmentation: Endogenous: Brief ideas about normal process of pigmentation, melanosis, jaundice (causes and effects)

3.5: Necrosis: Definition and causes; nuclear and cytoplasmic changes; types: coagulative, liquefactive, caseous, fat and fibroid

3.6: Gangrene: Definition and types - dry, moist and gas gangrene

Unit IV: Biostatistics

4.1: Probability Distributions: Normal, Binomial, Poisson distribution, Z-transformation, p-value, Probability - Addition and multiplication rules and their applications

4.2: Measures of Variation: Variance, standard deviation, standard error

4.3: Testing of Hypothesis: Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis, Levels of significance and testing of hypothesis

4.4: Parametric and non-parametric test: Parametric tests: two-tailed Z-test and t-test Non-parametric test: Chi-square test and its applications

4.5: Correlation: Correlation coefficient and its significance

Paper IV

Course Code: RJSZOOSV04

Anatomy and Developmental Biology

Unit I: Integumentary system and derivatives

1.1: Basic structure of integument: Epidermis and dermis

1.2: Epidermal derivatives of Vertebrates

1.2.1: Hair, hoof, horn, claw, teeth, beak and epidermal scales (small scales, large scales, modified scales - spine)

1.2.2: Glands - types (mucous, serous, ceruminous, poison, uropygial and salt gland) and functions

1.2.3: Type of feathers

1.3: Dermal derivatives of Vertebrates: Scales in fish; scutes in reptiles and birds; dermal scales in mammals - Armadillo, Antler - Caribou

1.4: Special derivatives of integument: Wart in toad, rattle in snake, whale bone in baleen whale, kneepads in camel.

Unit II: Human Osteology

2.1: Introduction: Bone structure (Histology), physical properties, chemical composition and general functions of bones.

Cartilage: General structure, functions

2.2: Axial skeleton

2.2.1: Skull: General characteristics of skull bones - Cranial and facial bones

2.2.2: Vertebral column: General characteristics of a vertebra, structure of different types of vertebrae (cervical, thoracic, lumbar, sacrum and coccyx)

2.2.3: Ribs and sternum: General skeleton of ribs and sternum

2.2.4: Hyoid bone: Structure and function.

2.3: Appendicular skeleton

2.3.1: Pectoral girdle and bones of forelimbs

2.3.2: Pelvic girdle and bones of hind limbs

Unit III: Muscles of long bones of Human limbs

3.1: Introduction and types of long limb muscles

3.1.1: Flexors, Extensor, Rotator, Abductors, Adductors

3.2: Muscles of forelimbs

3.2.1: Muscles that move the arm (Humerus) - *Triceps brachii*, *Biceps brachii*, *brachialis* and *brachioradialis*

3.2.2: Muscles that move the forearm (Radius-ulna) - *Flexor carpi radialis*, *Flexor carpi ulnaris* and *Extensor carpi ulnaris*

3.2.3: Muscles that move the wrist, hand and fingers - *Flexor digitorum superficialis*, *Extensor carpi radialis* and *Extensor digitorum*

3.3: Muscles of hindlimbs

3.3.1: Muscles that move the thigh (Femur) - Sartorius, Adductor group, Quadriceps group (*Rectus femoris*, *Vastus lateralis*, *Vastus medialis*), Hamstring group (*Biceps femoris*, *Semimembranosus*, *Semitendinosus*)

3.3.2: Muscles that move the lower leg (tibia-fibula) - *Fibularis longus*, *Gastrocnemius*, *Tibialis anterior*, *Soleus*, *Extensor digitorum longus* and *Fibularis tertius*

3.3.3: Muscles that move the ankle, foot and toes - *Tibialis anterior*, *Extensor digitorum*, *Longus* and *Fibularis* muscles

Unit IV: Developmental biology of Chick

4.1: Introduction to Developmental Biology: Basic concept and principles of developmental biology - morphogenesis, organogenesis, fate maps, cell adhesion, cell affinity and cell differentiation.

4.2: Development of Chick embryo

4.2.1: Structure of Hen's egg, physico-chemical nature and forms of yolk - granular, platelets and spheres; fertilization, cleavage, blastulation, gastrulation

4.2.2: Structure of chick embryo - 18hours, 24 hours, 33 hours, 48 hours and 72 hours

4.2.3: Extra embryonic membranes

4.2.4: Organizer: Introduction, Spemann Mangold experiment, Hensen's node as an organizer

Practical Syllabus for Semester V

Course Code: RJSZOOSVP05

Practical I

1. Classification of phyla up to class and study of the general characters up to class.

Kingdom Protista - Animal-like Protists: Protozoa

A. Phylum: Sarcomastigophora

Class Sarcodina e.g. *Amoeba*

Class Mastigophora e.g. *Euglena*

B. Phylum: Ciliophora

Class Ciliata e.g. *Paramecium*

Class Phyllopharyngea e.g. *Dysteria*

C. Phylum: Sporozoa,

Class Aconoidasida e.g. *Eimeria*

Class Conoidasida e.g. *Sarcocystis*

Kingdom Animalia

D. Phylum: Porifera

Class Calcarea e.g. *Scypha* (Little vase sponge)

