AC/II(21-22).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 2021–2022)

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 2021–2022)

Course Code: RUSZOO301

Course Title: Genetics, Heredity and Nucleic Acids

Academic year 2021-22

COURSE OUTCOMES:

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

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

References:

- 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.
- Daniel L., Hartl, Elizabeth W. Jones,Genetics: Analysis of Genes and Genomes, (2005), Jones& Bartlett Publishers
- 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

****

Course Code: RUSZOO302

Course Title: Life processes

Academic year 2021-22

COURSE OUTCOMES:

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

	• Types of neurons on the basis of structure and function • Conduction of nerve impulse: Resting potential, action potential and refractory period • Synaptic transmission – Chemical and Electrical • Neurotransmitter (Addiction to psychotic substances) • Endocrine regulation: Hormones as chemical messengers and feedback mechanisms, hormones as therapeutic agents	
	Movement and Locomotion • Locomotory organs (Structures and Functions) - Pseudopodia in *Amoeba* (sol gel theory), Cilia in *Paramoecium* • Wings and legs in Cockroach • Tube feet in Starfish • Fins of fish	
	Structure of Striated muscle fiber in human and Sliding filament theory	
	Reproduction • Asexual Reproduction- Fission, fragmentation, budding, gemmule formation Sexual reproduction – Gametogenesis, Structure of male and female gametes in human • Types of fertilization -Oviparity, viviparity, ovo-viviparity • 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: 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 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 a. Sponge gemmules b. Hydra budding c. T.S. of mammalian testis 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.
- Majupuria T. C.,Invertebrate Zoology, NaginS.and Co
- 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.

****

Course Code: RUSZOO303

Course Title: Ethology and Economic Zoology

Academic year 2021-22

COURSE OUTCOMES:

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

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

	b) Instincts c) Imprinting d) Communication in animals: Chemical signals and sound signals Displacement activities in animals: Courtship and mating behaviour in animals and ritualization	
2.	Study of Protozoan parasites: a) *Trypanosoma gambiense* b) *Giardia intestinanalis*	
3.	Study of Helminth parasites: a) *Ancylostoma duodenale* b) *Dracunculus medenensis*	
4.	Parasitic adaptations: Scolex and mature proglottid of Tapeworm	
5.	Study of Ectoparasites: a) Leech b) Tick c) Mite	
6.	Study of Honey Bee: a) Life Cycle of Honey Bee and Bee Hive 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
- ReenaMathur, Animal Behaviour, (2014), Rastogi Publications.
- Dawkins, An introduction to Animal Behaviour, (2012), 6thEdition, Cambridge University Press.
- Agarwal, V.K.,Animal Behaviour, (2010), S Chand And Co.
- Tinbergen, Animal Behaviour
- Saxena S. C,Biology of Insects,(1992), Oxford and IBH Publishing Co New Delhi, Bombay, Calcutta
- Mathur V. K. and UpadhayayK,A Text Book of Entomology, (1974), GoelPrintingpress, Barani.
- Roger A. Morse,Bee and Bee Keeping, Conell University Press London
- Clive A. Edwards, Norman Q. Arancon and RhondaSherman, Vermiculture

Technology: Earthworms, Organic Wastes, and Environmental Management, (2010),1st Edition, CRC Press.

- Chatterjee K.D.,Parasitology:(Protozoology and Helminthology), (2010), 13/e (6th reprint)Chatterjee Medical Publishers.
- Arora, Medical Parasitology, (2010), 3rd edition, CBS publishers.
- C.K JayaramPaniker, Textbook of Medical Parasitology, (2018), 8th edition, Jaypee Brothers.
- Kochhar S.K.,A text book of Parasitology- Dominant Pub. & Dis, New Delhi.
- Gerald and Schmidt,Essentials of Parasitology, (1990), 4th edition, Universal Bookstall, New Delhi.
- Sharma P.N.andRatnu L.N., Parasitology, (1984), Chand S &Co.Pvt.Ltd.
- 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.

****

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**

  *** (Deviation from the usual modality)**

  Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

  - 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.

