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 2021–2022)

PROGRAM OUTCOMES

PO	PO Description **A student completing Bachelor's Degree in Science (B. Sc) program will be able to:**
PO 1	Recall and explain acquired scientific knowledge in a comprehensive manner and apply the skills acquired in their chosen discipline. Interpret scientific ideas and relate its interconnectedness to various fields in science.
PO 2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
PO 3	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
PO 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
PO 5	Take complex challenges, work responsibly and independently, as well as in cohesion with a team for completion of a task. Communicate effectively, convincingly and in an articulate manner.
PO 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
PO 7	Follow ethical practices at work place and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
PO 8	Keep abreast with current scientific developments in the specific discipline and adapt to technological advancements for better application of scientific knowledge as a lifelong learner.

PROGRAM SPECIFIC OUTCOMES

PSO	Description **A student completing Bachelor's Degree in Science program in the subject of Zoology will be able to:**
PSO 1	Identify the major groups of organisms, discuss the basis of their biodiversity and draw parallels with their phylogenetic relationship, using well thought cardinal features of classification on the basis of morphology and molecular information.
PSO 2	Understand and analyse the evolutionary link amongst the animals and also understand the basic classification patterns of invertebrates and vertebrates. They will be able to compare and contrast between the anatomy and physiology of different invertebrates and vertebrate phylum.
PSO 3	Analyse the genes, genomes, cells, cell organelles, tissues and histological studies, understand the linkage of genes, mechanisms of sex determination, various structures of DNA and apply the knowledge of genetics to the process of evolution.
PSO 4	Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
PSO 5	Analyse and understand the broad concepts of ecology, food webs, food chains and the interconnectedness of biotic and abiotic factors. Comprehend the concepts of Population dynamics, communities and its dependence on the ecosystems.
PSO 6	Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.
PSO 7	Solve the environmental problems involving interaction of humans and natural systems at local or global level.
PSO 8	Apply their knowledge in fields of Biostatistics and research methodology.
PSO 9	Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within Zoology.
PSO 10	Get a flavour of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.
PSO 11	Apply their knowledge in problem solving and future course of their career development in higher education and research.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
F. Y. B. Sc.	I	**RUSZOO101**	Levels of Organization- I and Biodiversity	2
	I	**RUSZOO102**	Animal Biotechnology and Instrumentation	2
	I	**RUSZOOP101**	Practicals based of both papers of semester I	2
	II	**RUSZOO201**	Levels of organization- II and Ecology	2
	II	**RUSZOO202**	Nutrition, Public health and Hygiene	2
	II	**RUSZOOP201**	Practicals based of both papers of semester II	2
S. Y. B. Sc.	III	**RUSZOO301**	Genetics, Heredity and Nucleic Acids	2
	III	**RUSZOO302**	Life processes	2
	III	**RUSZOO303**	Ethology and Economic Zoology	2
	III	**RUSZOOP301**	Practicals based of all papers of semester III	3
	IV	**RUSZOO401**	Evolution and Population Genetics	2
	IV	**RUSZOO402**	Cell Biology and Biomolecules	2
	IV	**RUSZOO403**	Reproductive Biology and Pollution	2
	IV	**RUSZOOP401**	Practicals based of all papers of semester IV	3
	V	**RUSZOO501**	Study of animal types – Non chordates	2.5

	V	**RUSZOO502**	Haematology and Immunology	2.5
	V	**RUSZOO503**	Molecular Biology and Biotechnology	2.5
T. Y. B. Sc.	**V**	**RUSZOO504**	Endocrinology, Osteology and Embryology.	2.5
	V	**RUSZOOP501 + RUSZOOP502**	Practical based both RUSZOO501 and RUSZOO502	3
	V	**RUSZOOP503 + RUSZOOP504**	Practical based both RUSZOO503 and RUSZOO504	3
	VI	**RUSZOO601**	Study of animal type: Chordates	2.5
	VI	**RUSZOO602**	Physiology, Histology and Pathology	2.5
	VI	**RUSZOO603**	Toxicology and Computational Biology	2.5
	VI	**RUSZOO604**	Environmental Biology and Entomology	2.5
	VI	**RUSZOOP601 + RUSZOOP602**	Practical based both RUSZOO601 and RUSZOO602	3
	VI	**RUSZOOP603 + RUSZOOP604**	Practical based both RUSZOO603 and RUSZOO604	3

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Syllabus for: F. Y. B. Sc.

Program: B.Sc.

Program Code: Zoology (RUSZOO)

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

Course Code: RUSZOO101

Course Title: Levels of organisation I and Biodiversity

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Learn and understand about Taxonomy, Systematics and classification of animals, its objectives and importance.
CO 2	Understand the significance of use of scientific terminologies, concept of ICZ and binomial nomenclature.
CO 3	Acquire deep insight of different aspects of Type Studies of various groups of Non-chordates, their classification upto level of order, general and salient features, habit and habitat, geographical distribution and economic importance.
CO 4	Apply knowledge of classification and should be able to classify a non-chordate animal.
CO 5	Understand the concept of Hotspot, biodiversity values, threats to biodiversity, conservation and management of biodiversity.
CO 6	Apply the knowledge of conservation and conserve locally found flora and fauna
CO 7	Appreciate and identify the biodiversity hotspots and interrelate conservation with climate change.

Detailed Syllabus

RUSZOO101	Title: LEVELS OF ORGANIZATION-I AND BIODIVERSITY	Credits-2
Unit I	**Introduction to systematic and Levels of Organization: Non-chordates**	**15 lectures**
	Importance and application of systematics in biology: • Basic concept of animal taxonomy: Classical taxonomy to systematics-taxonomic terms; taxonomy; classification and nomenclature; phenon, taxon and category • Modern concepts and recent trends: chemotaxonomy, cytotaxonomy, serotaxonomy and molecular taxonomy • Taxonomic procedures – collection, preservation and process of identification of Biological species. • Taxonomic keys – different kinds of taxonomic keys, their merits and demerits, Process of typification of different zoological types • International Code of Zoological Nomenclature (ICZN), its operative principles; history of rules of Zoological nomenclature, Bionomial nomenclature	
	Levels of organization in animal kingdom: • Uni-cellularity versus multi-cellularity, colonization and organization of germ layers (Diploblastic and triploblastic condition) - Division of labour and organization of tissues (brief fate of ectoderm, mesoderm and endoderm) • Coelom - Types a) Acoelomate - e.g. Platyhelminthes - *Planaria* b) Pseudocoelomate - e.g. Nematoda - *Ascaris* (Round worm) c) Coelomate - e.g. Annelida - *Pheretima* (Earthworm)	
	• Symmetry – Types a) Asymmetry - e.g. *Amoeba* b) Radial – e.g. Bi-radial –*Aurelia* (Jelly –fish); Penta–radial- *Asterais* (Starfish) c) Bi-lateral- e.g. Simple- *Planaria*; Complex – *Mus* (Rat)	
	Segmentation and metamerism – Types a) Homonymous– e.g. Annelida- *Pheretima* (Earthworm) b) Heteronomous– e.g. Crustacean- *Panulirus* (Lobster) c) Cephalization–e.g. Insecta- *Periplanata* (cockroach) d) Tagmatization–e.g. *Panulirus* (Lobster) e) Cephalothorax - e.g- *Penaeus* (Prawn)	
Unit II	**Non chordates: Unicellular and multicellular organization**	**15 lectures**
	Salient features with examples for phyla, sub-phyla and classes mentioned below; **Unicellular organization**: phylum Protozoa: Bioluminescence in	