Class Hexactinellida e.g. *Hyalonemna* (Glass-rope sponge) Class Demospongia e.g. *Spongilla* (Freshwater sponge)

E. Phylum Cnidaria

Class Hydrozoa e.g. *Vellela* (By-the-wind sailor)

Class Scyphozoa e.g. *Rhizostoma* (Barrel jellyfish) Class Anthozoa e.g. *Corallium* (Coral)

F. Phylum Platyhelminthes

Class Turbellaria e.g. *Dugesia* (Planaria)

Class Trematoda e.g. *Fasciola* (Liverfluke) Class Cestoda e.g. *Taenia* (Tapeworm)

G. Phylum Nematoda

Class Aphasmida (Adenophorea) e.g. *Trichinella* (Trichina worm) Class Phasmida (Secernentea) e.g. *Ascaris* (Roundworm)

H. Phylum Annelida

Class Polychaeta e.g. *Arenicola* (Lugworm)

Class Oligochaeta e.g. *Tubifex* (Sludge worm) Class Hirudinea e.g. *Pontobdella* (Marine leech)

I. Phylum Arthropoda

Subphylum Chelicerata

Class Arachnida e.g. *Hotentotta* (Scorpion)

Class Merostomata e.g. *Limulus* (Horseshoe crab) Class Pycnogonida e.g. *Nymphon* (Sea spider)

Subphylum Crustacea

Class Malacostraca e.g. *Panulirus* (Lobster) Class Maxillipoda e.g. Cyclops (Copepods)

Subphylum Uniramia

Class Chilopoda e.g. *Scolopendra* (Centipedes) Class Diplopoda e.g. *Xenobolus* (Millipedes)

Class Insecta e.g. *Attacus* (Moth)

J. Phylum Mollusca

Class Aplacophora e.g. *Chaetoderma* (Glisten worm solenogaster) Class Polyplacophora e.g. *Tonicella* (Lined Chiton) Class Monoplacophora e.g. *Neopilina* Class Gastropoda e.g. *Turbo* (Turban shell) Class Pelycypoda e.g. *Donax* (Wedge shell) Class Scaphopoda e.g. *Dentalium* (Tusk shell) Class Cephalopoda e.g. *Octopus*

K. Phylum Echinodermata

Class Asterozoa e.g. *Asterias* (Starfish)

Class Ophiurozoa e.g. *Ophiothrix* (Brittle star)

Class Echinozoa e.g. *Echinus* (Sea urchin)

Class Holothurozoa e.g. *Cucumaria* (Sea cucumber) Class Crinozoa e.g. *Crinoid* (Sea lily)

L. Phylum Hemichordata

Class Enteropneusta e.g. *Saccoglossus*

Class Pterobranchia e.g. *Rhabdopleura*

Class Planctosphaerozoa e.g. *Planctosphaera*

2. Minor Phyla

Acoelomate

M. Phylum Acanthocephala e.g. *Echinorhynchus*

Coelomate

N. Phylum Chaetognatha e.g. *Sagitta*

O. Phylum Onychophora e.g. *Peripatus* (Velvet worm)

3. Study of *Sepia* with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected.

a) Digestive system,

b) Reproductive system

c) Nervous system

d) Jaws

e) Radula

f) Chromatophores

g) Spermatophores

h) Statocyst

4. Study tour - Visit to fish market / Aquarium / Local Gardens / Local available niche / National Parks / Sanctuaries / and such other places to observe invertebrates with special emphasis on Western Ghats and coast of Maharashtra and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.

Practical II

1. Enumeration of Erythrocytes - Total Count.

2. Enumeration of Leucocytes - Total Count.
3. Differential count of Leucocytes.
4. Erythrocyte Sedimentation Rate by suitable method - Westergren or Wintrobe method.
5. Estimation of haemoglobin by Sahli's acid haematin method.
6. Determination of serum LDH by using colorimeter / spectrophotometer.
7. Estimation of total serum/ plasma proteins by Folin's method.
8. Estimation of serum/ plasma total triglycerides by Phosphovanillin method.
9. Latex agglutination test - Rheumatoid Arthritis.
10. Determination of bleeding and clotting time.