****

Course Code: RUSZOO401

Course Title: Evolution and Population Genetics

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION 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 • Origin of universe • Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory • Origin of life • Origin of eukaryotic cell.	
	Evidences in favour of organic evolution • Morphology and comparative anatomy: Homology, Analogy and Vestigial organs. • Embryology: Homology of early development, Homology in the embryos, Retrogressive metamorphosis • Geographical distribution • Paleontology • Connecting links • Physiology • Genetics	
	Theories of organic evolution • Theory of Lamarck • Theory of Darwin and Neo Darwinism • Mutation Theory • Synthetic theory • Weisman's germplasm theory • Neutral theory of molecular evolution	
	Evolution of Man	
Unit II	**Population genetics and evolution**	**15 lectures**
	Introduction to population genetics: Definition and Brief explanation of the following terms: Population, gene pool, Allele frequency, genotype frequency, phenotype frequency, microevolution	
	Population genetics • Hardy-Weinberg Law • 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 • **Patterns of Natural Selection** – Stabilizing selection, Directional Selection (Examples: Peppered moth, Antibiotic resistance in bacteria, Pesticide resistance), Disruptive selection, Sexual selection: Zahavi's Handicap principal with respect to sexual selection and mate choice.	
	Evolutionary genetics • **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). • **Nature of genetic variations**- Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism: Heterozygote advantage and Frequency dependent selection, Neutral variations, Geographic variation (Cline) • **Species Concept** - Biological species concept and evolutionary species concept. • **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) • **Macroevolution**-Concept and Patterns of macroevolution (Stasis, Preadaptation/Exaptation, Mass extinctions, Adaptive radiation and Coevolution) • **Convergent Evolution, Divergent Evolution and Mega-evolution:** Introduction and concept	
Unit III	**Scientific Attitude methodology, writing and ethics**	**15 Lectures**
	Process of science: A dynamic approach to investigation • **The Scientific method** - Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery • **Scientific Research** - Definition, difference between method and methodology characteristics, types • **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) • **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 • **Structure and components of research report** - Report writing, Types of report • **Computer application** - Plotting of graphs, Statistical analysis of data. Internet and its application in research-Literature survey, Online submission of manuscript for publication	
	Ethics • **Ethics in animal research** - The ethical and sensitive care and use of animals in research, teaching and testing, Approval from Institutional animal ethics Committee. • **Ethics in clinical research**-Approval from Clinical Research Ethics Committee, Informed consent • **Approval from concerned/ appropriate authorities**-National Biodiversity Authority, State Biodiversity Board, Forest Department • **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. 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.	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.	

References:

- Smith, Theory of Evolution, Cambridge Press, and Low price Ed.
- Strickberger, Evolution, CBS publication
- Evolution- P.S.Verma and Agarwal
- Moody, Introduction to Evolution
- E. P. Solomon, L. R. Berg, D. W. Martin, Biology, Thompson Brooks/Cole
- C. Starr, R. Taggart, C. Evers, L. Starr, Biology -The Unity and Diversity of Life, Brooks/Cole Cengage learning, International Edition
- RC. Kothari, Research Methodology, Methods and Techniques, Wiley Eastern Ltd. Mumbai
- Paul D Leedy, Practical research planning and design, 2nd edition, Macmilan Publication

****

Course Code: RUSZOO402

Course Title: Cell Biology and Biomolecules

Academic year 2021-22

COURSE OUTCOMES:

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

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

	• Biological role and their Clinical significance	
	Vitamins • Water soluble vitamins (e.g. Vit C, Vit B12) • Lipid soluble vitamins (e.g. Vit A, Vit D) • 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) a) Nucleus b) Endoplasmic reticulum (Smooth and rough) c) Mitochondria. d) Golgi apparatus 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) a) Hyperglycemia, Hypoglycemia b)Thalessemia, Kwashiorkar c) Obesity, Atherosclerosis	

References:

- Singh and Tomoar, Cell Biology, RastogiPublication.
- E.D.P De Robertis and E.M.R Robertis,Cell and molecular Biology,CBSPublishersand Distributors.
- GoeffreyM.Coper,The cell A molecular Approach, ASM Press Washington D.C.
- TyagiSuruchi,A textbook of cytology, Dominant Publishers and Distributors New-Delhi.
- Gupta P.K and Pawar C.B.,Cell Biology, Himalaya publication
- Insertus,Molecular Biology of the cell, (6th edition), Campbell Biology (9th edition)
- Lehninger A.L. Nelson D.L. and Cox M.M., Principles of Biochemistry, 2005, 2nd and 3rd edition
- D. K. Sharma,Biochemistry, 2010, Narosa Publishing house PVT.Ltd.