	Noctiluca (Active bioluminescence)	
	Multicellular organization: Colonization level –Phylum Porifera	
	Multicellular organization: Division of labour (cell –differentiation) PhylumCoelenterate Mechanism & theories of coral formation, types of coral reefs	
	Triploblastic Acoelomate and Pseudocoelomate organization: • Acoelomate organization –Phylum Platyhelminthes • Pseudocoelomate Organization: Phylum Nemathelminthes	
	Triploblastic coelomate organization: • Animals with metameric segmentation: Phylum Annelida, Regeneration in annelids • Animals with jointed appendages: Arthropdaincluding complete and incomplete metamorphosis, Active Bioluminescence in Glowworm and firefly. Mimicry in butterflies & its significance	
	Animals with Mantle: Phylum Mollusca, Mechanism of pearl formation	
	Animals with enterocoel: Phylum Echinodermata	
Unit III	**Biodiversity and Conservation**	**15 lectures**
	Introduction to Biodiversity: Definition**,** Concepts and Scope and Significance	
	Levels of Biodiversity: Introduction to Genetic, Species and Ecosystem Biodiversity	
	Introduction of Biodiversity Hotspots: Western Ghats (Kerala, Tamil Nadu, Karnataka, Goa Maharashtra, Gujarat) and Indo-Burma Border **(**Arunachal Pradesh, Nagaland, Mizoram, Manipur)	
	Values of biodiversity: Direct and Indirect use value	
	Threats to Biodiversity: Habitat loss and Man-Wildlife conflict • Case study: Elephant man conflict and Introduction to alien species. • Case study of introduction of wolf in yellow stone national park.	
	Biodiversity conservation and management: • Conservation strategies: in situ, ex-situ, National parks, Sanctuaries and Biosphere reserves. • Introduction to International efforts: Convention on Biological Diversity (CBD) • International Union for Conservation of Nature and Natural Resources (IUCN), • United Nations Environment Program - World Conservation Monitoring Centre (UNEP-WCMC), wetland conservation (Ramsar sites)	

	• National Biodiversity Action Plan, 2002 • Introduction to Indian Wildlife (Protection) Act, 1972 and Convention for International Trade of endangered species	
RUSZOOP101	**PRACTICALS**	**Credits- 1**
	LEVELS OF ORGANIZATION-I AND BIODIVERSITY	
1.	**Levels of organization**: a) Symmetry - *Ameoba*, Sea anemone,Liverfluke, *Planaria* b) Coelom – *Planaria, Ascaris,* Earthworm c) Segmentation – Tapeworm and Earthworm d) Cephalization - Cockroach	
2.	**Classification:** a) Protozoa - *Ameoba,Paramoecium, Euglena, Plasmodium* b) Porifera - *Leucosolenia, Euspongia* c) Coelenterata – *Hydra, Obelia* colony, *Aurelia,* Sea anemone, *Fungia* d) Platyhelminthes - *Planaria, Fasciola hepatica, Taenia solium* e) Nemathelmithes - *Ascaris* f) Annelida - *Nereis,* Earthworm, Leech g) Arthropoda - Crab, Lobster, *Lepisma,* Beetle, Dragonfly, Butterfly, Moth, Spider, Millipede and Centipede h) Mollusca – *Chiton, Dentalium, Pila,* Bivalves, *Sepia, Nautilus* i) Echinodermata – Starfish, Brittle star, Sea urchin, Sea cucumber and Feather star	
3.	**Introduction to safe handling of animal in laboratories.**	
4.	**Mounting of Foraminiferan shells**	
5.	**Study of types of corals**: Brain Coral, Organ pipe Coral, Staghorn Coral, Mushroom Coral	
6.	**Study of:** Symbiosis, Camouflage, Cannibalistic mate-eating animals, Animal architects (Termite, Harvester ant, Baya weaver bird) Active Bioluminescent organisms (Noctiluca, Firefly, Glow worm)	
7.	**Culture of *Paramoecium***	
8.	**Study of water vascular system of star fish**	
9.	**Metamorphosis in cockroach, dragon fly, honey bee and butterfly, Lepisma**	
10.	**Estimation of population density of animals by line transect method** (frequency distribution& through Pie diagram only).	
11.	**Estimation of population density of animals by quadrant method** (frequency distribution& through Pie diagram only).	
12.	**Study of Crustacean larvae** (permanent slide).	
	Field visit to any biodiversity related sites/ institute visit report.	

References:

- V.V. Dalvie, G.B. Raje, P. Sardesai, N.S. Prabhu. Wonders of the Animal World-University Text Book of Zoology, F. Y. B.Sc. Semester I Course 1, Univ Press.
- Jordan and Verma. Vertebrate Zoology Volume I, S. Chand and Co.
- Jordan and Verma. Invertebrate Zoology Volume II, S. Chand and Co.
- T. C. Majupuria , S. Nagin and Co. Invertebrate Zoology.
- P. S. Dhami and J. K. Dhami. Chordate Zoolog, R. Chand and Co.
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- Introduction to Vertebrates, Moore Cambridge University,Low Priced Edition.
- S. A. Miller and J. B. Harley. Zoology, Tata McGraw Hill.
- R. L. Kotpal. Invertebrates, Modern Textbook of Zoology.
- E. P. Odum. Fundamentals of Ecology, Sunders Publication.
- M. C. Dash, Fundamentals of Ecology, 2nd edition, Tata McGraw Hill.
- S.V.S Rana. Essentials of Ecology and Environmental Science.
- S.V.S Rana, Biodiversity, Prentice Hall Publications.
- V. B. Rastogi. Modern Biology.
- D. R. Khanna. Biology of Mollusca.
- Jeffery Parker and William. A. A Textbook of Zoology, Vol. II- T, Haswell-Low Price Publications.
- P. D. Sharma. Ecology and Environment, R. K. Rastogi Publications
- R. Dajoz. Introduction to Ecology.
- Wildlife Laws and its Impact on Tribes, Deep and Deep Publications
- K. C. Agarwal. Biodiversity, Agro Botanica Publications
- Butterflies of India – Isaac Kehimkar- BNHS Publication.

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Course Code: RUSZOO102

Course Title: Animal Biotechnology and Instrumentation

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Calculate the concentration of solutions.
CO 2	Recall good laboratory practices and work safely in the Department Laboratory.
CO 3	Calculate central tendencies of group and ungroup data.
CO 4	Comprehend the data and also prepare correct graphical presentation for it.
CO 5	Describe types of transgenesis methods, gene therapy, principle of DNA finger printing and its applications and application of biotechnology in animal husbandry and Medicine.
CO 6	Understand the principle and working of various basic laboratory instruments like microscope, pH meter, centrifuge etc.
CO 7	Compare and contrast between different types of centrifuges and calculate the Rf values in different chromatography (adsorption and thin layer)