Course code: RJSZOOSVP06

Practical III

1. Study of mammalian tissues: V.S. of Tooth, T.S. of Stomach, T.S. of small intestine, T.S. of Liver.
2. Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining.
3. Identification of diseases or conditions (from slides or pictures): Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema
4. To study the effect of CCl₄ on the level of enzyme activity in liver on aspartate and alanine amino transferase, alkaline phosphatase (*in vitro* approach).
5. Study and interpretation of abnormal pathological reports: Blood (CBC), Urine (Routine) and Stool (Routine).
6. Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) and manually:
 - a. Problems based on Z-test
 - b. Problems based on t-test
 - c. Problems based on Chi-square test
 - d. Correlation, regression analysis - demonstration only.
 - e. Problems based on ANOVA - demonstration only.(Learner is expected to identify appropriate test for the given problem)

Practical IV

1. Study of integumentary systems - V. S. of Skin of Shark, Frog, *Calotes*, Pigeon and Human
2. Study of Human Axial Skeleton - Skull (whole) and Vertebral column (axis, atlas, typical cervical, typical thoracic, typical lumbar, sacrum, coccyx)
3. Study of Human Appendicular Skeleton - Pectoral and pelvic girdle with limb bones
4. Study of muscles of forelimbs - *Biceps brachii*, *Brachialis*, *Brachio radialis*, *Triceps brachii*, *Flexor carpi radialis*, *Flexor carpi ulnaris* and *Extensor carpi ulnaris*
5. Study of muscles of hind limbs - Sartorius, Adductor group, Quadriceps group *Rectus femoris*, *Vastus lateralis*, *Vastus medialis*, Hamstring group (*Biceps femoris*, *Semimembranosus*, *Semitendinosus*), *Fibularis longus*, *Gastrocnemius Tibialis anterior*, *Soleus*, *Extensor digitorum longus*, *Fibularis tertius*
6. Study of ontogeny of chick embryo using permanent slides - 18 hours, 24 hours, 33 hours, 48 hours and 72 hours.
7. Preparation of temporary mounting of chick embryo up to 48 hours of incubation.

T. Y. B. Sc. Zoology: Semester VI (Theory)

Paper I

Course Code: RJSZOOSVI01

Taxonomy - Chordates and Type Study

Unit I: Phylum Chordata: Group Protochordata and Group Euchordata I

1.1: General characters, Difference between non-chordates and chordates

Origin of chordates: Annelids as ancestors, Arachnids as ancestors and affinities with Echinodermata

1.2: Protochordata

1.2.1: General characters of Group Protochordata

1.2.2: Distinguishing characters of Subphylum Urochordata and Cephalochordata

1.2.3: Subphylum Urochordata

Class Ascidiacea e.g. *Herdmania* Class Thaliacea e.g. *Salpa* Class Larvacea e.g. *Oikopleura*

1.2.4: Subphylum Cephalochordata

Class Leptocardii e.g. *Branchiostoma (Amphioxus)*

1.3: Group Euchordata I

Group Euchordata: General characters

Subphylum Vertebrata: General characters

Division Agnatha and Gnathostomata: Distinguishing characters.

General characters with examples of:

Class Ostracodermii e.g. *Cephalaspis*

Class Cyclostomata e.g. *Petromyzon* (Lamprey)

Unit II: Group Euchordata II

2.2.1: Division: Gnathostomata

Superclass: Pisces and Tetrapoda

Superclass - Pisces: Distinguishing characters Class Placodermi e.g. *Climatius*

Class Chondrichthyes e.g. *Rhinobatos* (Guitar fish) Class Osteichthyes e.g. *Exocetus* (Flying fish)

2.2.2: Dipnoi (Lung fish): Distribution, habit and habitat, external and internal characters, affinities with super class Pisces, affinities and differences with class Amphibia

2.3: Superclass Tetrapoda

Class Amphibia: General characters Examples:

a. Limbless amphibian e.g. *Ichthyophis* (Caecilian)

b. Tailed amphibian e.g. *Amphiuma*

c. Tailless amphibian e.g. *Hyla* (Tree frog)

Unit III: Group Euchordata III

3.1: Class Reptilia: General characters Examples

a. Extinct reptile e.g. *Ichthyosaurus*

b. Living fossil e.g. *Sphenodon* (Tuatara)

c. Aquatic reptile e.g. *Chelonia* (Sea turtle)

d. Arboreal reptile e.g. *Chamaeleo* (Chamaeleon)

3.2: Class Aves: General Characters Examples

a. Arboreal bird e.g. *Melanerpes* (Wood pecker)

b. Terrestrial bird e.g. *Gallus* (Fowl)

c. Swimming bird e.g. *Phalacrocorax* (Cormorant)

d. Wading bird e.g. *Ardeola* (Heron)

e. Birds of prey e.g. *Tyto* (Owl)

f. Flightless birds e.g. *Dromaius* (Emu)

3.3: Class Mammalia: General characters Examples

a. Egg-laying mammals e.g. *Ornithorhynchus* (Duck-billed platypus)

b. Pouched mammals e.g. *Macropus* (Kangaroo)

c. Insect eating mammals e.g. *Sorex* (Common shrew)

d. Toothless mammals e.g. *Bradypus* (Sloth)

e. Gnawing mammals e.g. *Funambulus* (Squirrel)

f. Primates e.g. *Macaca* (Monkey)

Unit IV: Type study: Shark

4.1: Habit & habitat, distribution, external characters, classification and economic importance.

