

Resolution No.:AC/I(19-20).2.RUS12

**S.P.Mandali's  
RAMNARAIN RUIA AUTONOMOUS COLLEGE**



Syllabus for: S.Y.B.Sc.

Program: B.Sc.

Course Code: ZOOLOGY (**RUSZOO**)

(Choice Based Credit System (CBCS) with effect from academic year 2019-20)

## **PREFACE**

Science plays a key role in overall advancement and progress of the society. All UG and PG students should be accordingly equipped with well-designed and structured knowledge, current evolvments and skills to contribute in all fields of science and technology. This approach has compelled us to include necessary modifications to Zoology syllabi of University of Mumbai. The subject board meeting was conducted to receive and include all the necessary suggestions for the benefaction and betterment of students. Here we present revised S.Y.B.Sc. Zoology syllabus for Semester III and Semester IV which emphasizes on development of students from scientific point of view. It is hoped that this curriculum document prepared would provide the expected level of competency.

**Syllabus for S.Y.B.ScZoology  
SEMESTER III  
Credit Based and Grading System**

<b>PAPER CODE</b>	<b>UNIT</b>	<b>TOPIC</b>	<b>CREDITS</b>	<b>LECTURES/ WEEK</b>
<b>RUSZOO301</b>	I	Fundamentals of Genetics	2	3
	II	Chromosomes and Heredity		
	III	Nucleic acids		
<b>RUSZOO302</b>	I	Study of Nutrition and Excretion	2	3
	II	Study of Respiration and Circulation		
	III	Control and Coordination, Locomotion and Reproduction		
<b>RUSZOO303</b>	I	Ethology	2	3
	II	Parasitology		
	III	Economic Zoology		
<b>Practical RUSZOOP301</b>	Practical based on RUSZOO301, RUSZOO302 and RUSZOO303		3	9

**Syllabus for S.Y.B.ScZoology  
SEMESTER IV  
Credit Based and Grading System**

<b>PAPER CODE</b>	<b>UNIT</b>	<b>TOPIC</b>	<b>CREDITS</b>	<b>LECTURES/ WEEK</b>
<b>RUSZOO401</b>	I	Origin and Evolution of Life	2	3
	II	Population genetics and Evolution		
	III	Scientific Attitude methodology, writing and ethics		
<b>RUSZOO402</b>	I	Cell Biology	2	3
	II	Endo-membrane system		
	III	Biomolecules		
<b>RUSZOO403</b>	I	Comparative Embryology	2	3
	II	Aspects of Human Reproduction		
	III	Pollution and its effect on organisms		
<b>Practical RUSZOO401</b>	Practical based on RUSZOO401, RUSZOO402 and RUSZOO403		3	9

## S.Y.B.Sc. ZOOLOGY

### Unit wise distribution

Semester III			Semester IV		
Paper I	Paper II	Paper III	Paper I	Paper II	Paper III
<b>Unit I</b> Fundamentals of Genetics	<b>Unit I</b> Study of Nutrition and excretion	<b>Unit I</b> Ethology	<b>Unit I</b> Origin and Evolution of Life	<b>Unit I</b> Cell Biology	<b>Unit I</b> Comparative Embryology
<b>Unit II</b> Chromosome and Heredity	<b>Unit II</b> Study of Respiration and Circulation	<b>Unit II</b> Parasitology	<b>Unit II</b> Population Genetics and Evolution	<b>Unit II</b> Endo-Membrane system	<b>Unit II</b> Aspects of human Reproduction
<b>Unit III</b> Nucleic acids	<b>Unit III</b> Control and coordination Locomotion and reproduction	<b>Unit III</b> Economic Zoology	<b>Unit III</b> Scientific attitude methodology, Writing and Ethics	<b>Unit III</b> Bio-molecules	<b>Unit III</b> Pollution and Effects on Animals
<b>Practical based on</b> RUSZOO301	<b>Practical based on</b> RUSZOO302	<b>Practical based on</b> RUSZOO303	<b>Practical based on</b> RUSZOO401	<b>Practical based on</b> RUSZOO402	<b>Practical based on</b> RUSZOO403

**S.Y.B.Sc. ZOOLOGY  
(THEORY)  
SEMESTER III  
Paper code: RUSZOO301  
Genetics, Heredity & Nucleic acids**

**Objective:**

- To introduce Mendelian principles, patterns of inheritance, classification of chromosomes, concept of sex determination and structure of nucleic acids along with the concept of central dogma of molecular biology and the concept of gene regulation.

**Desired Outcome:**

- Understand the principles of inheritance, linkage and crossing over, concept and types of chromosomes, mechanisms of sex determination, nucleic acids and central dogma of life.

**Unit I: Fundamentals of Genetics (15 lectures)**

**1.1: Introduction to genetics**

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

**1.2: Mendelian Genetics**

- 1.2.1 Mendelian Genetics: Monohybrid cross, Dihybrid cross, test cross, back cross, Mendel's laws of Inheritance, Mendelian traits in man
- 1.2.2 Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Lethal alleles, Epistasis - Recessive, Double recessive, dominant and double dominant
- 1.2.3 Chromosome theory of inheritance.
- 1.2.4 Pedigree analysis-Autosomal dominant and autosomal recessive, X-linked dominant, and X-linked recessive

**1.3: Multiple Alleles and Multiple Genes**

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

**1.4: Linkage and Crossing Over**

- 1.4.1 Linkage and crossing over, types of crossing over, cytological basis of crossing over.

## **Unit: II: Chromosomes and Heredity**

**(15 lectures)**

### **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,
- 2.2.4 Gynandromorphs.
- 2.2.5 Parthenogenesis.
- 2.2.6 Hormonal influence on sex determination-Freemartin and sex reversal.
- 2.2.7 Role of environmental factors- *Bonellia* and Crocodile
- 2.2.8 Barr bodies and Lyon hypothesis

### **2.3: Sex linked, sex influenced and sex limited inheritance**

- 2.3.1 X-Linked: Colour blindness, Haemophilia
- 2.3.2 Y-linked: Hypertrichosis
- 2.3.3 Sex-influenced genes and Sex limited genes

## **Unit III: Nucleic acids**

**(15 lectures)**

### **3.1: Genetic material**

- 3.1.1 Griffith's transformation experiments, Avery-MacLeod and McCarty, Hershey and Chase experiment of Bacteriophage infection.
- 3.1.2 Chemical composition and structure of nucleic acids.
- 3.1.3 Double helix nature of DNA, Solenoid model of DNA.
- 3.1.4 Types of DNA – A, B, Z & H forms.
- 3.1.5 DNA in Prokaryotes -chromosomal and plasmid and Extra nuclear DNA – mitochondria and chloroplast.
- 3.1.6 RNA as a genetic material in viruses and Types of RNA (Structure and function).