Detailed Syllabus

RUSZOO102	Title: ANIMAL BIOTECHNOLOGY and INSTRUMENTATION	Credits- 2
Unit I	**Laboratory safety, Units and Measurement**	**15 lectures**
	Introduction to good laboratory practices	
	Use of safety symbols: • Concept • Types of hazards • Precautions	
	Units of measurement: • Calculations and related conversions of each: a) Metric system- length (meter to micrometer) b) Weight (gram to microgram) c) Volumetric (Cubic measures) • Temperature: Celsius, Fahrenheit, Kelvin • Concentrations: Percent solutions, ppt, ppm, ppb dilutions, Normality, Molarity and Molality • Biostatistics: a) Introduction and scope b) Sampling and its types c) Central Tendencies (mean, median, mode) d) Tabulation and Graphical representations(Histograms, bar diagrams, piediagrams)	
Unit II	**Animal Biotechnology**	**15 lectures**
	Biotechnology: Scope and achievements of Biotechnology (Fishery, Animal Husbandry, Medical, Industrial)	
	Transgenesis: • Retro viral method • Nuclear transplantation method • DNA microinjection method • Embryonic stem cell method	
	Cloning (Natural and Artificial) • Natural cloning **-** *Planaria,* Identical twins (monozygotic) and Non-identical twins (dizygotic) • Artificial cloning **-**Dolly and Macaque monkey	
	Ethical issues of transgenic and cloned animals	
	Applications of Biotechnology: • Blotting techniques- **Southern, Northern and Eastern** • DNA fingerprinting - Technique in brief and its application in forensic science (Crime Investigation) • Recombinant DNA in medicines (recombinant insulin) • Gene therapy: Ex-vivo and *In vivo,* Severe Combined Immunodeficiency (SCID), and Cystic Fibrosis • Green genes: Green Fluorescent Protein (GFP) from Jelly fish-valuable as reporter genes used to detect food poisoning	
Unit III	**Instrumentation**	**15 Lectures**

	Microscopy: Construction**,** Principle and applications of dissecting and compound microscope	
	Colorimetry and Spectroscopy: Principle and applications	
	pH: • Sorenson's pH scale • pH meter - Principle and applications	
	Centrifuge: Principle and applications (clinical and ultra-centrifuges)	
	Chromatography: Principle and applications (Partition and Adsorption)	
	Electrophoresis: Principle and applications (AGE and PAGE)	
	Assignment: Genetically modified Organisms (GMOs): Production and applications (Submission of typed or written report)	
RUSZOOP102	**PRACTICALS**	**Credit-1**
ANIMAL BIOTECHNOLOGY AND INSTRUMENTATION		
1.	a) Interpretation of safety symbols (toxic, corrosive, explosive, flammable, skin irritant, oxidizing, compressed gases, aspiration hazards and Biohazardous infectious material, Radioactivity, Environmental toxicity) b) Study of Central tendencies and plotting of Bar diagram, histogram and pie diagram	
2.	To demonstrate immobilization of Enzyme and its activity.	
3.	Calculation of pH of three different samples (one each acidic, alkaline and neutral) using Red Cabbage Indicator and confirming the result with pH meter	
4.	a) Study of parts of microscope and their functions. b) Technique of focusing a permanent slide under 10X and 45X.	
5.	a) Dilution of given sample and estimation of OD using colorimeter b) Calculation of concentration from the given OD using formula.	
6.	a) Separation of amino acids from the mixture by paper chromatography. b) Calculation of Rf value of a separated pigments/amino acids from the given chromatogram and their identification from standard chart.	
7.	a) Separation of pigments by adsorption chromatography using chalk b) Separation of Lipids by TLC	
8.	Visit to Forensic laboratory / Biotechnology Laboratory and submission of report.	

References:

- V.V. Dalvie, R. G. Deshmukh, R. D'souza and H.U. Shingadia. Basic Laboratory Techniques, Instrumentation and Biotechnology- University Text Book of Zoology,

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- A. Borem, D. Bowe. Understanding biotechnolog, Low price edition –Pearson Publication
- R. C. Dubey. A Textbook of Biotechnology, S. Chand Publication.
- A. H. Patel. A Manual of Medical Laboratory Technology, Navneet Prakashan Ltd.
- Dr. P. K. Bajpai. Biological instruments and methodology, S. Chand company Ltd.
- Frank H. Stephenson. Calculations in Molecular biology and Biotechnology, Academic Press.

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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**

  *** (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.

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Course Code: RUSZOO201

Course Title: Levels of organization- II and Ecology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Learn about different aspects of type's studies of various groups of Chordates. Their identification and classification up to order, general and salient features, habit and habitat, geographical distribution and economic importance.
CO 2	Apply knowledge of classification and should be able to classify a chordate animal up to class.
CO 4	Acquire knowledge and understanding of relationship, distribution, abundance of organism in an environment and understand and explain the major ecological concepts of energy flow, Bio-geochemical cycles, population and community
CO 5	Learn about interrelationship between organism in population and communities, structural adaptation and functional adjustment of organism to their physical environment.
CO 6	Calculate Natality, Mortality and fecundity of a population and identify different population graphs and survivorship curves.
CO 7	Apply scientific knowledge of ecology to analyse social and environmental issues

Detailed syllabus

RUSZOO201	Title: LEVELS OF ORGANIZATION-II AND ECOLOGY	Credits-2
Unit I	**Levels of Organization: Chordates**	**15 lectures**
	Salient features with examples for phyla, sub-phyla and classes mentioned below; **Phylum: Hemichordata**	
	Phylum: Chordata • Subphylum: Urochordata • Subphylum: Cephalochordata	
	Subphylum Vertebrata • Super-class: Agnatha – Class Cyclostomata • Super-class: Gnathostomata • Class: Pisces (Cartilagenous and bony fish), Passive bioluminescence in Angler fish, Parental care in fishes • Class: Amphibia, parental care in Amphibians • Class: Reptilia, Regeneration in Lizard • Class: Aves, Migration and brood parasitism in birds • Class: Mammalia, Parental care, Echolocation (Bat, Dolphin & Whale) & Adaptation to desert life	
Unit II	**Population Ecology and Ecosystem**	**15 lectures**
	Concept of ecosystem	
	Concept of energy flow: different types of ecological pyramids Food chain and food web (Aquatic and terrestrial), Detritus food chain, Lentic & Lotic ecosystem, concept of biomagnifications. • Edaphic: Soil formation, Components of Soil, Types of soil and Soil Profile. • Light: Relation to terrestrial and aquatic habitat, photoperiodism, diurnal migration, adaptations of animals to dark. • Temperature: range, tolerance, Bergman's Principle, Allen's Rule, effects of temperature on living organisms.	
	Concept of biogeochemical cycles with respect to current ecological issues: • Carbon cycle • Nitrogen cycle • Phosphorous cycle (Bird & bat guano) • Sulfur cycle	
	Concept of population and community: • Population - Natality, mortality, population growth, survivorship curve, density age and sex composition • Community (Forest, grassland & pond) - Ecological niche, ecological succession (different seral stages), ecological climax (significance)	
	Concept of animal interaction: Symbiosis, Mutualism, Commensalisms, Parasitism and predation, Antibiosis	
Unit 3	**National parks and Sanctuaries of India**	**15**