4.2: Skin, exoskeleton, endoskeleton and systems

a) Digestive system

b) Respiratory system

c) Blood vascular system

d) Nervous system and receptor organs

e) Urinogenital system, copulation, fertilization and development

Paper II

Course Code: RJSZOOSVI02

Physiology and Tissue Culture

Unit I: Enzymology

1.1: Introduction and Nomenclature: Definition; concept of activation energy; nomenclature and classification (based on IUB - Enzyme Commission) of enzymes; chemical nature of enzyme, co-factors and co-enzymes

1.2: Enzyme Action and Kinetics: Mechanism; Factors affecting enzyme activity - substrate, pH and temperature. Derivation of Michaelis-Menten equation and Lineweaver-Burk plot; Concept and significance of K_m , V_{max}

1.3: Enzyme Inhibition: Competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors

1.4: Regulation of Enzyme Activity: Allosteric regulation and regulation by covalent modification of enzymes; Isozymes (LDH)

1.5: Industrial applications of enzymes: Food and detergents

Unit II: Homeostasis

2.1: Homeostasis

2.1.1: External and internal environment; Acclimation and acclimatization

2.1.2: Body clock - Circadian & Diurnal rhythm

2.2: Thermoregulation

2.2.1: Endothermy and ectothermy

2.2.2: Temperature balance: Heat production - shivering and non-shivering thermogenesis; brown fat, mechanisms of heat loss

2.2.3: Adaptive response to temperature - daily torpor, hibernation, aestivation

2.3: Osmotic and Ionic Regulation

2.3.1: Living in hypo-osmotic, hyper-osmotic and terrestrial environment - Water absorption, salt water ingestion and salt excretion, salt glands, metabolic water

2.3.2: Role of kidney in ionic regulation

Unit III: Endocrinology

3.1: General organization of mammalian endocrine system

3.2: Hormones: Classification, properties, mechanism of hormone action

3.3: Histology, functions and disorders of the following endocrine glands: Pituitary

Thyroid

Parathyroid Pancreas Adrenal

Unit IV: Animal Tissue Culture

4.1: Aseptic techniques

4.1.1: Sterilization - basic principles of sterilization, importance of sterility in cell culture

4.1.2: Sterile handling - swabbing, capping, flaming, handling bottles and flasks, pipetting, pouring

4.2: Culture media

4.2.1: Types of media - Natural and Artificial media

4.2.2: Balanced Salt Solutions

4.2.3: Complete Media - amino acids, vitamins, salts, glucose, oxygen supplements, hormones and growth factors, antibiotics

4.2.4: Factors influencing cell culture - surface tension and foaming, viscosity, temperature, osmolality, pH, CO₂, bicarbonate and O₂

4.3: Advantages of tissue culture - control of the environment, *in vitro* modelling of *in vivo* conditions

4.4: Limitations of tissue culture

4.5: Culture techniques

4.5.1: Preparation of cells / organs for culture

4.5.2: Cover slip, Flask and Tube culture

4.5.3: Primary and established cell lines

4.5.4: Hybridoma technology

Paper III

Course Code: RJSZOOSVI03

Genetics and Bioinformatics

Unit I: Molecular Biology

1.1: Types of mutation

1.1.1: Point mutations - substitution, deletion and insertion mutations

Substitution mutations - silent, missense and nonsense mutations, transition and transversion

Deletion and Insertion mutations - frameshift mutations

1.1.2: Trinucleotide repeat expansions - fragile X syndrome, Huntington disease

1.1.3: Spontaneous mutation - tautomeric shifts, spontaneous lesions

1.2: Induced mutations

1.2.1: Physical agents:

Ionizing radiation (X-rays, α , β and γ rays) Non-ionizing radiation (UV light)

1.2.2: Chemical agents:

Base analogs (5-bromouracil)

Intercalating agents (ethidium bromide) Deaminating agents (nitrous acid) Hydroxylating agents (hydroxylamine) Alkylating agents (mustard gas) Aflatoxin (aflatoxin B1)

1.3: Preventative and repair mechanisms for DNA damage

1.3.1: Mechanisms that prevent DNA damage - superoxide dismutase and catalase

1.3.2: Mechanisms that repair damaged DNA - direct DNA repair (alkyl transferases, photoreactivation, excision repair)

1.3.3: Postreplication repair - recombination repair, mismatch repair, SOS repair

1.4: Eukaryotic gene expression

1.4.1: Regulatory protein domains - zinc fingers, helix-turn-helix domain and leucine zipper

1.4.2: DNA methylation

Unit II: Genetic Engineering

2.1: Tools in Genetic Engineering

2.1.1: Enzymes involved in Genetic Engineering: Introduction, nomenclature and types of restriction enzymes with examples, Ligases - *E. coli* DNA ligase, T4 DNA ligase, polynucleotide kinase, phosphatases, DNA polymerases, reverse transcriptase, terminal transferase