### **3.2: Flow of genetic information in a Eukaryotic cell**

- 3.2.1 DNA Replication
- 3.2.2 Transcription of mRNA
- 3.2.3 Translation and Genetic code

### **3.3: Gene Expressions and regulation**

- 3.3.1 One gene-one enzyme hypothesis /one polypeptide hypothesis
- 3.3.2 Concept of operon
- 3.3.3 Lac operon

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## Paper code: RUSZOO302

### Life processes

#### Objective:

- To introduce the concept of physiology of Nutrition, excretion, respiration, circulation, control and coordination, locomotion and reproduction along with the structures involved in all these processes in different classes of organisms.

#### Desired Outcome:

- Learners would understand the increasing complexity of physiology of all life processes and its evolutionary hierarchy and would be able to correlate the habit and habitat with the structures involved in all these processes in different classes of organisms.

### Unit I: Study of Nutrition and Excretion

(15 lectures)

#### 1.1: Comparative study of Nutritional Apparatus with reference to feeding adaptations - -Structure and functions:

- 1.1.1 Invertebrates- eg: Amoeba- Pseudopodia, Hydra-Tentacles, Earthworm-Suction, Cockroach-biting and chewing.
- 1.1.2 Vertebrates-Fish, Reptiles-Calotes
- 1.1.3 Functional Physiology of digestion with respect to Man

#### 1.2: Comparative Study of Excretory and Osmoregulatory systems of:

- 1.2.1 Amoeba - Contractile vacuoles
- 1.2.2 Planaria -Flame cells
- 1.2.3 Earthworm –Nephridia
- 1.2.4 Cockroach-Malphigian tubules and green gland
- 1.2.5 Bivalve -Organ of Bojanus
- 1.2.6 Categorization of animals based on principle nitrogenous excretory products
- 1.2.7 Structure of kidney, Uriniferous tubule and physiology of urine formation in Man.

### Unit II: Study of Respiration and Circulation(15 lectures)

#### 2.1: Respiration

- 2.1.1 Comparative study of Respiratory organs - Structure and Function with reference to Earthworm, Spider, Rohu, Rabbit.
- 2.1.2 Accessory respiratory structures: *Anabas /Clarius*
- 2.1.3 Structure of lungs and physiology of respiration in man

#### 2.2: Circulation.

- 2.2.1 Comparative study of circulation: Open and closed - single and double
- 2.2.2 Types of circulating fluids - Water, coelomic fluid, haemolymph, lymph and

- Blood
- 2.2.3 Comparative study of Hearts (Structure and function) with reference to Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon
  - 2.2.4 Physiology of Human Heart

### **Unit III: Control and coordination, Locomotion and reproduction (15 lectures)**

#### **3.1: Control and coordination**

- 3.1.1 Irritability –*Paramecium*, Nerve net in Hydra, Nerve ring and nerve cord in earthworm
- 3.1.2 Types of neurons on the basis of structure and function
- 3.1.3 Conduction of nerve impulse: Resting potential, action potential anrefractory period
- 3.1.4 Synaptic transmission – Chemical and Electrical
- 3.1.5 Endocrine regulation: Hormones as chemical messengers, feedback mechanisms

#### **3.2: Movement and Locomotion**

- 3.2.1 Locomotory organs (Structures and Functions) - Pseudopodia in *Amoeba* (sol gel theory), Cilia in *Paramecium*
- 3.2.2 Wings and legs in Cockroach
- 3.2.3 Tube feet in Starfish
- 3.2.4 Fins of fish

#### **3.3: Structure of Striated muscle fiber in human and Sliding filament theory**

#### **3.4: Reproduction**

- 3.4.1 Asexual Reproduction- Fission, fragmentation, budding, gemmule formation  
Sexual reproduction – Gametogenesis, Structure of male and female gametes in human
- 3.4.2 Types of fertilization -Oviparity, viviparity, ovo-viviparity

**Paper Code: RUSZOO303**  
**Ethology, Parasitology and Economic Zoology**

**Objective:**

- To equip learners with knowledge of animal interaction and their environmental adaptations to enable the learners to understand different behavioral patterns along with the concepts of parasitism, the modes of transmission of parasites and its life cycle besides economic aspects of zoology like apiculture, vermiculture, dairy science.

**Desired Outcome:**

- Learners would gain an insight into different aspects of animal behavior and their role in biological adaptations including the epidemiological aspects of parasites that affect humans along with the study of symptoms of the disease and its treatment. This would equip students with modern techniques in animal husbandry and encourage young learners for self-employment.

**Unit I: Ethology (15 lectures)**

**1.1: Introduction to Ethology**

- 1.1.1. Definition, History and Scope of Ethology
- 1.1.2. Animal behaviour - Innate and Learned behavior
- 1.1.3. Types of learning -Habituation, Imprinting and types of imprinting (filial and Sexual), Classical conditioning, Instrumental learning and insight learning

**1.2: Aspects of animal behaviour**

- 1.2.1. Communication in Bees and Ants
- 1.2.2. Mimicry and colouration
- 1.2.3. Role of hormones and pheromones in sexual behavior
- 1.2.4. Displacement activities, Ritualization
- 1.2.5. Migration in fish, schooling behavior
- 1.2.6. Habitat selection, territorial behaviour, food selection and foraging behaviour in African ungulates

**1.3: Social behaviour**

- 1.3.1. Social behaviour in primates -Hanuman langur
- 1.3.2. Elements of Socio-biology: Selfishness, cooperation, altruism, kinship and inclusive fitness