		Lectures
	Concept of Endangered and Critically Endangered species: Using examples of Indian Wildlife with respect to National Parks and Wildlife Sanctuaries of India – a) Sanjay Gandhi National Park b) Tadoba Tiger Reserve c) Corbett National Park d) Kaziranga National Park e) Gir National Park f) Silent Valley g) Pirotan Island Marine Park h) Keoladeo Ghana National Park i) Bandipur Sanctuary j) Namdapha National Park k) Hemis National Park l) Keibul Lamjao National Park	
	Management strategies with special reference to Tiger and Rhinoceros in India	
	Ecotourism	
	Bio-piracy	
RUSZOOP201	**PRACTICALS**	**Credit-01**
1.	**Classification:** a) Hemichordata - *Balanoglossus* b) Urochordata - *Herdmania* c) Cephalochordata - *Amphioxus* d) Cyclostomato – *Petromyzon*, *Myxine* e) Pisces – Shark, Skates, Sting ray/Electric ray, Flying fish**,**bioluminescence in angler fish f) Amphibia – Frog, Toad, Caecilian, Salamander g) Reptilia – Chameleon, *Calotes*, Turtle, Tortoise, Snake, Crocodile h) Aves – Kite, Kingfisher, Duck i) Mammalia – Shrew, Hedgehog, Guinea pig, Bat	
2.	a) **Calculation of** Natality, Mortality, Population density from given data b) Estimation of population density by capture-recapture method	
3.	**Interpretation of Growth curves** (Sigmoid and J shaped)	
4.	**Estimation of hardness from given water sample** (Tap water versus Well water)	
5.	**Estimation of free carbon dioxide (free CO2) from two different samples** (Aerated drinks (diluted) versus Tap water)	
6.	**Estimation of dissolved oxygen (O2) from two different samples** (Tap water and Bottled Mineral water)	
7.	**Estimation of sulfur from given soil sample**.	
8.	**Construction of food chain and food web using given information/data**: a) Identification and interpretation of ecological pyramids of energy, biomass and number b) Construction of different types of pyramids from given data.	

9.	Breeding and parental care in Amphibians (Rhacophorus, Midwife toad Darwin's frog, Caecilian)	
10.	Parental in fishes (Tilapia, cat fish, viviparity, oviparity, ovoviviparity, sea horse, pipe fish)	
11.	Mounting of scales of Fish,	
12.	Identification of common urban birds with respect to: a) feathers b) beaks and c) claws (Preferably slide show)	
13.	Field visit to Snake park: To study venomous and non-venomous snakes and adaptive radiation in other reptiles. (Submission of written or typed report)	
14.	**Field visit:** Guided nature tour to any National Park and submission of report.	

References:

- University Text Book of Zoology- Introduction to Ecology and Wildlife, F.Y.B.Sc. Semester II Course 3. University Press.
- Eugene P. Odum and Grey W. Barrett. Fundamentals of Ecology - Brook Cole/ Cengage learning.
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- Subramaniam and et el. Ecology - Narosa Publishing House.
- Mona Purohit. Wildlife laws and its impact on tribes - Deep and deep Publication.
- Eldra Solomon, Linda R. Berg and Diana W. Martin. Biology - Thomson/ Brooks/ Cole.
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Course Code: RUSZOO202

Course Title: Nutrition, Public health and Hygiene

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Calculate the BMI index and analyse the different food components and their proportions for having a balanced meal.
CO 2	Identify different food sources rich in different vitamins like A, B, C
CO 3	Differentiate between Kwashiorkar and Marasmus, Diabetes type I and Diabetes type II and suggest corrective lifestyle measure to overcome it.
CO 4	Comprehend the importance of physical, psychological and social health for personal growth and recall the harmful effects of self-medication and excessive use of mobile.
CO 5	Appreciate and become aware of the programmes implemented by WHO and Government of India in eradication of Polio and Leprosy from India.
CO 6	Comprehend the importance of first aid in accident and dog bite and implement it.
CO 7	Explain causes, symptoms, preventative measures and treatment noncommunicable diseases, stress related diseases and implement the preventative measures for betterment of society

Detailed syllabus

RUSZOO202	Title: NUTRITION, PUBLIC HEALTH AND HYGIENE	Credit-02
Unit I	**Nutrition and Health**	**15 lectures**
	Concept of balanced diet: Food Pyramid, Dietary recommendations to a normal adult, Infant, Pregnant woman and Aged person	
	Malnutrition disorders: • Anemia (Iron deficiency and Vitamin B12) - (cause, symptoms, diagnosis, treatment and prevention) • Marasmus (cause, symptoms, diagnosis, treatment and prevention) • Kwashiorkar (cause, symptoms, diagnosis, treatment and prevention) • Goiter (cause, symptoms, diagnosis, treatment and prevention)	
	Vitamins – cause, symptoms, diagnosis, treatment and prevention (Scurvy, Rickets, Beriberi, Pellagra and Night blindness) and poisoning.	
	Starvation, acidity and peptic ulcers: cause, symptoms, diagnosis, treatment and prevention.	
	Obesity: Definition, consequences and treatment.	
	Importance of fibers in food.	
	Diabetes type I and II	
	Anthropometry – Definition, Measurements and applications.	
Unit II	**Public Health and Hygiene**	**15 lectures**
	Health: • Definition of Health, the need for health education and health goal • Physical, psychological and Social health issues • WHO and its programs - Polio, Small pox, Malaria and Leprosy (concept, brief accounts and outcome with respect to India) • Ill effects of self-medication	
	Water and water supply • Sources and properties of water • Purification of water, small scale, medium scale and large scale (rapid sand filters) • Water footprint (concept, brief accounts and significance)	
	Hygiene • Hygiene and health factors at home, personal hygiene, oral hygiene and sex hygiene • Radiation risk- Mobile Cell tower and electronic gadgets (data of recommended level, effects and precaution.	
	First Aid: Dog bite and its treatment	
	Blood bank – Concept and significance	
Unit III	**Common Human Diseases and Disorders**	**15 Lectures**
	Stress related disorders:	

	• Hypertension • Swine flu and Dengue • Anxiety • Insomnia • Migraine • Depression (Causes, symptoms, precaution and remedy)	
	Communicable and non-communicable diseases: (Cause/causative agents, symptoms and diagnosis, precaution, prevention and remedy Management/treatment) • Tuberculosis only pulmonary in theory others extra pulmonary in practical • Typhoid • Hepatitis (A and B) C, D and E • AIDS • Gonorrhea • Syphilis • Diseases of respiratory system- Asthma and Bronchitis • Cholera	
RUSZOOP202	**PRACTICALS**	**Credits- 1**
NUTRITION, PUBLIC HEALTH AND HYGIENE		
1.	Qualitative estimation of Vitamin C by Iodometric method.	
2.	Study of microscopic structure of starch granules of different cereals (wheat, maize and jowar)	
3.	a) Estimation of maltose from brown and white bread b) Moisture content from biscuits or other suitable food products.	
4.	Food adulteration test –Milk adulterants (starch and glucose), Methylene blue reduction test (MBRT)	
5.	a) Estimation of protein content of two egg varieties b) Study of efficacy of different antacids (any two)	
6.	**Study of Human Parasites** – a) Endoparasites – Protozoans (*Entamoeba*, *Plasmodium*), Helminthes (*Ascaris, Wuchereria*) b) Ectoparasites – Head louse and Tick c) Exoparasites – Bed bug and Mosquitoes	
7.	Screening of anemic/non-anemic persons using CuSO4 method.	
8.	BMI analysis – using formula.	
9.	Diseases - Oral cancer, TB, bronchitis (causes, symptoms and management)	
10.	Preparation and submission of BMI report.	
11.	**First Aid –** Practical training for students to be conducted by the experts and respective authorities.	

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- Parks K. Textbook of Preventive and Social Medicine- BanarasidasBhanotJabalpar.
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- Chatterjee K. D. Parasitology (Protozoology and Helminthoology) - Chatterjee Medial Publishers.
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- Srilakshmi B. Dietetics - New Age International (P) Ltd. Publishers.
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- Dr. Dastur R. H. Are You Healing Yourself Mr. Executive - IBH Publishing Company.
- Dr. Shashi Goyal, Pooja Gupta. Food Nutrition and Health- S. Chand Publications.
- Michael J. Gidney, Barrie M. Margetts, John M. Kearney and Lenore Arab. Public Health Nutrition- Willey Blackwell Publication.
- Dr. Swaminathan. Food and Nutrition – Vol. I and II, Bappco Publication.
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- Paramjit Rana. Total Health.

