AC/II(20-21).2.RUS12

# S. P. Mandali's

# Ramnarain Ruia Autonomous College

***(Affiliated to University of Mumbai)***




## Syllabus for: UG

## Program: B.Sc.

## Program Code: Zoology (RUSZOO)

(Credit Based Semester and Grading System
for the academic year 2020–2021)

# S. P. Mandali's

# Ramnarain Ruia Autonomous College

***(Affiliated to University of Mumbai)***

## Syllabus for: S. Y. B. Sc.

## Program: B.Sc.

## Program Code: Zoology (RUSZOO)

(Credit Based Semester and Grading System
for the academic year 2020–2021)

**Course Code: RUSZOO301**

# Course Title: Genetics, Heredity and Nucleic Acids

## Academic year 2020-21

**COURSE OUTCOMES:**

| COURSE OUTCOME | DESCRIPTION<br>After successfully completing the course, the students will be able to: |
|---|---|
| **CO 1** | Understand Mendel's fundamental law of inheritance and solve problems based on Mendelian genetics |
| **CO 2** | Recall various exceptions Mendel's fundamental law of inheritance and can solve problem based on inheritance. |
| **CO 3** | Construct and analyse Pedigree charts. |
| **CO 4** | Understand the cytological basis for variations, applications of genetics, sex determination, sex linked inheritance, gene expression and regulation. |
| **CO 5** | Analyse the chemical composition of DNA and RNA and give a comparative account of the same. |
| **CO 6** | Calculate the mitotic index of *Alium cepa* root tip spread. |



**Detailed syllabus**

| RUSZOO301 | Title: Genetics, Heredity& Nucleic acids | Credits-02 |
|---|---|---|
| **Unit I** | **Fundamentals of Genetics** | **15 lectures** |
| | **Introduction to genetics**<br>• Definition, scope and importance of genetics.<br>• Classical and Modern concept of Gene (Cistron, muton, recon).<br>• Brief explanation of the following terms: Allele, wild type and mutant alleles, locus, dominant and recessive traits, homozygous and heterozygous, genotype and phenotype, genome. | |
| | **Mendelian Genetics**<br>• Mendelian Genetics: Monohybrid cross, Dihybrid cross, test cross, back cross, Mendel's laws of Inheritance, Mendelian traits in man.<br>• Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Lethal alleles, Epistasis - Recessive, Double recessive, dominant and double dominant.<br>• Chromosome theory of inheritance.<br>• Pedigree analysis-Autosomal dominant and autosomal recessive, X-linked dominant, and X-linked recessive | |
| | **Multiple Alleles and Multiple Genes**<br>• Concept of multiple alleles, Coat colour in rabbit, ABO and Rh blood group systems **and its medico-legal importance. (include case studies)**<br>• Polygenic inheritance with reference to skin colour and eye colour in man.<br>• Concept of pleiotropy. | |
| | **Linkage and Crossing Over**<br>• Linkage: Definition, types and significance<br>• Crossing over: Mechanism, types, significance and cytological basis | |
| | **Human genetics**<br>• Study of syndromes: Genetic basis and symptoms of Turner's, Klienfelter's, Down's, Cri-du chat, Patau's, Edwards<br>• Human Pedigree analysis with symbols, Significance of genetic counselling (Can include case studies) | |
| **Unit II** | **Chromosomes and Heredity** | **15 lectures** |
| | **Chromosomes**<br>• Introduction to morphology of chromosome, Chromosome structure- Heterochromatin, Euchromatin<br>• Classification based on the position of centromere<br>• Types of Chromosomes- Autosomes and Sex chromosomes | |

| | | |
|---|---|---|
| | • Study of chromosome morphology in different animals (*C. elegans, Drosophila* and Zebra fish)<br>• Endomitosis, Giant chromosomes- Polytene and Lamp brush chromosomes and significance of Balbiani rings | |
| | **Sex- determination**<br>• Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW.<br>• Sex determination in honey bees- Haplodiploidy,<br>• Sex determination in Drosophila-Genic balance theory, intersex,<br>• Gynandromorphs.<br>• Parthenogenesis.<br>• Hormonal influence on sex determination-Freemartin and sex reversal.<br>• Role of environmental factors- *Bonellia, Crepidila fornicata,* Crocodile and Turtle.<br>• Lyon hypothesis and Barr bodies formation in mammals, Mechanisms of Dosage compensation in *Drosophila* and *C. elegans* | |
| | **Sex linked, sex influenced and sex-limited inheritance**<br>• X-Linked: Colour blindness, Haemophilia<br>• Y-linked: Hypertrichosis<br>• Sex-influenced genes and Sex-limited genes | |
| **Unit III** | **Nucleic acids** | **15 Lectures** |
| | **Genetic material**<br>• Griffith's transformation experiments, Avery-Macleod and McCarty, Hershey and Chase experiment of Bacteriophage infection.<br>• Chemical composition and structure of nucleic acids.<br>• Double helix nature of DNA, Solenoid model of DNA.<br>• Types of DNA – A, B, Z & H forms.<br>• DNA in Prokaryotes -chromosomal and plasmid and Extra nuclear DNA –mitochondria and chloroplast.<br>• RNA as a genetic material in viruses and Types of RNA (Structure and function). | |
| | **Flow of genetic information in a Eukaryotic cell**<br>• DNA Replication<br>• Transcription of mRNA<br>• Translation and Genetic code | |
| | **Gene Expressions and regulation**<br>• One gene-one enzyme hypothesis /one polypeptide hypothesis<br>• Concept of operon<br>• Lac operon | |
| **RUSZOOP301** | **PRACTICALS** | **Credits-03** |