## Unit II: Parasitology

(15 lectures)

### 2.1: Introduction to Parasitology

- 2.1.1. Definitions: parasitism, host, parasite, vector-biological and mechanical  
Types of parasites- Ectoparasites, Endoparasite and their subtypes
- 2.1.2. Parasitic adaptations in Ectoparasites and Endoparasites
- 2.1.3. Types of hosts: intermediate and definitive, reservoir

### 2.2: Host-parasite relationship-Host specificity

- 2.2.1. Definition
- 2.2.2. Structural specificity
- 2.2.3. Physiological specificity and ecological specificity

### 2.3: Life cycle, pathogenicity, control measures and treatment

- 2.3.1. *Entamoeba histolytica*
- 2.3.2. *Fasciola hepatica*
- 2.3.3. *Taenia solium*
- 2.3.4. *Wuchereria bancrofti*

### 2.4: Morphology, life cycle, pathogenicity, control measures and treatment

- 2.4.1. Head louse (*Pediculus humanus capitis*)
- 2.4.2. Mite (*Sarcoptes scabiei*)
- 2.4.3. Bed bug (*Cimex lectularis*)

### 2.5: Parasitological significance

- 2.5.1. Zoonosis - Bird flu
- 2.5.2. Anthrax
- 2.5.3. Rabies
- 2.5.4. Toxoplasmosis

## Unit III: Economic Zoology

(15 lectures)

### 3.1: Apiculture

- 3.1.1. Methods of bee keeping and management – An introduction to different species of honey bees used in apiculture.
- 3.1.2. Selection of flora and bees for apiculture
- 3.1.3. Advantages and disadvantages of traditional and modern methods of Apiculture
- 3.1.4. Pests and Bee enemies- Wax moth, wasp, black ants, bee eaters, king crow and disease control
- 3.1.5. Bee keeping industry- Present status and recent efforts to improve and boost the industry

- 3.1.6. Economic importance– Honey: Production, Chemical composition and economic importance
- 3.1.7. Bees wax- Economic importance
- 3.1.8. Role of honey bees in pollination

### **3.2: Vermiculture**

- 3.2.1. Rearing methods, management and economic importance- An introduction to different species of earthworms used in vermiculture
- 3.2.2. Methods of vermiculture.
- 3.2.3. Maintenance and harvesting
- 3.2.4. Economic importance: advantages of vermiculture, demands for worms;market for vermicompost and entrepreneurship.

### **3.3: Dairy Science**

- 3.3.1. Dairy development in India-Role of dairy development in rural economy, employment opportunities
- 3.3.2. Dairy Processing-Filtration, cooling, chilling, clarification, pasteurization, freezing
- 3.3.3. Milk -Composition of milk and Types of milk: Recombined milk, Soft curd milk, Skimmed and toned milk, Artificial milk
- 3.3.4. Milk products

### **SEMESTER III - Practical based on RUSZOO301**

1. Extraction and detection of DNA
2. Extraction and detection of RNA
3. Study of Polytene chromosome.
4. Study of Polyploidy in Garlic
5. Study of Drumstick in Human neutrophil
6. Detection of blood groups and Rh factor
7. Problems in genetics – a) Monohybrid/ Dihybrid cross  
b) X- linked inheritance  
c) Multiple alleles
8. Study of Chromosome morphology during metaphase stage of different species. (Photograph to be provided)
9. Pedigree analysis
10. Problems on molecular biology
11. Finger printing Lifting techniques, Patterns and pedigree analysis.
12. **Project-** ‘Survey of inheritable Human traits using family tree analysis along with graphical presentation of the data’ (Submission of written or printed report)

### **SEMESTER III Practical based on RUSZOO302**

1. Urine analysis—Normal and abnormal constituents
2. Detection of ammonia in water excreted by fish
3. Study of operculum movement of fish
4. Detection of uric acid from excreta of Birds
5. Study of striated and non- striated muscle fibre
6. Hydra feeding-Tentacular feeding
7. Feeding apparatus of Prawn and Sepia-Radula
8. Study of nutritional Apparatus (Amphioxus, Bivalves, Pigeon, Ruminantstomach)
9. Study of respiratory structures:
  - a. Gills of Bony fish and Cartilaginous fish.
  - b. Lungs of Frog
  - c. Lungs of Mammals
  - d. Accessory respiratory structure in *Anabas* (Labyrinthine organ )
  - e. Air sacs of Pigeon
10. Study of locomotory organs (*Amoeba*, Unio, Cockroach, Starfish, Fish, and Birds)
11. Study of hearts (Cockroach, Shark, Frog, *Calotes*, Crocodile, Mammal)
12. Study of permanent slides on topic of Reproduction
  - a. Sponge gemmules
  - b. Hydra budding
  - c. T.S. of mammalian testis
  - d. T.S. of mammalian ovary

### Semester III - Practical based on RUSZOO303

1. Extraction of Casein from two samples of Milk and its qualitative estimation.
2. Quantitative estimation of Lipid content from two samples of milk.
3. Preparation of paneer from given milk sample.
4. Measurement of density of milk using different samples by Lactometer.
5. Study of Honey Bee:
  - a) Life Cycle of Honey Bee and Bee Hive
  - b) Mouthparts of Honey Bee
  - c) Legs of Honey Bee
  - d) Sting Apparatus of Honey Bee
6. Study of ethological aspects:
  - a) Warning Colouration
  - b) Instincts
  - c) Imprinting
  - d) Communication in animals: Chemical signals and sound signals
  - e) Displacement activities in animals: Courtship and mating behavior in animals and ritualization
7. Study of Protozoan parasites:
  - a) *Trypanosoma gambiense*
  - b) *Giardia intestinalis*
8. Study of Helminth parasites:
  - a) *Ancylostoma duodenale*
  - b) *Dracunculus medenensis*
9. Parasitic adaptations: Scolex and mature proglottid of Tapeworm
10. Study of Ectoparasites:
  - a) Leech
  - b) Tick
  - c) Mite
11. **Project-** Suggested topics on economic Zoology (eg. Apiculture, sericulture/ lac culture / Vermicompost Technique / Construction of artificial beehives /Animal husbandry/ aquaculture etc.)