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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**

  *** (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:

(C) Internal Examination

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

(D) 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- I and II

Course	101/102			201/202			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

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

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)	

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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.
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- 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 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
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- 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 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.
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- 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**

  *** (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.

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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.	

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- Strickberger, Evolution, CBS publication
- Evolution- P.S.Verma and Agarwal
- Moody, Introduction to Evolution
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- 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

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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	

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- GoeffreyM.Coper,The cell A molecular Approach, ASM Press Washington D.C.
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- 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

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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:

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- Martin H. Johnson,Essential Reproduction, Wiley-Blackwell Publication.
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- Mohan P. Arora, Embryology.
- Dalela,Verma and Tyagi, Chordate Embryology.
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- Taylor, Green and Stout,Biological Science, Cambridge Publication
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- 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.

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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**
  *** (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

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

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for: T. Y. B. Sc.

Program: B.Sc.

Program Code: Zoology (RUSZOO)

(Credit Based Semester and Grading System
for the academic year 2021–2022)

NOTE

In the context of UGC circular of 2006 and the need to understand animal systems better at specialization stages in Zoology, limited anatomical studies of the animals has been introduced at the level of specialization in Zoology, i.e. at T.Y.B.Sc. level. These anatomical studies have been introduced keeping in focus that all aspects of ethics of animal experimentation is informed to the students and that it will be ensured that students are made to understand the ethical use of animals in Biology. In this context, anatomical studies in a limited manner will be used for training with the following conditions:

1) The college is agreed to the inclusion of anatomical studies provided, that the students are not asked to kill and cut open live animals.

2) The animal specimen if used for anatomical studies will be procured dead from local food market and are items of regular consumption by people.

3) The sessions of anatomical studies are arranged in a planned manner to minimise the number of animal specimens used and to reuse the same animal specimen for multiple sessions.

4) Further, College will constitute an Anatomical Study monitoring board which will be informed about the use of animals and that the usage will comply to the guidelines of ethical use and handling of animals.

5) Students opting for specialization in Zoology (T.Y.B.Sc.) will be informed in advance about the inclusion of anatomical studies in the course work.

Course Code: RUSZOO501

Course Title: Study of animal types: Non-chordates

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Learn and describe the unique characters of phylum Annelid, Arthropoda, Mollusca, Echinodermata.
CO 2	Understand body organization, systematic position, habit and habitat, internal systems and physiology of phylum Annelid to Echinodermata.
CO 3	Understand the economic importance of phyla Annelid to Echinodermata
CO 4	Develop conceptual clarity with regard to the anatomy of animals at different levels and will get an idea of general characteristics and Detaileds of invertebrate animal systems.
CO 5	Interrelate the working and different systems of non-chordates and link it with their evolutionary process

Detailed syllabus

RUSZOO501	Title: Study of Animal types: Non-chordates	Credits: 2.5
Unit I	**Phylum- Annelid e.g. Earthworm**	**15 lectures**
	Systematic position, habit and habitat	
	Structure and histology of body wall	
	Locomotion	
	Type of nutrition	
	Physiology of respiration	
	Physiology of excretion & excretory system	
	Physiology of reproductive system	
	Nervous system	
	Regeneration	
Unit II	**Phylum- Arthropoda e.g. Cockroach**	**15 lectures**
	Systematic position, Habit and habitat	
	External characters	
	Morphology and Physiology of Digestive system Physiology of Blood vascular system	
	Physiology of Excretory system	
	Morphology and Physiology of Male and Female	
	Urinogenital System	
	Anatomy of Nervous system and sense organs	
Unit III	**Phylum-Mollusca e.g. Sepia**	**15 Lectures**
	Systematic position, Habit and habitat	
	External characters	
	Morphology and Physiology of Digestive system	
	Morphology and Physiology of Circulatory system	
	Morphology and Physiology of Excretory system	
	Morphology of Reproductive system	
	Morphology of Nervous system and sense organs	
	Economic importance	
Unit IV	**Phylum- Echinodermata e.g. Starfish**	**15 Lectures**
	Systematic position, Habit and habitat	
	External characters, Endoskeleton, coelom	

	Digestive system, Physiology of Digestive system	
	Locomotion: Water Vascular System	
	Physiology of Circulatory system	
	Reproductive system	
	Fertilization and larval development	
	Nervous system	
	Regeneration	
	Assignment - Model – Animal Systems	
RUSZOOP501	**PRACTICALS**	**Credits-03**
STUDY OF ANIMAL TYPES: NON-CHORDATES		
1.	**Hydra** a) Preparation of culture media of Hydra culture. b) Estimation of growth rate of Hydra depending on use of different culture media. c) Study of regeneration in Hydra	
2.	**Anatomical study of Earthworm so as to study its** **a) Morphology** **b) Digestive system** **c) Reproductive system** **d) Nervous system** **e) Excretion-mounting of septal nephridium**	
3.	**Study of Cockroach** a) Morphology b) Study of mouth parts c) Digestive system d) Reproductive system e) Nervous system f) Respiratory system (trachea and spiracle) g) Locomotion (Mounting of legs)	
4.	**Study of Sepia so as to study its** a) Morphology b) Digestive system c) Reproductive system d) Nervous system	
5.	**Study of Star fish for its** a) Morphology b) Water vascular system c) Digestive system d) Reproductive system e) Nervous system	

6.	**Anatomical study of prawn** a) Brain b) Appendages c) Statocyst	
7.	**Note: Visit to local fish market to study available invertebrates**	

References:

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Course Code: RUSZOO502

Course Title: Haematology and Immunology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Explain various components and formation of Blood, its cellular components and their function.
CO 2	Demonstrate the total count of RBCs, WBCs and Hb level and comprehend blood disorders.
CO 3	Be familiar with diagnostic tests performed in the pathological laboratories and recall their clinical significance.
CO 4	Apply for professional DMLT courses as well as utilize this knowledge in research.
CO 5	Explain the components of immune system and its function in the protection of the body.
CO 6	Give the reasons for Rheumatoid arthritis as an autoimmune disease, SCID and AIDS as immunodeficiency disease and describe various antigen-antibody reactions for diagnostic tests, type of vaccine and role of adjuvant in vaccine.
CO 7	Explain the role of immune components in organ transplantation, cancer treatment and recall the concept of Immunomodulation and will be able to do research in it.