| Genetics, Heredity and Nucleic acids | | |
|---|---|---|
| **1.** | Study of Polytene chromosome | |
| **2.** | Mounting of Barr bodies. | |
| **3.** | Study of Mitosis by a temporary squash preparation of onion root tip and calculation of mitotic index | |
| **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 –<br>a) Monohybrid/ Dihybrid cross<br>b) X linked inheritance<br>c) Multiple alleles | |
| **8.** | Study of Chromosome morphology during metaphase stage of different species. (Photograph to be provided) | |
| **9.** | Study of Human Karyotypes and Genetic disorders (Show karyotype spread pictoral) | |
| **10.** | Pedigree analysis | |
| **11.** | Finger printing Lifting techniques, Patterns and pedigree analysis. | |
| **12.** | Extraction and detection of DNA | |
| **13.** | Extraction and detection of RNA | |
| **14.** | Maintenance of *Drosophila* culture, identify male and female flies, etherizing flies for transfer, identifying different larval stages (Activity based practical) | |
| | **Project**- 'Survey of inheritable Human traits using family tree analysis along with graphical presentation of the data' (Submission of written or printed report) | |

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- Gardner, E.J., Simmons, M.J and Snustad, D.P. John Wiley and Sons, Principles of Genetics, (1991), Jhon Wiley and Sons, New York.
- Klug, W.S., Cummings M.R., Spencer, C.A. Benjamin Cummings, Concepts of Genetics, 11th edition, (2014), Pearson.
- Russell, P. J,iGenetics- A Molecular Approach, (2009), 3rd edition, Benjamin Cummings publication.
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- Griffiths, A.J.F., Wessler. S.R., Lewontin, R.C. andCarroll, S.B.,Introduction to Genetic Analysis, (2000), W. H. Freeman and Co.
- Verma P.S. andAgrawal P.K., Cell Biology, Genetics, Molecular Biology Evolution and Ecology, (2006), 9th edition, S. Chand Publication, New Delhi.
- Eldon john Gardner, Michael J. Simmons, D. PeterSnustad, Principles of Genetics, (2006), Eight edition, Jhon Wiley and Sons
- Weaver, Hedrick, Genetics, (1996), third edition, McGraw Hill Education
- Benjamin A. Pierce,Genetics A conceptual approach, (2016), 6th edition, Southwestern University, W.H. Freeman and company, New York

- Monroe W. Strickberger,Genetics, (2008), Third Edition, PHI Learning publication.
- Leland H. Hartwell, LeroyHood,Michael L. Goldberg, Ann E. Reynolds, Lee M. Silver,Genetics from gene to genome, (2010), 4th edition, McGraw Hill Education


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**Course Code: RUSZOO302**

# Course Title: Life processes

## Academic year 2020-21

**COURSE OUTCOMES:**

| COURSE OUTCOME | DESCRIPTION<br>After successfully completing the course, the students will be able to: |
|---|---|
| **CO 1** | Develop an understanding of the evolution of increasing complexity of physiology of all life processes and its evolutionary hierarchy. |
| **CO 2** | Understand and recall different structures of digestive apparatus, respiratory apparatus, circulatory apparatus and reproductive systems of different invertebrates and vertebrates. |
| **CO 3** | Compare and contrast between the integrating structure, function and development of different systems amongst different phyla. |
| **CO 4** | Understand and explain the concept of seasonal and continuous breeder and give and comparative account. |
| **CO 5** | Have an analytical overview of the evolutionary concepts including homology and homoplasy, and Detaileded discussions of major organ systems. |
| **CO 6** | Draw diagrams of digestive systems, respiratory systems, circulatory systems of different invertebrate and vertebrate animals. |
| **CO 7** | Correlate between the habit and habitat with the structures involved in all the physiologic processes in different classes of organisms |