## REFERENCE BOOKS

### Semester –III - RUSZ00301

1. Principles of Genetics. Gardner, E.J., Simmons, M.J and Snustad, D.P. John Wiley and Sons
2. Concepts of Genetics. Klug, W.S., Cummings M.R., Spencer, C.A. Benjamin Cummings
3. Genetics- A Molecular Approach. Russell, P. J Benjamin Cummings
4. Genetics: Analysis of Genes and Genomes. Daniel L., Hartl, Elizabeth W. Jones Jones& Bartlett Publishers
5. Introduction to Genetic Analysis. Griffiths, A.J.F., Wessler. S.R., Lewontin, R.C. andCarroll, S.B. W. H. Freeman and Co.
6. Cell Biology Genetics , Molecular Biology Evolution and Ecology Verma P.S. andAgrawal P.K., 9th edition, S. Chand Publication, New Delhi
7. Principles of Genetics – Eight edition- Eldon john Gardner, Michael J. Simmons, D.PeterSnustad
8. Genetics- Weaver, Hedrick, third edition, McGraw Hill Education
9. Genetics A Mendelian approach Peter J.Russel, Pearson Benjamin Cummings
10. Genetics A conceptual approach, Benjamin A. Pierce, Southwestern University, W.H. Freeman and company, New York
11. Genetics, Third Edition, Monroe W. Strickberger
12. Genetics from gene to genome, third edition, Leeland H. Hartwell, LeeroyHood,Michael 7. L. Goldberg, Ann E. Reynolds, Lee M. Silver, McGraw Hill Education

### Semester –III - RUSZ00302

1. Vertebrate Zoology Volume I- Jordan and Verma , S. Chand and Co.
2. Invertebrate Zoology Volume II- Jordan and Verma , S. Chand and Co.
3. Invertebrate Zoology- Majupuria T. C., NaginS.and Co.
4. Chordate Zoology- Dhami P. S. and Dhami J. K. , R. Chand and Co.
5. Invertebrate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.
6. Introduction to Vertebrates- Moore Cambridge University- Low Priced Edition.
7. Zoology- Miller S. A. and Harley J. B., Tata McGraw Hill.
8. Modern Textbook of Zoology, Invertebrates, Kotpal R. L.
9. Biological Science, Taylor D.J., Stout G.W., Green N.P.O, SoperR.,CambridgeUniversity Press.

### Semester –III - RUSZOO303

1. Animal Behaviour- David McFarland
2. Animal Behaviour- Mohan Arora
3. Animal Behaviour- ReenaMathur
4. An introduction to Animal Behaviour- Dawkins
5. Animal Behaviour-Agarwal
6. Animal Behaviour- Tinbergen
7. Biology of Insects- 1992 Saxena S. C. Oxford and IBH Publishing Co New Delhi, Bombay, Calcutta
8. A Text Book of Entomology- 1974Mathur V. K. and Upadhyay K GoelPrintingpress, Barani.
9. Bee and Bee Keeping- Roger A. Morse, Conell University Press London
10. Vermiculture Technology - Clive A. Edwards, Norman Q. Arancon and RhondaSherman
11. Parasitology- Chatterjee K.D., Chatterjee Medical Publishers.
12. Medical Parasitology- Arora
13. Textbook of Medical Parasitology-. C.K JayaramPaniker, Jaypee Brothers.
14. A text book of Parasitology- Kochhar S.K. Dominant Pub. & Dis, New Delhi.
15. Essentials of Parasitology- Gerald and Schmidt: Universal Bookstall, New Delhi.
16. Parasitology- Sharma P.N.andRatnu L.N., Chand S &Co.Pvt.Ltd.
17. Introduction to Parasitology- Chandler and Read John Wiley & Sons
18. Economic Zoology- Biostatistics and Animal behaviour – S.Mathur, RastogiPublicatons.
19. Economic Zoology- Shukla G.S. &Upadhyay V.B., Rastogi Publications.
20. A handbook on Economic Zoology, S.Chand& Co.



**Three Units- Each Unit 20 Marks [Total marks = 60]**

**Q.1. A) Answer any two of the following: (10M)**

- 1)
- 2)
- 3)

**Q.1. B) Write short note on: (Any two): (10M)**

- 1)
- 2)
- 3)

**Q.2. A) Answer any two of the following: (10M)**

- 1)
- 2)
- 3)

**Q.2. B) Write short note on: (Any two) (10M)**

- 1)
- 2)
- 3)

**Q.3. A) Answer any two of the following: (10M)**

- 1)
- 2)
- 3)

**Q.3. B) Write short note on: (Any two) (10M)**

- 1)
- 2)
- 3)

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**PRACTICAL**  
**(Based on RUSZOO301)**  
**Skeleton-Practical Examination Question Paper Pattern**

**Time: 3hrs**

**Marks: 50**

**Major Question (10 marks)**

**Q1. Extraction and detection of DNA**

**OR**

**Q1. Extraction and detection of RNA**

**Minor Question (07 marks)**

**Q2.** Study of drumstick in female neutrophils.

OR

**Q2.** Study of polyploidy-Temporary squash preparation of Garlic root tip

OR

**Q2.** Detection of blood groups and Rh factor

**Q3.** Problems on Genetics and Molecular biology (Transcription/Genetic code)

**(10 marks - 01 problem each)**

**Q4.** Identification

**(10 marks)**

a) Chromosome morphology

b) Pedigree analysis

**Q5.** Project report submission and viva on 'Survey of inheritable Human traits/  
Fingerprint

analysis using family tree along with graphical presentation of the data'

**(10 marks)**

**Q.6. Journal**

**(03 marks)**

**PRACTICAL**

**(Based on RUSZOO302)**  
**Skeleton-Practical Examination Question Paper Pattern**

**Time: 3hrs**

**Marks: 50**

**Major Question (15 marks)**

**Q1.** Urine analysis—Normal and abnormal constituents

**Minor Question**

**(10 marks)**

**Q2.** Detection of ammonia in water excreted by fish

OR

**Q2.** Detection of uric acid from excreta of Birds

**Q3.** Study of operculum movement of fish

OR

**Q3.** Study of nutritional apparatus of Hydra/Prawns/Sepia

**(5 marks)**

**Q4. Identification (15 marks)**

- a) Nutritional apparatus
- b) Respiratory structures
- c) Locomotory organs
- d) Study of hearts
- e) Permanent slides on reproduction