2.1.2: Vectors for gene cloning: General properties, advantages and disadvantages of cloning vectors - plasmid vectors (pBR322), phage vectors (λ Phage), cosmid vectors (c2XB)

2.1.3: Cloning techniques: Cloning after restriction digestion - blunt and cohesive end ligation, creation of restriction sites using linkers and adapters, cloning after homopolymer tailing, cDNA synthesis (Reverse transcription), genomic and cDNA libraries

2.2: Techniques in Genetic Engineering

2.2.1: PCR techniques: Principle of polymerase chain reaction (PCR), Applications of PCR

2.2.2: Sequencing techniques: DNA sequencing: Maxam-Gilbert method, Sanger's method
Protein sequencing: Sanger's method, Edman's method
Applications of sequencing techniques

2.2.3: Detection techniques: Blotting techniques - Southern blotting, Northern blotting and Western blotting
Applications of blotting techniques

Unit III: Human Genetics

3.1: Non-disjunction during mitosis and meiosis

3.1.1: Chromosomal Aberrations: Structural: Deletion: types, effects and disorders;
Translocation: types: Robertsonian and non-Robertsonian disorders; Inversion: types, effects and significance;

Duplication and their evolutionary significance (multigene families)

Numerical: Aneuploidy and Polyploidy (Autopolyploidy and Allopolyploidy)

3.2: Genetic Disorders

3.2.1: Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism

3.2.2: Single gene mutation: Cystic fibrosis

3.2.3: Multifactorial: Breast Cancer

3.2.4: Uniparental Disomy: Angelman Syndrome and Prader-Willi Syndrome

3.3: Diagnosis

3.3.1: Prenatal Diagnosis: Amniocentesis and Chorionic villus sampling, Banding techniques (G, C, Q), FISH, Protein truncation test (PTT)

3.3.2: Genetic counselling

Unit IV: Bioinformatics

4.1: Introduction

4.1.1: Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, OMIM, PubMed)

4.1.2: Applications of Bioinformatics

4.2: Databases - Tools and their uses

4.2.1: Biological databases;

Primary sequence databases: Nucleic acid sequence databases (GenBank, EMBLEBI, DDBJ)
Protein sequence databases (UniProtKB, PIR)

Secondary sequence databases

Derived databases - PROSITE, BLOCKS

Structure databases and bibliographic databases

4.3: Sequence alignment methods

4.3.1: BLAST, FASTA

4.3.2: Types of sequence alignment (Pairwise & Multiple sequence alignment)

4.3.3: Significance of sequence alignment

4.4: Predictive applications using DNA and protein sequences

4.4.1: Evolutionary studies: Concept of phylogenetic tree, convergent and parallel evolution

4.4.2: Pharmacogenomics: Discovering a drug: Target identification

4.4.3: Protein Chips and Functional Proteomics: Different types of protein chip (detecting and quantifying), applications of Proteomics

4.4.4: Metabolomics: Concept and applications

Paper IV

Course Code: RJSZOOSVI04

Environmental Biology and Zoopharmacognosy

Unit I: Environment management

1.1: Natural resources and their Classification

1.1.1: Forest resources, water resources (surface and ground) and mineral resources

1.1.2: Energy resources: renewable (solar, tidal, wind, biofuel) and non-renewable resources (coal, petroleum oil, natural gas)

1.2: Exploitation and Modification of Natural Resources: Impact on climate, flora and fauna

1.3: Waste Management

1.3.1: Technologies in solid waste management:

a) Traditional methods for solid waste management: Composting, Incineration, Landfill Recycling, Windrow composting

b) Modern methods for solid waste management: Anaerobic digestion, ethanol production, biodrying, pyrolysis, Upflow anaerobic sludge blanket (UASB) technology, waste autoclave

1.3.2: e-waste and hazardous waste (biological, chemical, medical and nuclear) management

1.4: Water management

1.4.1: Rainwater harvesting: Definition ways of harvesting, components, model of rain water harvesting: Rural and Urban, Advantages and disadvantages

1.4.2: Watershed management: Definition, need and objectives, classification (mini, micro, mili, sub-watershed, macro-watershed), Watershed management practices: Contour, gully control, stone bunds. Growing greenery and integrated watershed approach (IWA).

1.4.3: Case study: Ice-stupa artificial glaciers by Sonam Wangchuk

1.4.4: Effluent treatment, recycling plants, control and treatment of sewage water.