**Detailed syllabus**

| RUSZOO302 | Title: LIFE PROCESSES | Credits-02 |
|---|---|---|
| **Unit I** | **Study of Nutrition and Excretion** | **15 lectures** |
| | **Comparative study of Nutritional Apparatus with reference to feeding adaptations -Structure and functions:**<br>• Invertebrates- eg: Amoeba- Pseudopodia, Hydra- Tentacles, Earthworm-Suction, Cockroach-biting and chewing.<br>• Vertebrates-Fish, Reptiles-Calotes<br>• Digestive system and physiology of digestion with respect to Man | |
| | **Comparative Study of Excretory and Osmoregulatory systems of:**<br>• Amoeba - Contractile vacuoles<br>• Planaria -Flame cells<br>• Earthworm –Nephridia<br>• Cockroach-Malphigian tubules and green gland<br>• Bivalve -Organ of Bojanus<br>• Categorization of animals based on principle nitrogenous excretory products<br>• Structure of kidney, Uriniferous tubule and physiology of urine formation in Man. | |
| **Unit II** | **Study of Respiration and Circulation** | **15 lectures** |
| | **Respiration**<br>• Comparative study of Respiratory organs - Structure and Function with reference to Earthworm, Spider, Rohu, Rabbit.<br>• Accessory respiratory structures: *Anabas* /*Clarius*<br>• Structure of lungs and physiology of respiration in man | |
| | **Circulation**<br>• Comparative study of circulation: Open and closed - single and double<br>• Types of circulating fluids - Water, coelomic fluid, haemolymph, lymph and Blood<br>• Comparative study of Hearts (Structure and function) with reference to Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon<br>• Physiology of Human Heart | |
| **Unit III** | **Control and coordination, Locomotion and reproduction** | **15 Lectures** |
| | **Control and coordination**<br>• Irritability –*Paramecium*, Nerve net in Hydra, Nerve ring and nerve cord in earthworm<br>• Types of neurons on the basis of structure and function | |

| | | |
|---|---|---|
| | • Conduction of nerve impulse: Resting potential, action potential and refractory period<br>• Synaptic transmission – Chemical and Electrical<br>• Neurotransmitter (Addiction to psychotic substances)<br>• Endocrine regulation: Hormones as chemical messengers and feedback mechanisms, hormones as therapeutic agents | |
| | **Movement and Locomotion**<br>• Locomotory organs (Structures and Functions) - Pseudopodia in *Amoeba* (sol gel theory), Cilia in *Paramoecium*<br>• Wings and legs in Cockroach<br>• Tube feet in Starfish<br>• Fins of fish | |
| | **Structure of Striated muscle fiber in human and Sliding filament theory** | |
| | **Reproduction**<br>• Asexual Reproduction- Fission, fragmentation, budding, gemmule formation Sexual reproduction – Gametogenesis, Structure of male and female gametes in human<br>• Types of fertilization -Oviparity, viviparity, ovo-viviparity<br>• Strategies of reproduction-Concept of seasonal, continuous breeder, estrous and menstrual cycle | |
| **RUSZOOP302** | **PRACTICALS** | **3 Credits** |
| **LIFE PROCESSES** | | |
| **1.** | Hydra feeding-Tentacular feeding | |
| **2.** | Feeding apparatus of Prawn and Sepia-Radula | |
| **3.** | Study of nutritional Apparatus (Amphioxus, Bivalves, Pigeon, Ruminant stomach) | |
| **4.** | Urine analysis—Normal and abnormal constituents | |
| **5.** | Detection of uric acid from excreta of Birds | |
| **6.** | Detection of Creatinine in urine. | |
| **7.** | Detection of ammonia in water excreted by fish | |
| **8.** | Study of operculum movement of fish. | |
| **9.** | Study of respiratory structures:<br>a. Gills of Bony fish and Cartilaginous fish.<br>b. Lungs of Frog<br>c. Lungs of Mammals<br>d. Accessory respiratory structure in *Anabas* (Labyrinthine organ) | |

| | | |
|---|---|---|
| | e. Air sacs of Pigeon | |
| **10.** | Study of hearts (Cockroach, Shark, Frog, *Calotes*, Crocodile, Mammal) | |
| **11.** | Determination of blood sugar by GOD and POD method. | |
| **12.** | Study of bleeding time and clotting time | |
| **13.** | Study of locomotory organs (*Amoeba*, Unio, Cockroach, Starfish, Fish, and Birds) | |
| **14.** | Study of striated and non- striated muscle fibre | |
| **15.** | Study of permanent slides on topic of Reproduction<br>a. Sponge gemmules<br>b. Hydra budding<br>c. T.S. of mammalian testis<br>d. T.S. of mammalian ovary | |

**References:**


- Jordan and Verma, Vertebrate Zoology Volume I, (2004), 2nd edition S. Chand and Co.
- Jordan and Verma,Invertebrate Zoology Volume II, (1963), S. Chand and Co.
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- Dhami P. S. and Dhami J. K.,Chordate Zoology, (2014), R. Chand and Co.
- Dhami P. S. and Dhami J. K,Invertebrate Zoology., (2015) R. Chand and Co.
- Introduction to Invertebrates- Moore Cambridge University- Low Priced Edition.
- Miller S. A. and Harley J. B,Zoology., (2005), 6th edition, Tata McGraw Hill.
- Kotpal R. L., Modern Textbook of Zoology, Invertebrates, (2016), Rastogi Publication.
- Taylor D.J., Stout G.W., Green N.P.O,SoperR, Biological Science,CambridgeUniversity Press.