**Q5. Viva and Journal (05 marks)**

**PRACTICAL**  
**(Based on RUSZOO303)**

**Skeleton -Practical Examination Question Paper Pattern**

**Time: 3hrsMarks: 50**

**Major Question(12 marks)**

**Q1.** Extraction of Casein from Milk and its qualitative estimation

OR

**Q1.** Preparation of paneer from the given milk sample and measurement of density of milk using different samples by lactometer

OR

**Q1.** Quantitative estimation of Lipid content from two samples of milk.

**Minor Question (10 marks)**

**Q2.** Life Cycle of Honey Bee and Bee Hive

OR

**Q2.** Mouthparts of Honey Bee

OR

**Q2.** Legs of Honey Bee

OR

**Q2.** Sting Apparatus of Honey Bee

**Q3.** Identify and describe as per instructions (**15 marks**)

- a) Ethology
- b) Protozoan parasites
- c) Helminth parasites
- d) Ectoparasites
- e) Parasitic adaptations

**Q4.** Project submission and Viva based on project (**10 marks**)

**Q5.** Journal (**03 marks**)

**S.Y.B.Sc. ZOOLOGY  
(THEORY)  
SEMESTER IV  
Paper code: RUSZOO401  
Evolution and Population Genetics**

**Objective:**

- To impart scientific knowledge to the learner about how life originated and evolved on our planet in order to enhance their understanding of genetic variability within a population and how the change in the gene pool leads to evolution of species along with different skills necessary for research and scientific writing.

**Desired Outcomes:**

- Learner will gain insight about origin of life and will know about the different theories of evolution, which would help them understand the forces that cause evolutionary changes in natural populations and comprehend the mechanisms of speciation. In addition, learners will develop research aptitude and understand the ethical aspects of research.

**Unit I: Origin and evolution of Life (15 lectures)**

**1.1: Introduction**

- 1.1.1 Origin of universe
- 1.1.2 Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory
- 1.1.3 Origin of life
- 1.1.4 Origin of eukaryotic cell.

**1.2: Evidences in favor of organic evolution**

- 1.2.1 Evidences from: Geographical distribution, Paleontology Anatomy, Embryology, Physiology and Genetics.

**1.3: Theories of organic evolution**

- 1.3.1 Theory of Lamarck
- 1.3.2 Theory of Darwin and Neo Darwinism
- 1.3.3 Mutation Theory
- 1.3.4 Synthetic theory
- 1.3.5 Weisman's germplasm theory
- 1.3.6 Neutral theory of molecular evolution

**1.4: Evolution of Man**



## **Unit II: Population genetics and evolution**

**(15 lectures)**

### **2.1: Introduction to population genetics (Definition)**

- 2.1.1 Definition and Brief explanation of the following terms: Population, gene pool, Allele frequency, genotype frequency, phenotype frequency, microevolution

### **2.2: Population genetics**

#### **2.2.1 Hardy-Weinberg Law**

- 2.2.2 **Factors that disrupt Hardy Weinberg equilibrium**– Mutation, Migration (Gene flow), Non-random mating (Inbreeding, inbreeding depression, Assortative mating, Positive and Negative, Dis-assortative mating), Genetic drift (Sampling error, fixation, Bottleneck effect and Founder effect), Natural Selection

- 2.2.3 **Patterns of Natural Selection** – Stabilizing selection, Directional Selection (Examples: Peppered moth, Antibiotic resistance in bacteria, Pesticide resistance), Disruptive selection

### **2.3: Evolutionary genetics**

- 2.3.1 **Genetic variation** - Genetic basis of variation: Mutations and Recombination (crossing over during meiosis, independent assortment of chromosomes during meiosis and random union of gametes during fertilization).

- 2.3.2 **Nature of genetic variations**- Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism: Heterozygote advantage and Frequency dependent selection, Neutral variations, Geographic variation (Cline)

- 2.3.3 **Species Concept** - Biological species concept and evolutionary species concept

- 2.3.4 **Speciation and Isolating mechanisms** – Definition and Modes of speciation (Allopatric, Sympatric Parapatric and Peripatric), Geographical isolation, Reproductive isolation and its isolating mechanisms (Pre-zygotic and Post-zygotic)

- 2.3.5 **Macroevolution**-Concept and Patterns of macroevolution (Stasis, Preadaptation/Exaptation, Mass extinctions, Adaptive radiation and Coevolution)

- 2.3.6 **Megaevolution**

## **Unit III: Scientific Attitude methodology, writing and ethics**

**(15 lectures)**

### **3.1: Process of science: A dynamic approach to investigation**

- 3.1.1 **The Scientific method** - Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery

- 3.1.2 **Scientific Research** - Definition, difference between method and methodology characteristics, types

- 3.1.3 **Steps in the Scientific Method** - Identification of research problem, Formulation of research hypothesis, Testing the hypothesis using experiments or surveys, Preparing research/study design including methodology and execution (Appropriate controls, sample size, technically sound, free from bias, repeat experiments for consistency), Documentation of data, Data analysis and interpretation, Results and Conclusions
- 3.1.4 **Dissemination of data** - Reporting results to scientific community (Publication in peer-reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation)
- 3.1.5 **Application of knowledge** - Basic research, Applied research, Translational Research, Patent

### 3.2: Scientific writing

- 3.2.1 **Structure and components of a research paper** (Preparation of manuscript for publication of research paper) - Title, Authors and their affiliations, Abstract, Keywords and Abbreviations, Introduction, Material and Methods, Results, Discussion, Conclusions, Acknowledgement, Bibliography; Figures, Tables and their legends

### 3.3: Writing a review paper

- 3.3.1 **Structure and components of research report** - Report writing, Types of report
- 3.3.2 **Computer application** - Plotting of graphs, Statistical analysis of data. Internet and its application in research - Literature survey, Online submission of manuscript for publication

### 3.4: Ethics

- 3.4.1 **Ethics in animal research** - The ethical and sensitive care and use of animals in research, teaching and testing, Approval from Institutional animal ethics Committee.
- 3.4.2 **Ethics in clinical research** - Approval from Clinical Research Ethics Committee, Informed consent
- 3.4.3 **Approval from concerned/ appropriate authorities** - National Biodiversity Authority, State Biodiversity Board, Forest Department
- 3.4.4 **Conflict of interest**

### 3.5: Plagiarism

- 3.5.1 Concept, its types and different ways of committing plagiarism and Ethics and prevention, Detection of plagiarism.