1.5: Acts and Rules of Environment Management

1.5.1: Environment Protection Act - 1986, Air (Prevention and Control of Pollution) Act - 1981, Water (Prevention and Control of Pollution) Act - 1974

1.5.2: Hazardous Wastes (Management and Handling) Rules - 1989

1.5.3: EIA (Environmental Impact Assessment)

1.5.4: Role of Central and State Government (Pollution Control Board) and NGOs

Unit II: Wildlife Management

2.1: Habit, Habitat, Territory and Niche of Wild Animals: Herbivores, carnivores, solitary, social (flock, pod, community), pack and herd, types of habitats and territories, niche concept

2.2: Threats to Wildlife

2.2.1: Poaching and hunting, deforestation, encroachment, competition (intra-specific and inter-specific), overgrazing and climate change, diseases (zoonosis and reverse zoonosis)

2.2.2: Tourism and human animal conflict

2.3: Wildlife Conservation

2.3.1: Techniques and methods used for wildlife census: Aerial counts, camera trap, line transect census and track surveys, capture mark recapture method, wildlife radio telemetry

2.3.2: Forest management, policies and Acts:

Harvesting Trees, Thinning harvest, Clearcut Harvest, Shelterwood harvest, Seed tree harvest, Group selection harvest, Single-tree selection harvest, Prescribed burning, Reforestation

Forest policy 1894, 1952, 1988;

The Indian Forest Act, 1927; Forest (Conservation) Act, 1980

Unit III: Bioprospecting and Zoopharmacognosy

3.1: Bioprospecting

3.1.1: Traditional and modern bioprospecting, economic value of bioprospecting

3.1.2: Bioprospecting and conservation, advantages and disadvantages

3.2: Zoopharmacognosy

3.2.1: Definition and types

3.2.2: Self-medication and its mechanism

3.2.3: Methods of self-medication through:

a) Ingestion - ants and mammals

b) Geophagy - invertebrates and birds

c) Absorption and adsorption

3.2.4: Applications - Social and trans-generational aspects of insects, birds and mammals

3.2.5: Contribution to human medicines

Unit IV: Zoogeography

4.1: Introduction: Plate tectonics and continental drift theory

4.2: Animal Distribution and Barriers

4.2.1: Isolating Mechanisms

4.2.2: Patterns of animal distribution - continuous, discontinuous and bipolar

4.2.3: Barriers of distribution -Topographic, climatic, vegetative, large water masses, land mass, lack of salinity and special characteristic habit (homing instinct).

4.2.4: Means of dispersal - land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies

4.3: Zoogeographical Realms: Palearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic

Practical Syllabus for Semester VI

Course Code: RJSZOOSVIP07

Practical I

1. Group Protochordata

Subphylum Urochordata

Class Larvacea e.g. *Oikopleura* (Sea squirt)

Class Ascidiacea e.g. *Ciona* (Transparent Sea squirt) Class Thaliacea e.g. *Salpa* (Common salp)

Subphylum Cephalochordata

Class Leptocardii e.g. *Branchiostoma* (*Amphioxus*)

Subphylum Vertebrata: Division Agnatha

Class Ostracodermi e.g. *Pharyngolepis*

Class Cyclostomata e.g. *Petromyzon* (Lamprey)

2. Division Gnathostomata

Superclass Pisces:

Class Placodermi e.g. *Bothriolepis*

Class Chondrichthyes e.g. *Rhinobatos* (Guitar fish), *Chimaera* (Rabbitfish) Class Osteichthyes e.g. *Protopterus*, *Clarius* (Catfish)

Superclass Tetrapoda:

Class Amphibia e.g. *Alytes* (Midwife toad) and *Triton* (Salamander)

Class Reptilia e.g. *Varanus* (Monitor lizard) and *Crocodylus* (Crocodile)

3. Class Aves: Examples: *Eudyptes* (Penguin), *Phoenicopterus* (Flamingo) and *Gyps* (Vulture)

4. Class Mammalia: Examples: *Dasyurus* (Quoll), *Petaurista* (Flying squirrel) and *Macaca* (Monkey).

5. Study of Shark with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected.

a) Digestive system

b) Heart and Aortic arches

c) Urinogenital System

d) Endoskeleton of shark:

i. Axial - Skull and vertebral column

ii. Appendicular - Pelvic and pectoral fins, pelvic and pectoral girdle

6. Visit to fish market / Aquarium / Zoo/ National Park / Local Gardens / Local available niche / Sanctuaries / and such other places in Maharashtra and / or India and / or abroad to observe chordates and prepare a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.

Practical II

1. Effect of varying pH on activity of enzyme Acid Phosphatase.

2. Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase.