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## Course Code: RUSZOO303

# Course Title: Ethology and Economic Zoology

## Academic year 2020-21

**COURSE OUTCOMES:**

| COURSE OUTCOME | DESCRIPTION<br>After successfully completing the course, the students will be able to: |
|---|---|
| **CO 1** | Understand the biology of behaviour which is an important basis for adaptive capacities of animals and the needs of animals |
| **CO 2** | know the complex interactions among various living organisms. |
| **CO 3** | Understand different concepts of parasitism, taxonomic diversity of parasites and their parasitic mode of life. |
| **CO 4** | Demonstrate common protozoan, helminth parasites of humans as well as parasites of livestock |
| **CO 5** | Analyse the diagnosis and control of parasitic infections in humans and animals. |
| **CO 6** | Understand and explain the concepts of handling, managing farm animals for apiculture, vermiculture and dairy purpose. |
| **CO 7** | Equip students with modern techniques in animal husbandry and encourage them for self-employment |

**Detailed syllabus**

| RUSZOO303 | Title: ETHOLOGY AND ECONOMIC ZOOLOGY | Credits-02 |
|---|---|---|
| **Unit I** | **Ethology** | **15 lectures** |
| | **Introduction to Ethology**<br>• Definition, History and Scope of Ethology<br>• Animal behaviour - Innate and Learned behavior<br>• Types of learning -Habituation, Imprinting and types of imprinting (filial and Sexual), Classical conditioning, Instrumental learning and insight learning | |
| | **Aspects of animal behaviour**<br>• Communication in Bees and Ants<br>• Mimicry and colouration<br>• Role of hormones and pheromones in sexual behavior<br>• Displacement activities, Ritualization<br>• Migration in fish, schooling behavior<br>• Habitat selection, territorial behaviour, food selection and foraging behavior in African ungulates | |
| | **Social behaviour**<br>• Social behaviour in primates -Hanuman langur<br>• Elements of Socio-biology: Selfishness, cooperation, altruism, kinship and inclusive fitness | |
| **Unit II** | **Parasitology** | **15 lectures** |
| | **Introduction to Parasitology**<br>• Definitions: parasitism, host, parasite, vector-biological and mechanical, Types of parasites- Ectoparasites, Endoparasite and their subtypes<br>• Parasitic adaptations in Ectoparasites and Endoparasites<br>• Types of hosts: intermediate and definitive, reservoir | |
| | **Host-parasite relationship-Host specificity**<br>• Definition<br>• Structural specificity<br>• Physiological specificity and ecological specificity | |
| | **Life cycle, pathogenicity, control measures and treatment**<br>• *Entamoeba histolytica*<br>• *Fasciola hepatica*<br>• *Taenia solium*<br>• *Wuchereriabancrofti* | |
| | **Morphology, life cycle, pathogenicity, control measures and treatment**<br>• Head louse (*Pediculus humanuscapitis*)<br>• Mite (*Sarcoptesscabiei*) | |

| | | |
|---|---|---|
| | • Bed bug (*Cimexlectularis*) | |
| | **Parasitological significance**<br>• Zoonosis - Bird flu<br>• Anthrax<br>• Rabies<br>• Toxoplasmosis | |
| **Unit III** | **Economic Zoology** | **15 Lectures** |
| | **Apiculture**<br>• Methods of bee keeping and management – An introduction to different species of honey bees used in apiculture.<br>• Selection of flora and bees for apiculture<br>• Advantages and disadvantages of traditional and modern methods of Apiculture<br>• Pests and Bee enemies- Wax moth, wasp, black ants, bee-eaters, king crow and disease control<br>• Bee keeping industry- Present status and recent efforts to improve and boost the industry<br>• Economic importance– Honey: Production, Chemical composition and economic importance<br>• Bees wax- Economic importance<br>• Role of honey bees in pollination | |
| | **Vermiculture**<br>• Rearing methods, management and economic importance- An introduction to different species of earthworms used in vermiculture<br>• Methods of vermiculture.<br>• Maintenance and harvesting<br>• Economic importance: advantages of vermiculture, demands for worms; market for vermicompost and entrepreneurship. | |
| | **Dairy Science**<br>• Dairy development in India-Role of dairy development in rural economy, employment opportunities<br>• Dairy Processing-Filtration, cooling, chilling, clarification, pasteurization, freezing<br>• Milk -Composition of milk and Types of milk: Recombined milk, Soft curd milk, Skimmed and toned milk, Artificial milk<br>• Milk products | |
| **RUSZOOP303** | **PRACTICALS** | **3 Credits** |
| **Ethologyand Economic Zoology** | | |
| **1.** | Study of ethological aspects:<br>a) Warning Colouration | |

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

**References:**


- David McFarland, Animal Behaviour: Psychobiology, Ethology and Evolution, (1998), 3rd edition, BenjamminCumings publication.
- Mohan Arora, Animal Behaviour, (1996), Himalaya Publication House
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Technology: Earthworms, Organic Wastes, and Environmental Management, (2010),1st Edition, CRC Press.

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- Chandler and Read,Introduction to Parasitology, (1961), 10th edition, John Wiley & Sons
- S.Mathur,Economic Zoology- Biostatistics and Animal behaviour, RastogiPublicatons.
- Shukla G.S. &Upadhyay V.B.,Economic Zoology, Rastogi Publications.
- A handbook on Economic Zoology, S.Chand& Co.