**Paper code: RUSZOO402**  
**Cell Biology and Biomolecules**

**Objective:**

- To study the structural and functional organization of cell with an emphasis on nucleus, plasma membrane and cytoskeleton, Ultrastructure of cell organelles and their functions along with the structure of biomolecules, and their role in sustenance of life.

**Desired outcome:**

- Learner would acquire insight of the intricacy of endomembrane system and transport mechanisms for maintenance and composition of cell leading to the interlinking of endomembrane system for functioning of cell, besides they will realize the importance of biomolecules and their clinical significance.

**Unit I: Cell Biology** (15 lectures)

**1.1: Introduction to cell biology**

- 1.1.1 Definition and scope
- 1.1.2 Cell theory
- 1.1.3 Generalized prokaryotic, eukaryotic cell: size, shape and structure

**1.2: Nucleus**

- 1.2.1 Size, shape, number and position
- 1.2.2 Structure and functions of interphase nucleus
- 1.2.3 Ultrastructure of nuclear membrane and pore complex
- 1.2.4 Nucleolus: general organization, chemical composition and functions
- 1.2.5 Nuclear sap/ nuclear matrix
- 1.2.6 Nucleo-cytoplasmic interactions

**1.3: Plasma membrane**

- 1.3.1 Fluid Mosaic Model
- 1.3.2 Junctional complexes
- 1.3.3 Membrane receptors
- 1.3.4 Modifications: Microvilli, Desmosomes and Plasmodesmata

**1.4: Transport across membrane**

- 1.4.1 Diffusion and Osmosis
- 1.4.2 Transport: Passive and Active
- 1.4.3 Endocytosis and Exocytosis

**1.5: Cytoskeletal structures**

- 1.5.1 Microtubules: Composition and functions
- 1.5.2 Microfilaments: Composition and functions

## **Unit II: Endomembrane System**

**(15 lectures)**

### **2.1: Endoplasmic reticulum**

- 2.1.1 Discovery, occurrence and Types
- 2.1.2 Ultrastructure and Functions
- 2.1.3 Disorder of endoplasmic reticulum- Cystic Fibrosis

### **2.2: Golgi complex**

- 2.2.1 Origin, occurrence and morphology
- 2.2.2 Ultra structure and functions
- 2.2.3 Disorder of Golgi complex- Congenital disorders of glycosylation

### **2.3: Lysosomes**

- 2.3.1 Origin, occurrence and polymorphism
- 2.3.2 Ultrastructure and Functions
- 2.3.3 Disorder of lysosomes- Tay Sach's disease

### **2.4 Mitochondria**

- 2.4.1 Origin, occurrence and morphology
- 2.4.2 Ultrastructure and functions
- 2.4.3 Marker enzymes, Mitochondrial biogenesis, Semi-autonomous nature of mitochondria
- 2.4.4 Disorder of mitochondria- Mitochondrial encephalopathy

## **Unit III: Biomolecules**

**(15 lectures)**

### **3.1: Chemistry of Water molecule**

- 3.1.1 Properties - Polarity, Osmolarity, Ionization of water,
- 3.1.2 Buffering against pH changes.

### **3.2: Biomolecules**

- 3.2.1 Concept of Micromolecules and Macromolecules.

### **3.3: Carbohydrates**

- 3.3.1 Definition Classification, Properties and Isomerism, Glycosidic bond
- 3.3.2 Structure of Monosaccharides (Glucose and Fructose), Disaccharides (Lactose and Sucrose), Polysaccharides (Cellulose, Starch, Glycogen and Chitin)
- 3.3.3 Biological role and their Clinical significance

### **3.3: Amino Acids and Proteins**

- 3.3.1 Basic structure of amino acid, classification of amino acids, Essential and Non-essential amino acids, Peptide bond
- 3.3.2 Protein conformation: Primary, Secondary, Tertiary and Quaternary
- 3.3.3 Types of proteins – Structural (Keratin, Collagen) and functional proteins (Hemoglobin)
- 3.3.4 Biological role and their Clinical significance

### **3.4: Lipids**

- 3.4.1 Definition, classification of lipids with examples, Ester linkage
- 3.4.2 Physical and Chemical properties of lipids
- 3.4.3 Saturated and Unsaturated fatty acids, Essential fatty acids
- 3.4.4 Triacylglycerols, Phospholipids (Lecithin and Cephalin) and Steroids (Cholesterol)
- 3.4.5 Biological role and their Clinical significance

### **3.5: Vitamins**

- 3.5.1 Water soluble vitamins (e.g. Vit C, Vit B12)
- 3.5.2 Lipid soluble vitamins (e.g. Vit A, Vit D)
- 3.5.3 Biological role and their Clinical significance

**Paper Code: RUSZOO403**  
**Embryology, Human Reproduction and Pollution**

**Objective:**

- To acquaint the learner with key concepts of embryology, different aspects of human reproduction in order to create awareness regarding the causes of infertility, different techniques to overcome infertility and the concept of birth control and also to provide a panoramic view of impact of human activities leading to pollution and its implications, thus creating environmental awareness.

**Desired Outcomes:**

- Learner will learn to compare the different pre-embryonic stages, the functional aspects and classification of extra-embryonic membranes and placentae in order to understand human reproductive Physiology along with advances in Artificial Reproductive Technology and related ethical issues. In addition, they will be sensitized about the adverse effects of pollution and its control measures to focus on current environmental issues.