3. Effect of varying substrate concentration on activity of enzyme Acid Phosphatase.

4. Effect of inhibitor on the activity of enzyme Acid Phosphatase.

5. Separation of LDH isozymes by agarose / polyacrylamide gel electrophoresis.

6. Histology of endocrine glands: T.S. of pituitary, thyroid, parathyroid, pancreas, adrenal.

7. Instruments for tissue culture - Autoclave Millipore filter, CO₂ incubator, Laminar air-flow. (Principle and use).

8. Packaging of glassware for tissue culture.

9. Aseptic transfer techniques.

10. Trypsinization and vital staining using Trypan blue stain.

Course Code: RJSZOOSVIP08

Practical III

1. Quantitative Estimation of RNA by Orcinol method.
2. Quantitative Estimation of DNA by Diphenylamine method.
3. Separation of Genomic DNA by Agarose gel electrophoresis.
4. Colorimetric estimation of proteins from given sample by Folin-Lowry's method.
5. Problems based on Restriction endonucleases.
6. Karyotype (Idiogram) analysis for the following syndromes with comments on numerical and / or structural variations in chromosomes (no cutting of chromosomes):
 - a. Turner's syndrome
 - b. Klinefelter's syndrome
 - c. Down's syndrome
 - d. Cri-du-chat syndrome
 - e. D-G translocation
 - f. Edward's syndrome
 - g. Patau's syndrome
7. Interpretation of genetic formulae: Deletion, duplication, inversion and translocation.
8. Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.
9. Explore BLAST for nucleotide sequence comparison.
10. Explore the databases (Nucleotide, Protein) at NCBI for querying a nucleotide or protein sequence.
11. Exploring bibliographic database PubMed for downloading a research paper on subject of interest with the use of operators.

Practical IV

1. Estimation of phosphates from sample water.
2. Estimation of BOD from sample water.
3. Estimation of COD from sample water.
4. Estimation of Nitrates from sample water.
5. Estimation of acidity and alkalinity of sample water by methyl orange and phenolphthalein indicator.

6. Comparative study of sound intensity in different places by Decibel meter.
7. Study of bioprospecting:
 - a. Tumour suppression compounds e.g. Sponge.
 - b. Skin erythema treatment from gel - *Aloe vera*, *Aloe ferox*.
8. Study of Zoopharmacognosy in ants, cats, elephants and dogs.
9. Indicate the distribution of fauna in the world map with respect to its realm and comment on the pattern of distribution.
 - a. Palearctic: Giant Panda and Japanese Macaque
 - b. Ethiopian: Common ostrich and African bush elephant
 - c. Oriental: Indian one-horned Rhinoceros and Gharial
 - d. Australian: Platypus and Red Kangaroo
 - e. Neotropical: Guanaco and South American Tapir
 - f. Nearctic: Virginia opossum and Sea otter
 - g. Antarctic: Emperor Penguin and Antarctic Minke Whale
10. Excursion (Study tour / Visit) to Zoo / Sanctuary / National park / Research institute, etc. and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.

SCHEME OF EXAMINATION (FOR BOTH SEMESTERS)

Internal examination

The first internal class test comprising of 20 marks shall consist of 20 multiple choice questions with equal weightage.

The second class test of 20 marks will be in the form of an assignment that the student shall submit on notification.

Question paper pattern for external theory

Total: 60 marks

Q.1 Based on Unit I..... 12 M

a,b,c- Attempt any two questions out of three

Q.2 Based on Unit II.....12M

a,b,c- Attempt any two questions out of three

Q.3 Based on Unit III.....12M

a,b,c- Attempt any two questions out of three

Q.4 Based on Unit IV.....12M

a,b,c- Attempt any two questions out of three

Q.5 Short notes (Mixed from all Units)..... 12M (3M each)

a or a- Unit I

b or b- Unit II

c or c- Unit III

d or d- Unit IV

T. Y. B. Sc. Zoology: Semester V (Practical)

Skeleton of Practical Examination Question Paper- Practical I

Total Marks: 50

Q.1 Sepia: 05

Sketch and label _____ system.

(Digestive / Reproductive system / Nervous system)

OR

Identify and Describe: a, b & c

(Jaws / Radula / Chromatophores / Spermatophores / Statocyst)

OR

Perform virtual dissection of _____ system.

Q.2. Identify and classify giving reasons: 12

a) Protozoa / Porifera / Cnidaria

b) Platyhelminthes / Nematoda

c) Annelida / Arthropoda

d) Mollusca / Echinodermata

Q.3 Identify, classify and describe 09

a) Acanthocephala / Chaetognatha / Onychophora

b) Hemichordata

c) Observe the animal* (photo/existing preserved specimen) and identify phylum giving reasons.

*A suitable animal which is not prescribed in the syllabus

Q.4 Field report - Submission and Discussion 10

Q.5 Viva voce 05

Skeleton of Practical Examination Question Paper- Practical II**Total Marks: 50**

Q.1 Enumerate erythrocytes in the given sample and comment on clinical condition. 15

OR

Q.1 Enumerate leucocytes in the given sample and comment on clinical condition.

OR

Q.1 Present a report on differential count of leucocytes and comment on clinical condition.

Q.2 Estimate total plasma proteins by Folin's method. 10

OR

Q.2 Estimate serum/plasma total triglycerides by Phosphovanillin method.

Q.3 Estimate haemoglobin by Sahli's acid haematin method. 10

OR

Q.3 Record Erythrocyte Sedimentation Rate by Westergren / Wintrobe method.

OR

Q.3 Determine serum LDH by colorimetric/spectrophotometric method.

Q.4 Perform Latex agglutination test - Rheumatoid Arthritis. 05

OR

Q.4 Record bleeding / clotting time and comment on clinical significance.