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## MODALITY OF ASSESSMENT

**A] Internal assessment - 40%  40 marks**

| Sr. no. | Evaluation type | Marks |
|---|---|---|
| 1. | One class test (Multiple choice questions or Objective) | 20 |
| 2. | Assignment/ Case study/ Research project/ Group Discussion/ Presentation/ Viva | 20 |
| | **TOTAL** | **40** |

**B] External examination - 60%**

- **Semester End Theory Assessment = 60 Marks**
  - Duration – These examinations shall be of **two hours** each paper.
  - Paper Pattern: All questions shall be compulsory with internal choice within the questions.

**Paper Pattern**

| Questions | Options | Marks | Questions on |
|---|---|---|---|
| Q.1) A, B, C | Any 2 out of 3 | 16 | Unit I |
| Q.2) A, B, C | Any 2 out of 3 | 16 | Unit II |
| Q.3) A, B, C | Any 2 out of 3 | 16 | Unit III |
| Q.4)a, b, c, d, e | Any 3 out of 5 | 12 | All Units |
| | **TOTAL** | **60** | |

**Practical Examination Pattern:**

**(A) Internal Examination**

| Heading | Practical |
|---|---|
| **Journal** | 05 |
| **Lab Participation** | 05 |
| **Lab work/ Field report/ Presentation** | 10 |
| **Total** | **20** |

**(B) External (Semester end practical examination)**

| Particulars | Practical |
|---|---|
| **Lab work and / or *Viva voce*** | 30 |
| **Total** | **30** |

## PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In charge of the department; failing which the student will not be allowed to appear for the practical examination.**

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## Course Code: RUSZOO401

## Course Title: Evolution and Population Genetics

## Academic year 2020-21

**COURSE OUTCOMES:**

| COURSE OUTCOME | DESCRIPTION<br>After successfully completing the course, the students will be able to: |
|---|---|
| **CO 1** | 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. |
| **CO 2** | Analyse and identify different mechanisms of speciation. |
| **CO 3** | Calculate and solve the problems based on Hardy Weinberg equation. |
| **CO 4** | Develop the research aptitude. |
| **CO 5** | Gain experience at reading and evaluating the scientific literature |
| **CO 6** | Develop skills, concept and experience to understand the ethical aspects of research. |

**Detailed syllabus**

| RUSZOO401 | Title: Evolution and Population Genetics | Credits-02 |
|---|---|---|
| **Unit I** | **Origin and evolution of Life** | **15 lectures** |
| | **Introduction**<br>• Origin of universe<br>• Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory<br>• Origin of life<br>• Origin of eukaryotic cell. | |
| | **Evidences in favour of organic evolution**<br>• Morphology and comparative anatomy: Homology, Analogy and Vestigial organs.<br>• Embryology: Homology of early development, Homology in the embryos, Retrogressive metamorphosis<br>• Geographical distribution<br>• Paleontology<br>• Connecting links<br>• Physiology<br>• Genetics | |
| | **Theories of organic evolution**<br>• Theory of Lamarck<br>• Theory of Darwin and Neo Darwinism<br>• Mutation Theory<br>• Synthetic theory<br>• Weisman's germplasm theory<br>• Neutral theory of molecular evolution | |
| | **Evolution of Man** | |
| **Unit II** | **Population genetics and evolution** | **15 lectures** |
| | **Introduction to population genetics:**<br>Definition and Brief explanation of the following terms: Population, gene pool, Allele frequency, genotype frequency, phenotype frequency, microevolution | |
| | **Population genetics**<br>• Hardy-Weinberg Law<br>• 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 andFounder effect), Natural Selection | |

| | | |
|---|---|---|
| | • **Patterns of Natural Selection** – Stabilizing selection, Directional Selection (Examples: Peppered moth, Antibioticresistance in bacteria, Pesticide resistance), Disruptive selection, Sexual selection: Zahavi's Handicap principal with respect to sexual selection and mate choice. | |
| | **Evolutionary genetics**<br>• **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).<br>• **Nature of genetic variations**- Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism: Heterozygote advantage and Frequency dependent selection, Neutral variations, Geographic variation (Cline)<br>• **Species Concept** - Biological species concept and evolutionary species concept.<br>• **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)<br>• **Macroevolution**-Concept and Patterns of macroevolution (Stasis, Preadaptation/Exaptation, Mass extinctions, Adaptive radiation and Coevolution)<br>• **Convergent Evolution, Divergent Evolution and Megaevolution:** Introduction and concept | |
| **Unit III** | **Scientific Attitude methodology, writing and ethics** | **15 Lectures** |
| | **Process of science: A dynamic approach to investigation**<br>• **The Scientific method** - Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery<br>• **Scientific Research** - Definition, difference between method and methodology characteristics, types<br>• **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 | |