**Unit I: Comparative Embryology (15 lectures)**

- 1.1. Types of Eggs-Based on amount and distribution of yolk
- 1.2. Structure and Types of Sperms
- 1.3. Types and Patterns of Cleavage
- 1.4. Types of Blastulae (Amphioxus, Frog, Aves, Chick.)
- 1.5. Gastrulation
  - 1.5.1. Coelom-Formation and types
- 1.6: Extra embryonic membranes
  - 1.6.1. Types of Placentae (Based on histology, morphology and implantation)

**Unit II: Aspects of Human Reproduction (15 lectures)**

**2.1: Human Reproductive system and Hormonal regulation**

- 2.1.1. Anatomy of human male and female reproductive system
- 2.1.2. Hormonal regulation of Reproduction and Impact of age on reproduction  
Menopause and Andropause

**2.2: Contraception & birth control**

- 2.2.1. Difference between contraception and birth control
- 2.2.2. Natural Methods: Abstinence , Rhythm method, Temperature method,

Cervical mucus or Billings method, Coitus interruptus, Lactation amenorrhea

2.2.3. Artificial methods : Barrier methods, Hormonal methods, Intrauterine contraceptives, Sterilization, Termination, Abortion

## **2.3: Infertility**

### **2.3.1. Female infertility -**

- Causes - Failure to ovulate, production of infertile eggs, damage to oviducts (oviduct scarring and PID or Pelvic inflammatory disease, TB of oviduct), Uterus (T. B. of uterus and cervix)
- Infertility associated disorders (Endometriosis, Polycystic Ovarian syndrome - (PCOS), POF (Primary ovarian failure), STDs (Gonorrhoea, Chlamydia, Syphilis and Genital Herpes), Antibodies to sperm, Genetic causes -Recurrent abortions, Role of endocrine disruptors)

### **2.3.2. Male infertility –**

- Causes - Testicular failure, infections of epididymis, seminal vesicles or prostate, hypogonadism, cryptorchidism, congenital, Varicocele, Blockage, Azoospermia, Oligospermia, abnormal sperms, autoimmunity, ejaculatory disorders and Idiopathic infertility

## **2.4: Treatment of Infertility**

2.4.1. Removal /reduction of causative environmental factors

2.4.2. Surgical treatment

2.4.3. Hormonal treatment- Fertility drugs

2.4.4. Assisted Reproductive Technology

2.4.5. Sperm banks, cryopreservation of gametes and embryos

2.4.6. Surrogacy

## **2.5: Techniques and Ethical considerations of Artificial Reproductive Technology(ART)**

2.5.1. In vitro fertilization, Embryo transfer (ET), Intra-fallopian transfer (IFT), Intrauterine transfer (IUT), Gamete intra-fallopian transfer (GIFT), intra-zygote transfer (ZIFT), Intra-cytoplasmic sperm injection (ICSI) with ejaculated sperm and sperm retrieved from testicular biopsies –Testicular sperm extraction

## **Unit III: Pollution and its effects on organisms (15 lectures)**

### **3.1: Air Pollution**

3.1.1. Types and sources of air pollutants

3.1.2. Effects and control measures

### **3.2: Water Pollution**

- 3.2.1. Types and sources of water pollutants
- 3.2.2. Effects and control measures

### **3.3: Soil Pollution**

- 3.3.1. Types and sources of soil pollutants
- 3.3.2. Effects and control measures

### **3.4: Noise pollution**

- 3.4.1. Different means of noise pollution
- 3.4.2. Effects and control measures

### **3.5: Radioactive pollution**

### **3.6: Solid waste Pollution**

- 3.6.1. Types and sources,
- 3.6.2. Effects and control

### **3.7: Pollution – Climate change and Global warming**

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**SEMESTER IV**  
**Practical based on RUSZOO401**

- 1 Study of population density by Line transect method & Quadrant method and calculate different diversity indices.
  - a) Index of Dominance.
  - b) Index of frequency.
  - c) Rarity Index.
  - d) Shannon Index.
  - e) Index of species diversity
- 2 Study of Prokaryotic cells (bacteria) by Crystal violet staining technique.
- 3 Study of Eukaryotic cells (WBCs) from blood smear by Leishman's stain.
- 4 Identification and study of fossils
  - a) Arthropods: *Trilobite*
  - b) Mollusca: *Ammonite*
  - c) Aves: *Archaeopteryx*
- 5 Identification of
  - a) Allopatric speciation (*Cyprinodon* species)
  - b) Sympatric speciation (hawthorn fly and apple maggot fly)
  - c) Parapatric speciation (Snail)
- 6 Bibliography/ Abstract writing.
- 7 Preparation of Power point presentation
- 8 Detection of Plagiarism
- 9 Report submission on 'Current leading Research institutions in India'

**SEMESTER IV**  
**Practical based on RUSZOOOP402**

1. Study of permeability of cell through plasma membrane (Osmosis in blood cells).
2. Measurement of cell diameter by oculometer (by using permanent slide)
3. Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Barfoed's test, Anthrone test)
4. Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)
5. Qualitative test for lipids (solubility test, Sudan III test)
6. Study of rancidity of lipid by titrimetric method.
7. Ultra structure of cell organelles – (Electron micrographs)
  - a) Nucleus
  - b) Endoplasmic reticulum (Smooth and rough)
  - c) Mitochondria.
  - d) Golgi apparatus
  - e) Lysosomes
8. Study of clinical disorders due to carbohydrates, proteins and lipids imbalance (photograph to be provided / significance to given and disorder to be identified)
  - a) Hyperglycemia, Hypoglycemia
  - b) Thalassemia, Kwashiorkor
  - c) Obesity, Atherosclerosis