Detailed syllabus

RUSZOO502	Title: Haematology and Immunology	Credits: 2.5
Unit I	**Basic Haematology**	**15 lectures**
	Composition of blood - Plasma &formed elements	
	Blood volume - Total quantity and regulation, Haemorrhage	
	Plasma proteins - Inorganic constituents, respiratory gases, organic constituents other than proteins (include internal secretions, antibodies and enzymes)	
	RBCs - Structure and functions, abnormalities in structure, total count, variation in number; types of anaemia and genetic disorders; ESR	
	Haemoglobin – Structure, formation and degradation, role in transport of oxygen and carbon dioxide (Chloride shift and Bohr's effect);types of haemoglobin (foetal, adult and sickle)	
	WBCs -Types of leukocytes and function; total count and variation in number; leucopoiesis and leukaemia and its types.	
	Blood clotting -Thrombocytes; factors and mechanism of coagulation; anticoagulants; formation of blood platelets (thrombopoiesis); clotting mechanism; bleeding and clotting time; failure of clotting mechanism; haemophilia and purpura	
Unit II	**Applied Haematology**	**15 lectures**
	Introduction to Applied Haematology Definition, scope and brief introduction of basic branches: clinical, microbiological and forensic haematology	
	Diagnostic techniques used in haematology • Microscopic examination of blood: For detection of blood cancers (Lymphoma, Myeloma); infectious diseases (Malaria, Filariasis, Leishmaniasis); hemoglobinopathies (Sickle-cell, Thalassemia) • Coagulopathies: Diagnostic methods (haemophilia and purpura) • Microbiological examination: Blood culture:	

	Method and application in Diagnosis of infectious diseases (Typhoid and TB) • Biochemical examinations of blood for: **Liver function tests:** Albumin, AST, ALT, AST:ALT ratio, Total bilirubin, Direct bilirubin, Prothrombin time / International normalized ratio (PT/INR), Serum glucose, LDH and Alkaline phosphatase **Kidney function tests:** Serum creatinine, blood urea nitrogen **Carbohydrate metabolism tests**: Blood sugar, Glucose tolerance test, Glycosylated haemoglobin test **Other biochemical tests:** Blood hormones (Thyroid, FSH, LH) • Blood Bank: Collection, storage, preservation of its components • Blood transfusion: Crossing matching, Transfusion of blood and bone marrow transplant.	
Unit III	**Basic Immunology**	**15 Lectures**
	Overview of Immunology: Definition and scope	
	Components of immune system: • Innate immunity – Definition, Factors affecting innate immunity, Mechanisms of innate immunity – physical barriers, chemical barriers and cellular barriers • Adaptive or Acquired immunity – Active Acquired immunity – Natural and Artificial; Passive Acquired immunity – Natural and Artificial	
	Cells and Organs of immune system • Cells of immune system– B cells, T cells and null cells, macrophages, dendritic cells and mast cells • Organs of immune system– Primary – Thymus and bone marrow; Secondary - Lymph node and spleen	
	Antigens: Definition, properties of antigens; haptens • **Antibodies** Definition, basic structure, classes of antibodies – IgG, IgA, IgM, IgD and IgE	
	Hypersensitivity, Autoimmunity and Immunodeficiency • Definition of Hypersensitivity; Classification of hypersensitivity reactions: Type-I, Type-II,	

	Type-III and Type-IV (one example of each type) • Introduction and a brief account of autoimmunity and example, Rheumatoid arthritis • Introduction to immunodeficiency – Congenital, e.g. SCID; Acquired, e.g. AIDS	
Unit IV	**Applied Immunology**	**15 Lectures**
	Antigen-Antibody interaction • General features of antigen-antibody interaction; Precipitation reaction: Definition, characteristics and mechanism, precipitation in gels (slide test) - Radial immunodiffusion (Mancini method), Double immunodiffusion (Ouchterlonymethod) • Agglutination reaction: definition, characteristics and mechanism • Haemagglutination (slide and micro-tray agglutination), passive agglutination, Coomb's test and ELISA	
	Vaccines and Vaccination • Brief history of vaccination, principles of vaccines, Active and Passive immunization; Routes of vaccine administration • Classification of Vaccines: Live attenuated, Whole-Killed or inactivated, Sub-unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines • Adjuvants: Introduction and application; Adjuvants used for human vaccines (Alum, Virosomes and Liposomes, Saponins, Water-in-oil emulsions) • Vaccines against human pathogens: Polio; Hepatitis A and B; Rotavirus; Tuberculosis(BCG); Diphtheria, Tetanus and Pertussis (DPT); Typhoid (TAB) vaccines	
	Transplantation and Tumour Immunology • Introduction to transplantation; Types of grafts; Immunologic basis of graft rejection: MHC compatibility in organ transplantation, • Immunomodulator – only one example of drug. • **Tumour immunology (Cancer immunology):** Introduction to cellular transformation and cancer; Immunotherapy: Antigen-independent cytokine therapy,	

	Passive immunotherapy	
	Assignment - Model on Haematology/ Immunology topics	
RUSZOOP502	**PRACTICALS**	**Credits-03**
	HAEMATOLOGY AND IMMUNOLOGY	
1.	Enumeration of erythrocytes - Total count	
2.	Erythrocyte Sedimentation Rate by suitable method – Westergren or Wintrobe method	
3.	Estimation of haemoglobin by Sahli's acid haematin method	
4.	Enumeration of leucocytes –Total Count	
5.	Differential count of WBC	
6.	Determination of Serum LDH	
7.	Estimation of total plasma proteins by Folin's method	
8.	Estimation of serum/ plasma total triglycerides by Phosphovanillin method	
9.	Latex agglutination test - Rheumatoid Arthritis	
10.	To demonstrate Immunodiffusion method by Ouchterlony technique/Radial immune diffusion.	

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- Human Physiology - Volume 1; C.C.Chatterjee
- Essentials ofHaematology; ShirishM. Kawthalkar;Jaypee Brothers
- WilliamsHematology; Kenneth Kaushansky, Marshall A. Lichtman, E. Beutler, Thomas J. Kipps, JosefPrchal, Uri Seligsohn
- Essential Haematology; Victor Hoffbrand, Paul Moss, John Pettit
- Rapid Review ofHematology; RamadasNayak;Jaypee Brothers
- Precise Haematology; Usha Rusia,Meera Sikka, Renu Saxena; Wiley India
- Short Textbook ofHaematology; Shah B.S.; C.B.S. Publisher and Distributor
- Practical Zoology; Second Edition;Dr. K.C. Ghose &Dr. B. Manna; New Central Book Agency Pvt. Ltd., Kolkata; 1999
- Mechanisms ofBody Functions; Second Edition;DexterM.Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978
- A Text book ofPracticalPhysiology;First Edition; V.G. Ranade; A.V.G.Prakashan, Pune; 1968

Applied Hematology

- Harrison's Hematology and Oncology; 3rd Edition (Harrison's Specialty); Dan Longo; McGraw-Hill
- Essentials ofHaematology; SecondEdition; Kawthalkar Shirish M.; Jaypee; 2013
- Medical Biochemistry by M.N. Chatterjee and Rana Shinde;Jaypee; 2012
- EssentialsinHematology and Clinical Pathology; Nayak, Ramadas
- Clinical Pathology andHematology; Maheshwari, Nanda; Jaypee
- Practical Hematology; Dacie J V; Churchill Livingstone; 2006

• Lecture Notes: Haematology; Hatton, Chris S. R. Hughes-Jones, NevinC. Hay, Deborah;Wiley-Blackwell
• ABC series:ABC ofClinical Haematology; Provan; Drew Publisher: BMJ Books

Basic Immunology

• Immunology - Introductory Textbook; Shetty, N.; New Age International; 2005
• Immunology – Essentialand Fundamental; Pathak, S., &Palan, U.; Science Publishers;2005
• Immunology: A textbook; Rao, C. V.;Alpha Science Int'l Ltd.; 2005
• Ananthanarayan and Paniker's textbook of microbiology; C.J. Paniker (Ed.); Ananthanarayan, R.; Orient Blackswan; 2005
• Textbook ofImmunology; Haleemkhan, Rajendra Sagar, Sadguna
• Prescott's Microbiology;Ninth Edition; JoanneM.Willey,Linda M. Sherwood &ChristopherJ.Woolverton; McGraw-Hill Education; 2014