| | | |
|---|---|---|
| | • **Dissemination of data** - Reporting results to scientific community (Publication in peer-reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation)<br>• **Application of knowledge** - Basic research, Applied research, Translational Research, Patent | |
| | **Scientific writing: 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 | |
| | **Writing a review paper**<br>• **Structure and components of research report** - Report writing, Types of report<br>• **Computer application** - Plotting of graphs, Statistical analysis of data. Internet and its application in research-Literature survey, Online submission of manuscript for publication | |
| | **Ethics**<br>• **Ethics in animal research** - The ethical and sensitive care and use of animals in research, teaching and testing, Approval from Institutional animal ethics Committee.<br>• **Ethics in clinical research**-Approval from Clinical Research Ethics Committee, Informed consent<br>• **Approval from concerned/ appropriate authorities**-National Biodiversity Authority, State Biodiversity Board, Forest Department<br>• **Conflict of interest** | |
| | **Plagiarism:** Concept, its types and different ways of committing plagiarism and Ethics and prevention, Detection of plagiarism. | |
| **RUSZOOP401** | **PRACTICALS** | **Credits-03** |
| | **EVOLUTIONAND POPULATION GENETICS** | |
| **1.** | Study of population density by Line transect method & Quadrant method and calculate different diversity indices.<br>a) Index of Dominance<br>b) Index of frequency<br>c) Rarity Index<br>d) Shannon Index<br>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<br>a) Arthropods: *Trilobite*<br>b) Mollusca: *Ammonite*<br>c) Aves: *Archaeopteryx* | |
| **5.** | Identification of:<br>a) Allopatric speciation (*Cyprinodon* species)<br>b) Sympatric speciation (hawthorn fly and apple maggot fly)<br>c) Parapatric speciation (Snail) | |
| **6.** | Study of morphological similarities between Man and Ape (Girdles, Skull, long bones). | |
| **7.** | Study of successive stages of evolution of man with special reference to cranial capacity, skull, gait, dentition. (*Australopethicus, Homo erectus, Homo neandrethals, Cro-magnon* and *Homo sapiens*) | |
| **8.** | Bibliography/ Abstract writing. | |
| **9.** | Report submission on 'Current leading Research institutions in India'. | |
| **10.** | Technical Presentation of a scientific article; presentation tool, presentation content, abstract, charts, references/ bibliography. | |

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- Strickberger,Evolution, CBS publication
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- RC. Kothari, Research Methodology, Methods and Techniques, Wiley Eastern Ltd. Mumbai
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## Course Code: RUSZOO402

## Course Title: Cell Biology and Biomolecules

## Academic year 2020-21

**COURSE OUTCOMES:**

| COURSE OUTCOME | DESCRIPTION<br>After successfully completing the course, the students will be able to: |
|---|---|
| **CO 1** | Distinguish between the characters of Prokaryotic and Eukaryotic cell. |
| **CO 2** | Describe and explain structure and function of cell. |
| **CO 3** | Learn and understand about different cell organelles and cellular transport systems. |
| **CO 4** | Understand the importance of biomolecules and their clinical significance |
| **CO 5** | Recall classification and biological importance of Carbohydrate. |
| **CO 6** | Recall classification and biological importance of Protein. |
| **CO 7** | Recall classification and biological importance of Lipids. |

**Detailed syllabus**

| RUSZOO402 | Title: Cell Biology and Biomolecules | Credits-02 |
|---|---|---|
| **Unit I** | **Cell Biology** | **15 Lectures** |
| | **Introduction to cell biology**<br>• Definition and scope<br>• Cell theory<br>• Generalized prokaryotic, eukaryotic cell: size, shape and structure | |
| | **Nucleus**<br>• Size, shape, number and position<br>• Structure and functions of interphase nucleus<br>• Ultrastructure of nuclear membrane and pore complex<br>• Nucleolus: general organization, chemical composition andfunctions<br>• Nuclear sap/ nuclear matrix<br>• Nucleo-cytoplasmic interactions | |
| | **Plasma membrane**<br>• Fluid Mosaic Model<br>• Junctional complexes<br>• Membrane receptors<br>• Modifications: Microvilli, Desmosomes and Plasmodesmata | |
| | **Transport across membrane**<br>• Diffusion and Osmosis<br>• Transport: Passive and Active<br>• Endocytosis and Exocytosis | |
| | **Cytoskeletal structures**<br>• Microtubules: Composition and functions<br>• Microfilaments: Composition and functions | |
| **Unit II** | **Endomembrane System** | **15 lectures** |
| | **Endoplasmic reticulum**<br>• Discovery, occurrence and Types<br>• Ultrastructure and Functions<br>• Disorder of endoplasmic reticulum- Cystic Fibrosis | |
| | **Golgi complex**<br>• Origin, occurrence and morphology<br>• Ultra-structure and functions | |