**SEMESTER IV**  
**Practical based on RUSZOO403**

1. Comparative estimation of salinity of given water sample by Argentometric method and refractometer.
2. Estimation of conductivity by conductometer in milli Q water, Distilled water and double distilled water samples.
3. Fate Mapping Technique: Vital staining (Demonstration practical)
4. Detection of Creatinine in urine.
5. Determination of blood sugar by GOD and POD method
6. Study of bleeding time and clotting time.
7. Study of the following permanent slides, museum specimens and materials.
  - a. Mammalian sperm and ovum.
  - b. Egg types –Fish eggs, Frog eggs, Hen's egg.
  - c. Cleavage, blastula and gastrula (Amphioxus, Frog and Bird).
8. Study of commercially important fishery (*Catla*, Rohu, Catfish, Mackerel, Pomfret, Bombay duck, Prawn/ Shrimp, Crab, Lobster, Edible oyster)
9. Review writing based on programs telecast by Doordarshan, Discovery channel, Gyandarshan, UGC programs, Animal planet
10. **Project** related to environmental pollution and submission of report.
11. Study of natural ecosystem and field report of the visit

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4. A textbook of cytology SuruchiTyagi Dominant Publishers and Distributors NewDelhi.
5. Cell and molecular biology Gupta P.K ,Rastogi Publication, India.
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7. Molecular Biology of the cell (6<sup>th</sup> edition) by the Insertus
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10. Biochemistry, Dushyant Kumar Shrma, 2010, Narosa Publishing house PVT.Ltd.
11. Fundamentals of Biochemistry, Dr AC Deb, 1983, New Central Book Agency Ltd.
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2. Developmental Biology- Berril N.J., Tata McGraw –Hill Publication.
3. Essential Reproduction-Martin H. Johnson, Wiley-Blackwell Publication.
4. Chick Embryology- Bradley M. Pattern.
5. Embryology- Mohan P. Arora.
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8. Biological Science. Taylor, Green and Stout. Cambridge Publication
9. Biology. E. P. Solomon, L. R. Berg, D. W. Martin, Thompson Brooks/Cole
10. Human Biology-Daniel D Chiras Jones and Bartlett
11. The Physiology of Reproduction Vol I & II - E.K .Nobil and JU. D.Neil, Raven Press, New York.
12. Air Pollution, Kudesia V.P. PragatiPrakasan, Meerut
13. Fundamentals of Air Pollution Daniel A. Vallero, Academic press 5<sup>th</sup> Edition
14. Principles and Practices of Air Pollution Control and Analysis J.R. Mudakani I K International Pub. House Pvt. Ltd.
15. Text Book of Air Pollution and its Control, S.C.Bhatia Atlantic
16. Water Pollution, Kudesia V.P., PragatiPrakasan, Meerut
17. A text book of Environmental Chemistry and Pollution Control, S.S.Dogra, SwasticPub, New Delhi
18. Practical Methods for water and Air Pollution Monitoring, S.K.Bhargava, New Age
19. International Hand Book of Water and waste water Analysis, Kanwaljit Kaur, Atlantic Aquatic Pollution by Edward A. Laws
20. Environmental Science and Technology, Stanely E. Manahan
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22. A Text Book of Environmental Studies, Gurdeep R. Chatwal, Harish Sharma, Madhu Arora, Himalaya



**Three Units- Each Unit 20 Marks [Total marks = 60]**

**Q.1. A) Answer any two of the following: (10M)**

- 1)
- 2)
- 3)

**Q.1. B) Write short note on: (Any two): (10M)**

- 1)
- 2)
- 3)

**Q.2. A) Answer any two of the following: (10M)**

- 1)
- 2)
- 3)

**Q.2. B) Write short note on: (Any two) (10M)**

- 1)
- 2)
- 3)

**Q.3. A) Answer any two of the following: (10M)**

- 1)
- 2)
- 3)

**Q.3. B) Write short note on: (Any two) (10M)**

- 1)
  - 2)
  - 3)
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**PRACTICAL**  
**( Based on RUSZOO401)**  
**Skeleton-Practical Examination Question Paper Pattern**

**Time: 3hrsMarks: 50**

**Major Question** (12 marks)

**Q1.** Study Population density by Line transect or Quadrant method and calculate biodiversity indices (any 2)

**Minor Question** (08 marks)

**Q2.** Prepare a smear to show prokaryotic cell.

OR

**Q2.** Prepare a smear to show eukaryotic cell.

**Q3.** Identify and describe as per instructions (8 marks)

a) Fossils

b) Speciation

**Q4.** From the given article prepare the bibliography/ abstract (06 marks)

**Q5.** Power point presentation (06 marks)

**Q6.** Submission of report on 'Current leading Research institutions in India' (07 marks)

**Q7.** Journal (03 marks)



**PRACTICAL**  
**(Based on RUSZOO402)**  
**Skeleton-Practical Examination Question Paper Pattern**

**Time: 3hrsMarks: 50**

**Major Question (15 marks)**

**Q1.** Study of permeability of cell through plasma membrane (Osmosis in blood cells)

OR

**Q1.** Measurement of cell diameter by occulometer (by using permanent slide)

**Minor Question (12 marks)**

**Q2.** Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Barfoed's test, Anthrone test)

OR

**Q2.** Qualitative tests for proteins (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)

OR

**Q2.** Qualitative test for lipids (Solubility test, Sudan III test)

OR

**Q2.** Study of rancidity of lipids by titrimetric method

**Q3.** Identify and describe as per instructions **(15 marks)**

1. Ultra structure of cell organelles (a, b & c)
2. Clinical disorders (d & e)

**Q4.** Viva **(05 marks)**

**Q5.** Journal **(03 marks)**

**PRACTICAL**  
**( Based on RUSZOO403)**  
**Skeleton -Practical Examination Question Paper Pattern**

**Time: 3hrsMarks: 50**

**Major Question (12 marks)**

**Q1.** Detection of Creatinine in urine

OR

**Q1.** Determination of blood sugar by GOD and POD method

**Minor Question (05 marks)**

**Q2.** Estimation of Salinity by argentometric method from the given water sample

OR

**Q2.** Estimation of conductivity by conductometer from the given water sample

OR

**Q2.** Study of bleeding time and clotting time

**Q3.** Identify and describe as per instructions(**15 marks**)

1. Permanent slides (a & b)

2. Fishery (c, d & e)

**Q4.** Field Report and viva based on it.(**10 marks**)

**Q5.** Submission of project report related to Environmental pollution project and viva based on it.(**05 marks**)

**Q6.** Journal (**03 marks**)

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