Applied Immunology

• Cellular and molecular immunology; Abbas, A. K., Lichtman, A. H. &Pillai S.; Elsevier Health Sciences; 2014
•Roitt's essential immunology (Vol. 20); Delves,P. J., Martin, S. J., Burton, D. R., &Roitt, I.M.;JohnWiley& Sons; 2011
• The elements ofimmunology; Khan,F. H.; Pearson Education, India; 2009
• Immunology; Kindt, T.J., Goldsby, R. A., Osborne, B. A., Kuby, J.; Sixth Edition; W.H. Freeman and Company; 2006
• Janeway's Immunobiology; Murphy,K., &Weaver, C.; Garland Science;2016
• Fundamental Immunology; Paul, W.E.; Philadelphia: Lippincott-Raven;1999
• Immunology - Introductory Textbook; Shetty N.;New Age International;2005
• Prescott's Microbiology;Ninth Edition; JoanneM.Willey,Linda M. Sherwood &ChristopherJ.Woolverton; McGraw-Hill Education; 2014

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Course Code: RUSZOO503

Course Title: Molecular Biology and Biotechnology

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 the general principals of gene organization expression prokaryotes and eukaryotes, common gene analysis techniques, gene expression, different types of mutation, the role of mutagenic agents and methods of DNA repair system.
CO 2	Describe the principles for gene regulation in prokaryotic and eukaryotic cells, tools and techniques of genetic engineering and understand non-disjunction during mitosis and meiosis, its effects on genome and in turn on a person.
CO 3	Comprehend the importance and different methods of prenatal diagnosis to diagnose the diseased condition in a developing foetus.
CO 4	Understand the advantages of tissue culture in laboratory condition which can be useful for patients.
CO 5	Develop the skills of performing different aseptic techniques used to maintain sterility during experimental process.
CO 6	Analyse and compare the different culture media and optimum conditions required depending on the need of proliferating cells.
CO 7	Develop skills so as to equip them to work in upcoming fields of science and technology.

Detailed syllabus

RUSZOO503	Title: MOLECULAR BIOLOGY AND BIOTECHNOLOGY	Credits-2.5
Unit I	**Molecular Biology**	**15 lectures**
	Types of mutation • Point mutations – substitution, deletion and insertion mutations • Substitution mutations – silent (same-sense), missense and nonsense mutations, • Transition and transversion, Deletion and Insertion mutations – frameshift mutations • Trinucleotide repeat expansions – fragile X syndrome, Huntington disease • Spontaneous mutation – tautomeric shifts, spontaneous lesion	
	Induced mutations/mutagens/mutagenic agents/DNA damage • Physical agents – ionizing radiation (X-rays, α, β and γ rays), non-ionizing radiation (UV light) • Chemical agents – base analogs (5-bromouracil), intercalating agents (acridine dyes), deaminating agents (bisulfite compounds), hydroxylating agents (hydroxylamine), alkylating agents (ethylmethanesulphonate), aflatoxin (aflatoxin B1)	
	Preventative and repair mechanisms for DNA damage • Mechanisms that prevent DNA damage – superoxide dismutase and catalase • Mechanisms that repair damaged DNA – direct DNA repair (alkyltransferase, photoreactivation, excision repair) • Post-replication repair – recombination repair, mismatch repair, SOS repair,transcription - repair coupling	
	Eukaryotic gene expression • Regulatory proteins – zinc fingers, helix-turn-helix domain and leucine zipper • DNA methylation	
Unit II	**Genetic Engineering**	**15 lectures**
	Tools in Genetic Engineering • Enzymes involved in Genetic Engineering: Introduction, nomenclature and types with examples, working mechanism, Ligases – Restriction enzymes, E.coli DNA ligase, RNA polymerases.	

	• Vectors for gene cloning: General properties, advantages and disadvantages of cloning vectors – phage vectors, BAC vectors • Cloning techniques: Cloning after restriction digestion - blunt and cohesive end ligation, cDNA synthesis (Reverse transcription) • Transfection techniques: electroporation, virus mediated gene transfer – Retrovirus	
	Techniques in Genetic Engineering • **PCR techniques**: Principles, working and applications of thermocycler and introduction to RTPCR. • **Sequencing techniques:** DNA sequencing: Maxam-Gilbert method, Sanger's method – Manual and automated methods • **Protein sequencing:** Sanger's method, Edman's method, Applications of sequencing techniques • **Separation and detection techniques: Blotting techniques:** Southern blotting, Northern blotting and Western blotting Applications of blotting technique**.** • **DNA Microarray:** Introduction and Applications	
Unit III	**Human Genetics**	**15 Lectures**
	Non-disjunction during mitosis and meiosis **Chromosomal Aberrations:** Structural: Deletion: types, effects and disorders; Translocation: types: robertsonian and non-robertsonian, disorders; Inversion: types, effects and significance; Duplication and their evolutionary significance (multigene families) Numerical: Aneuploidy and Polyploidy (Autoploidy and Alloploid)	
	Genetic Disorders • **Inborn Errors of Metabolism**: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism, Niemann Pick syndrome • **Single gene mutation**: Cystic fibrosis, Muscular dystrophy • **Multifactoria**l: Breast Cancer, Diabetes Mellitus, Ischemic heart. • **Uniparental Disomy**: Angelman Syndrome and Prader-Willi Syndrome	
	Diagnosis • **Prenatal Diagnosis (Amniocentesis) and chorio-villus sampling -** Ultrasound scanning and Fetoscopy, Banding techniques (G, C, Q), FISH and M-FISH,	

	Protein truncation test (PTT), Single Nucleotide Polymorphism and its applications • **Genetic counselling:** Psycho-social and ethical aspects for the individual and the family in connection with genetic investigations.	
Unit IV	**Tissue culture**	**Lectures 15**
	Introduction to animal cell culture • Advantages of tissue culture – control of the environment, characterization and homogeneity of sample, economy, scale and mechanization, *in vitro* modeling of *in vivo* conditions • Limitations of tissue culture – expertise, quantity, dedifferentiation and selection, origin of cells, instability	
	Aseptic techniques • Objectives of aseptic techniques – maintaining sterility • Sterilization – basic principles of sterilization, importance of sterility in cell culture • Sterile handling – swabbing, capping, flaming, handling bottles and flasks, pipetting, pouring	
	Culture media • **Physicochemical properties –** pH, CO2 and bicarbonate, buffering, O2, osmolality, temperature, viscosity, surface tension and foaming • **Types of media –** Natural and Artificial media • Serum – protein, growth factors, hormones, nutrients and metabolites, lipids, minerals and inhibitors • **Balanced Salt Solutions** • **Complete Media–** amino acids, vitamins, salts, glucose, oxygen supplements, hormones and growth factors, antibiotics	
	Primary and secondary culture and establishment of cell lines. • Establishment of primary and secondary cultures of normal, adult and embryonic sources. • Isolation of cells – enzyme digestion, perfusion, mechanical disaggregation, explants cultures • Substrate for attachment • Culture conditions – selection against some cell types, conditioned medium, feeder cells	