| | | |
|---|---|---|
| | • Disorder of Golgi complex- Congenital disorders of glycosylation | |
| | **Lysosomes**<br>• Origin, occurrence and polymorphism<br>• Ultrastructure and Functions<br>• Disorder of lysosomes- Tay Sach's disease | |
| | **Mitochondria**<br>• Origin, occurrence and morphology<br>• Ultrastructure and functions<br>• Marker enzymes, Mitochondrial biogenesis, Semi-autonomousnature of mitochondria<br>• Disorder of mitochondria- Mitochondrial encephalopathy | |
| **Unit 3** | **Biomolecules** | **15 Lectures** |
| | **Chemistry of Water molecule**<br>• Properties - Polarity, Osmolarity, Ionization of water,<br>• Buffering against pH changes. | |
| | **Biomolecules:** Concept of Micro-molecules and Macromolecules | |
| | **Carbohydrates**<br>• Definition Classification, Properties and Isomerism, Glycosidic bond<br>• Structure of–Monosaccharides (Glucose and Fructose), Disaccharides (Lactose and Sucrose), Polysaccharides (Cellulose, Starch, Glycogen and Chitin)<br>• Biological role and their Clinical significance | |
| | **Amino Acids and Proteins**<br>• Basic structure of amino acid, classification of amino acids, Essential and Non-essential amino acids, Peptide bond<br>• Protein conformation: Primary, Secondary, Tertiary and Quaternary<br>• Types of proteins – Structural (Keratin, Collagen) and functional proteins (Hemoglobin)<br>• Biological role and their Clinical significance | |
| | **Lipids**<br>• Definition, classification of lipids with examples, Ester linkage<br>• Physical and Chemical properties of lipids<br>• Saturated and Unsaturated fatty acids, Essential fatty acid<br>• Triacylglycerols, Phospholipids (Lecithin and Cephalin) and Steroids (Cholesterol)<br>• Biological role and their Clinical significance | |

| | | |
|---|---|---|
| | **Vitamins**<br>• Water soluble vitamins (e.g. Vit C, Vit B12)<br>• Lipid soluble vitamins (e.g. Vit A, Vit D)<br>• Biological role and their Clinical significance | |
| **RUSZOOP402** | **PRACTICALS** | **Credits-03** |
| **CELL BIOLOGY AND BIOMOLECULES** | | |
| **1.** | Study of permeability of cell through plasma membrane (Osmosis in blood cells). | |
| **2.** | Measurement of cell diameter by occulometer (by using permanent slide) | |
| **3.** | Ultra-structure of cell organelles – (Electron micrographs)<br>a) Nucleus<br>b) Endoplasmic reticulum (Smooth and rough)<br>c) Mitochondria.<br>d) Golgi apparatus<br>e) Lysosomes | |
| **4.** | Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Barfoed's test, Anthrone test) | |
| **5.** | Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoprotein test) | |
| **6.** | Qualitative test for lipids (solubility test, Sudan III test) | |
| **7.** | Study of rancidity of lipid by titrimetric method. | |
| **8.** | Study of clinical disorders due to carbohydrates, proteins and lipids imbalance (photograph to be provided / significance to given and disorder to be identified)<br>a) Hyperglycemia, Hypoglycemia<br>b)Thalessemia, Kwashiorkar<br>c) Obesity, Atherosclerosis | |

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- E.E. Conn and P.K. Stumpf, Outline of Biochemistry, (1976). John Wiley and Sons, USA

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## Course Code: RUSZOO403

## Course Title: Reproductive Biology and Pollution

## Academic year 2020-21

**COURSE OUTCOMES:**

| COURSE OUTCOME | DESCRIPTION<br>After successfully completing the course, the students will be able to: |
|---|---|
| **CO 1** | Understand and describe different types of eggs, cleavage, blastulae in different animals. |
| **CO 2** | Compare and contrast between different egg types, blastulae types and sperms in different animals and interrelate it with their developmental process. |
| **CO 3** | Understand the basic concept of human reproduction along with natural and artificial methods of contraception |
| **CO 4** | Learn and describe causes of fertility related problems and concerned treatment |
| **CO 5** | Learn basic principles, causes, effects and preventive measures of different types of pollution |
| **CO 6** | Apply the theory of pollution in relevance to practical situation |

**Detailed syllabus**

| RUSZOO403 | Title: REPRODUCTIVE BIOLOGY AND POLLUTION | Credits-02 |
|---|---|---|
| **Unit I** | **Comparative Embryology** | **15 lectures** |
| | **Types of Eggs-Based on amount and distribution of yolk** | |
| | **Structure and Types of Sperms** | |
| | **Types and Patterns of Cleavage** | |
| | **Types of Blastulae (Amphioxus, Frog, Aves, Chick.)** | |
| | **Gastrulation**<br>• Coelom–Formation and types | |
| | **Extra embryonic membranes**<br>Types of Placentae (Based on histology, morphology and implantation) | |
| **Unit II** | **Aspects of Human Reproduction** | **15 lectures** |
| | **Human Reproductive system and Hormonal regulation**<br>• Anatomy of human male and female reproductive system<br>• Hormonal regulation of Reproduction and Impact of age on reproduction<br>• Menopause and Andropause | |
| | **Contraception & birth control**<br>• Difference between contraception and birth control<br>• Natural Methods: Abstinence, Rhythm method, Temperature method,<br>• Cervical mucus or Billings method, Coitus interruptus, Lactation amenorrhea<br>• Artificial methods: Barrier methods, Hormonal methods, Intrauterine contraceptives, Sterilization, Termination, Abortion | |
| | **Infertility**<br>**Female infertility -**<br>• 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)<br>• Infertility associated disorders (Endometriosis, Polycystic Ovarian syndrome -(PCOS), POF (Primary ovarian failure), STDs (Gonorrhea, Chlamydia, Syphilis and Genital Herpes), Antibodies to sperm, Genetic causes -Recurrent abortions, Role of endocrine disruptors)<br>**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 | |
| | **Treatment of Infertility**<br>• Removal /reduction of causative environmental factors<br>• Surgical treatment<br>• Hormonal treatment- Fertility drugs<br>• Assisted Reproductive Technology<br>• Sperm banks, cryopreservation of gametes and embryos<br>• Surrogacy | |
| | **Techniques and Ethical considerations of Artificial Reproductive Technology (ART)**<br>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 3** | **Pollution and its effects on organisms** | **15 Lectures** |
| | **Air Pollution**<br>• Types and sources of air pollutants<br>• Effects and control measures | |
| | **Water Pollution**<br>• Types and sources of water pollutants<br>• Effects and control measures | |
| | **Soil Pollution**<br>• Types and sources of soil pollutants<br>• Effects and control measures | |
| | **Noise pollution**<br>• Different means of noise pollution<br>• Effects and control measures | |
| | **Radioactive pollution** | |
| | **Solid waste Pollution**<br>• Types and sources,<br>• Effects and control | |
| | **Pollution – Climate change and Global warming** | |
| **RUSZOOP403** | **PRACTICALS** | **Credits-03** |
| **REPRODUCTIVE BIOLOGY AND POLLUTION** | | |
| **1.** | Study of the types of placentae of mice, rat, cow/buffalo, goat and yolk sac of shark. | |