- Dr AC Deb,Fundamentals of Biochemistry, 1983, New Central Book Agency Ltd.
- Dr. Rama Rao A.V.S.S and Dr. A. Suryalakshmi, A Textbook of Biochemistry, 9th edition.
- G Zubay,Biochemistry,(1983) Addison Wesley,
- L Stryer,Biochemistry, 3rd/4th/5th ed, (1989), Freeman and Co. NY
- Murray R.K. Granner D.K. Mayes P.A.Rodwell,Harper's Biochemistry,(1996), 26th edition, V.M. Hall international USA
- E.E. Conn and P.K. Stumpf, Outline of Biochemistry, (1976). John Wiley and Sons, USA

****

Course Code: RUSZOO403

Course Title: Reproductive Biology and Pollution

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION 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 (Amphioxus, Frog, Chick) • Coelom–Formation and types	
	Extra embryonic membranes Types of Placentae (Based on histology, morphology and implantation)	
Unit II	**Aspects of Human Reproduction**	**15 lectures**
	Human Reproductive system and Hormonal regulation • Anatomy of human male and female reproductive system • Hormonal regulation of Reproduction and Impact of age on reproduction • Menopause and Andropause	
	Contraception & birth control • Difference between contraception and birth control • Natural Methods: Abstinence, Rhythm method, Temperature method, • Cervical mucus or Billings method, Coitus interruptus, Lactation amenorrhea • Artificial methods: Barrier methods, Hormonal methods, Intrauterine contraceptives, Sterilization, Termination, Abortion	
	Infertility **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 (Gonorrhea, Chlamydia, Syphilis and Genital Herpes), Antibodies to sperm, Genetic causes -Recurrent abortions,	

	Role of endocrine disruptors) **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 • Removal /reduction of causative environmental factors • Surgical treatment • Hormonal treatment- Fertility drugs • Assisted Reproductive Technology • Sperm banks, cryopreservation of gametes and embryos • Surrogacy	
	Techniques and Ethical considerations of Artificial Reproductive Technology (ART) 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 • Types and sources of air pollutants • Effects and control measures	
	Water Pollution • Types and sources of water pollutants • Effects and control measures	
	Soil Pollution • Types and sources of soil pollutants • Effects and control measures	
	Noise pollution • Different means of noise pollution • Effects and control measures	
	Radioactive pollution	
	Solid waste Pollution • Types and sources, • 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. a. Mammalian sperm and ovum. b. Egg types –Fish eggs, Frog eggs, Hen's egg. 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	

References:

- Subramoniam T., Developmental Biology, Narosa Publishers.
- Berril N.J., Developmental Biology, Tata McGraw –Hill Publication.
- Martin H. Johnson,Essential Reproduction, Wiley-Blackwell Publication.
- Bradley M. Pattern,Chick Embryology.
- Mohan P. Arora, Embryology.
- Dalela,Verma and Tyagi, Chordate Embryology.
- E. L. Marieb,Human Anatomy and Physiology, Pearson Education Low PriceEdition
- Taylor, Green and Stout,Biological Science, Cambridge Publication
- E. P. Solomon, L. R. Berg, D. W. Martin,Biology, Thompson Brooks/Cole
- Daniel D Chiras Jones and Bartlett, Human Biology
- E.K.Nobil and J. U. D.Neil,The Physiology of Reproduction Vol I & II, Raven Press,New York.
- Kudesia V.P., Air Pollution, PragatiPrakasan, Meerut
- Daniel A. Vallero,Fundamentals of Air Pollution,Academic press 5thP Edition
- J.R. Mudakani,Principles and Practices of Air Pollution Control and Analysis, I KInternational Pub. House Pvt. Ltd.
- S.C.Bhatia, Text Book of Air Pollution and its Control, Atlantic
- KudesiaV.P,Water Pollution, PragatiPrakasan, Meerut
- S.S.Dogra, A text book of Environmental Chemistry and Pollution Control, SwasticPub, New Delhi

- S.K.Bhargava,Practical Methods for water and Air Pollution Monitoring,New Age
- K. Kaur, InternationalHand Book of Water and waste water Analysis
- Edward A. Laws, AtlanticAquatic Pollution.
- StanelyE.Manahan, Environmental Science and Technology.
- A.K. De,Environmental Chemistry, New Age International.
- GurdeepR.Chatwal, Harish Sharma, MadhuArora,A Text Book of Environmental Studies, Himalaya Publication.

****

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**
  *** (Deviation from the usual modality)**
  Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.
  - 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

****