Q.5 Viva voce 05

Q.6 Journal 05

Skeleton of Practical Examination Question Paper-Practical III

Total Marks: 50

Q.1 Demonstrate the effect of CCl₄ on the level of enzyme activity of aspartate/ alanine amino transferase / alkaline phosphatase in liver (*in vitro* approach) 10

Q.2 From the infiltrated tissue prepare block, trim and mount it on the block holder. 09

OR

Q.2 Mount the ribbon on slide from the given block.

OR

Q.2 Stain the given histological slide and identify the tissue.

Q.3 Identify and describe a, b, c, d. 08

a) & b) based on study of mammalian tissues

c) & d) based on diseases or conditions

Q.4 Interpret the pathological report - blood / urine / stool. 05

Q.5 Problems in Biostatistics (Any one) 08

Q.6 Viva voce 05

Q.7 Journal 05

Skeleton Question Paper for Practical Examination- Practical IV

Total Marks: 50

Q.1 Make a temporary mounting of chick embryo (up to 48 hours) 10

Q.2 Identify and describe 30

a) and b) Based on integumentary system

c) and d) Based on forelimb muscle

- e) and f) Based on hind limbs muscle
- g) and h) Based on osteology - human axial skeleton
- i) Based on osteology - human appendicular skeleton
- j) Chick embryo up to 72 hours

Q.3 Viva-voce	05
Q.4 Journal	05

T. Y. B. Sc. Zoology: Semester VI (Practical)

Skeleton of Practical Examination Question Paper-Practical I

Total Marks: 50

Q.1 Identify, classify giving reasons	06
a) Urochordata / Cephalochordata / Ostachodermi / Cyclostomata	
b) Observe the animal* (photo/existing preserved specimen) and state its class giving reasons.	
* The animal should be other than prescribed in the syllabus	
Q.2. Identify, classify and describe	15
a) Pisces	
b) Amphibia	
c) Reptilia	
d) Aves	
e) Mammalia	
Q.3 Study of shark with the help of Specimen / Photograph / Simulation	06
(Digestive system / Urinogenital system / Heart and aortic arches)	
Q.4 Identify, sketch and label / Identify and describe marked portion in given diagram	03
Skull or vertebra of shark / Fin of shark (Pectoral / Pelvic) / Girdle of shark (Pectoral / Pelvic)	
Q.5 Field report - Submission and Discussion	10
Q. 6 Viva Voce	05
Q.7 Journal	05

Skeleton of Practical Examination Question Paper- Practical II

Total Marks: 50

Q.1 Demonstrate the effect of _____ on the activity of acid phosphatase
(Substrate concentration / pH variation / Enzyme concentration / Inhibitor
concentration) 15

OR

Q.1 Perform trypsinization and show the isolated cells using suitable vital stain.

Q.2 Separate LDH isozymes from the given sample by agarose / polyacrylamide gel
electrophoresis 10

OR

Q.2 Demonstrate the packaging of glassware for tissue culture (any 3)

OR

Q.2 Demonstrate the technique of aseptic transfer.

Q.3 Identify and describe a, b, c, d, e 15

a to d: Slides / Photographs of based on histology of endocrine glands

e: Instruments for tissue culture (any one)

Q.4 Viva voce 05

Q.5 Journal 05

Skeleton of Practical Examination Question Paper-Practical IV

Total Marks: 50

Q.1 Isolation & Estimation of RNA by Orcinol method. 15

OR

Q.1 Isolation & Estimation of DNA by Diphenylamine method.

Q.2 Separation of Genomic DNA by Agarose gel electrophoresis. 09

OR

Q.2 Colorimetric estimation of proteins from given sample by Folin's method.

Q.3 Problems based on Restriction endonucleases (any two). 08

OR

Q.3 Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.

OR

Q.3a Analyse the given syndrome and comment on numerical and/or structural variations in chromosomes.

Q.3b Interpretation of a genetic formula.

Q.4 Demonstrate the use of bioinformatics tool: 08

BLAST for nucleotide sequence comparison.

OR

Databases at NCBI for querying a nucleotide / protein sequence with the help of suitable operator.

OR

PubMed for downloading a research paper of interest with the help of suitable operator.

Q.5 Viva voce 05

Q.6 Journal

05

Skeleton Question Paper for Practical Examination-Paper IV

Total Marks: 50

Q.1 Estimation of BOD / COD / nitrates from the given water sample	10
Q.2 Estimation of phosphates / acidity / alkalinity of sample water.	08
Q.3 Identification	06
a) Based on bioprospecting (<i>Sponge / Aloe ferox / Aloe vera</i> - any one)	
b) Zoopharmacognosy (ants, cats, elephants and dogs - any one)	
Q.4 Identify the given animals with respect to their realms and comment (any two).	06
Q.5 Study tour Visit Report - Submission and Discussion	10
Q.6 Viva voce	05
Q.7 Journal	05

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