| | | |
|---|---|---|
| **2.** | Study of extra embryonic membranes in chick. | |
| **3.** | Study of types of coelom with respect to development. | |
| **4.** | Fate Mapping Technique: Vital staining (Demonstration practical) | |
| **5.** | Study of the following permanent slides, museum specimens and materials.<br>a. Mammalian sperm and ovum.<br>b. Egg types –Fish eggs, Frog eggs, Hen's egg.<br>c. Cleavage, blastula and gastrula (Amphioxus, Frog and Bird). | |
| **6.** | Comparative estimation of salinity of given water sample by Argentometric method and refractometer. | |
| **7.** | Estimation of conductivity by conductometer in milli Q water, Distilled water and double distilled water samples. | |
| **8.** | Determination of Nitrates- nitrites from given water sample. | |
| **9.** | Determination of P-phosphorus from given water sample. | |
| **10.** | Determination of pH of soil and water by pH paper, pH meter and Universal indicator. (5 samples each) | |
| **11.** | Detection of heavy metal (Lead) from the given sample of water. | |
| | **Project** related to environmental pollution and submission of report. | |
| | Study of natural ecosystem and field report of the visit | |

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- Berril N.J., Developmental Biology, Tata McGraw –Hill Publication.
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- KudesiaV.P,Water Pollution, PragatiPrakasan, Meerut
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- S.K.Bhargava,Practical Methods for water and Air Pollution Monitoring,New Age
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- Edward A. Laws, AtlanticAquatic Pollution.
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- GurdeepR.Chatwal, Harish Sharma, MadhuArora,A Text Book of Environmental Studies, Himalaya Publication.


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## MODALITY OF ASSESSMENT

**A] Internal assessment - 40%  40 marks**

| Sr. no. | Evaluation type | Marks |
|---|---|---|
| 1. | One class test (Multiple choice questions or Objective) | 20 |
| 2. | Assignment/ Case study/ Research project/ Group Discussion/ Presentation/ Viva | 20 |
| | **TOTAL** | **40** |

**B] External examination - 60%**

- **Semester End Theory Assessment = 60 Marks**
  - Duration – These examinations shall be of **two hours** each paper.
  - Paper Pattern: All questions shall be compulsory with internal choice within the questions.

| Questions | Options | Marks | Questions on |
|---|---|---|---|
| Q.1) A, B, C | Any 2 out of 3 | 16 | Unit I |
| Q.2) A, B, C | Any 2 out of 3 | 16 | Unit II |
| Q.3) A, B, C | Any 2 out of 3 | 16 | Unit III |
| Q.4)a, b, c, d, e | Any 3 out of 5 | 12 | All Units |
| | **TOTAL** | **60** | |

**Practical Examination Pattern:**

**(A) Internal Examination**

| Heading | Practical |
|---|---|
| **Journal** | 05 |
| **Lab Participation** | 05 |
| **Lab work/ Field report/ Presentation** | 10 |
| **Total** | **20** |

**(B) External (Semester end practical examination)**

| Particulars | Practical |
|---|---|
| **Lab work and / or *Viva voce*** | 30 |
| **Total** | **30** |

## PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.
**In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In charge of the department; failing which the student will not be allowed to appear for the practical examination.**

## Overall Examination and Marks Distribution Pattern

### Semester- III and IV

| Course | 301/401 | | | 302/402 | | | 303/403 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Internal | External | Total | Internal | External | Total | Internal | External | Total | |
| Theory | 40 | 60 | 100 | 40 | 60 | 100 | 40 | 60 | 100 | 300 |
| Practicals | 20 | 30 | 50 | 20 | 30 | 50 | 20 | 30 | 50 | 150 |

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