RUSZOOP503	PRACTICALS	Credits-03
	MOLECULAR BIOLOGY AND BIOTECHNOLOGY	
1.	Isolation & Estimation of RNA by Orcinol method (formula method and standard graph)	
2.	Isolation & Estimation of DNA by Diphenylamine method (formula method and standard graph)	
3.	Separation of proteins by SDS-PAGE from the given sample (plasma proteins)	
4.	Colorimetric estimation of proteins from given sample by Bradford's method.	
5.	Karyotype (Idiogram) analysis for the following syndromes with comments on numerical & structural variations in chromosomes: a. Turner's syndrome b. Klinefelter's syndrome c. Down's syndrome d. Cri-du-chat syndrome e. D-G translocation f. Edward's syndrome g. Patau's syndrome	
6.	2. Problems in genetics based on abnormalities in chromosomes: a. Total number of chromosomes present = 46, male. Reciprocal translocation between chromosomes 2 and 5. Breakage and reunion has occurred between long arm of 2nd chromosome, band 21 and long arm of 5th chromosome, band 31 b. Interpret the following formula: 46, XY, t (2;5) (q21; q31) c. Duplication:46, XX, dup (1) (q22qq25) d. Total number of chromosomes = 46, female. Duplication on chromosome number 1, long arm between band 1q22 and 1q25 e. Turner's Syndrome: 45, X f. Klinefelter's Syndrome: 47, XXY	
7.	Stained preparation of Onion root tip and calculation of Mitotic index	
8.	Identification of contrasting traits in drosophila using photographs	
9.	Sterilization technique (Workplace, Glassware, Chemicals, Biological fluids or samples	
10.	Use of autoclave for sterilization of equipments for tissue culture, Packaging of glassware	
11.	Trypsinization and vital staining using Trypan blue stain	

12.	Tissue culture media preparation, aseptic transfer & inoculation of culture	
13.	Streaking of butt, slant and plate (continuous and discontinuous methods) with E.coli (Demonstration only)	

References:

Molecular Biology

- Genetics – The continuity of life; Daniel Fairbanks and Ralph Andersen; Brooks/ Cole Publishing Company; 1999
- Introduction to Molecular Biology; Peter Paolella; Tata McGraw Hill; 2010
- Molecular Biology; David Freifelder; Narosa Publishing House; 2008
- Genetics; Robert Weaver and Philip Hedrick; McGraw Hill; 2001
- iGenetics – A Molecular Approach; Third Edition; Peter J. Russell; Pearson Education, Inc. (Benjamin Cummings), San Francisco; 2010
- Molecular Biology – Academic Cell Update; Update Edition; David Clark; Elsevier, Inc.; 2010
- Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978
- Principles of Genetics; Eighth Edition; Gardner, Simmons and Snustad; John Wiley and Sons (Asia) Pte. Ltd., Singapore; 2002
- The Science of Genetics – An Introduction to Heredity; Fourth Edition; George W. Burns; Macmillan Publishing Co., Inc., New York; 1980
- Molecular Biology – Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013
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Genetic Engineering

- Current Protocols in Molecular Biology; Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, Seidman J. G., John A. Smith and Kevin Struhl; John Wiley& Son, Inc.; 2003
- Introduction to Proteomics; Daniel C. Liebler; Humana Press; 2002
- Molecular cloning; Joseph Sambrook, David William Russell; Third Edition; CSHL Press; 2001
- Gene Cloning – An Introduction; Brown .T.A; Fourth Edition; Wiley-Blackwell; 2011
- Recombinant DNA - Genes and Genomes- A short course; 3rd Edition; Watson, J.D., Myers, R.M., Caudy A., Witkowski, J.K.; Freeman and Co. NY; 2007
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- A textbook of Biotechnology; R.C.Dubey; S.Chand and Company Ltd., New Delhi
- Molecular Biology – Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013

Human Genetics

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- Cell and Molecular Biology; Eighth Edition; E.D.P. De Robertis, E.M.F. De Robertis Jr.; Info-Med Ltd.; 1988
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Tissue Culture

- Culture of animal cells – A manual of basic technique; R. Ian Freshney; John Wiley and Sons Publications; 2005
- Basic cell culture – A practical approach; J. M. Davis; Oxford University Press; Indian edition; 2005

- Animal cell culture – Biotechnology Series: Vol.1; Bina Mishra, B.P.Mishra, Pran P. Bhat, P.N.Bhat; Studium Press (India) Pvt. Ltd; 2011
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- Biotechnology of Animal Tissues; Dr.P.R.Yadav and Dr. Rajiv Tyagi; Discovery Publishing House, New Delhi; 2006

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Course Code: RUSZOO504

Course Title: Endocrinology, Osteology and Embryology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Understand the importance of epidermal and dermal derivatives and their functions.
CO 2	Comprehend the types & secretions of endocrine glands and their functions.
CO 3	Develop the conceptual clarity of the structure, types and functions of human skeleton.
CO 4	Understand and analyse the processes involved in embryonic development, comparative embryology and its application.
CO 5	Develop skills for doing research in the field of developmental biology

Detailed syllabus

RUSZOO504	Title: Endocrinology, Osteology and Embryology	Credits- 2.5
Unit I	**Endocrine glands and regulation**	**15 lectures**
	General organization of mammalian endocrine system	
	Hormones: Classification, properties, mechanism of hormone action, hormone secretion and transport	
	Histology and functions of following endocrine glands: Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and Ovaries • Study of following endocrine clinical disorders and their management: Diabetes, acromegaly, dwarfism, goiter, rickets, cushing syndrome.	
Unit II	**Human Osteology**	**15 Lectures**
	Introduction: **Cartilage and Bone** • Chemical composition, Structure and Function of Cartilage. • Chemical composition, Structure and Functions of Bone.	
	Axial skeleton • Skull: general characteristics of skull bones 1) cranial bones 2) facial bones • Vertebral column: General characteristics of a vertebra, structure of different types of vertebrae (cervical, thoracic, lumbar, sacrum & coccyx) • Ribs & sternum (Thorax): General skeleton of ribs & sternum • Hyoid bone: General structure	
	Appendicular skeleton • Pectoral girdle and Pelvic girdle • Forelimbs and Hindlimbs	
	Sexual dimorphism of human skeleton	
Unit III	**Experimental and Chick embryology**	**15 Lectures**
	Introduction to experimental embryology Germplasm theory, Mosaic theory, Regulative theory, Gradient theory, Spemann's theory of organizers	
	Basic concept and principles of experimental embryology - brief idea of morphogenesis and organogenesis, fate maps, cell adhesion, cell affinity	

	and differentiation.	
	Development of Chick: Structure of chick embryo – 18 hours, 24 hours, 36 hours, 48 hours, 72 hours	
	Signaling pathways and intercellular communication during development: Induction and competence, epithelial-mesenchymal interaction	
	Recent trends in developmental biology: Methods to determine the role of genes during development (transgenic and chimeric mouse, "knockout" experiments), Genes contributing to developmental defects (oncogenes), multipotent and pluripotent stem cells and their niche	
Unit IV	**Integumentary system and derivatives**	**15 Lectures**
	Basic structure of integument: Epidermis and dermis; classification of keratinized and non-keratinized derivatives	
	Epidermal derivatives of Vertebrates: Hair, hoof, horn, claw, teeth, beak, epidermal scales (large scales, small scales, modified scales - spine), glands - types and functions (mucous, serous, ceruminous, poison, uropygial, salt), feathers	
	Dermal derivatives of vertebrates: Scales in fish; scutes in reptiles and birds; dermal scales in mammals - Armadillo, Antler – Caribou	
	Special derivatives of integument (Epidermal): Wart in toad; rattle in snake; horny beak in turtle, birds, monotremes; spur in male birds - jacana, fowl; whale bone - baleen whale; liliac callosities – African mandrill; kneepads – camel	
RUSZOOP504	**PRACTICALS**	**3 Credits**
ENDOCRINOLOGY, OSTEOLOGY AND EMBRYOLOGY		
1.	To study the histology of glands: T.S. of pitutary, thyroid, pancreas, adrenal, ovary, testis	
2.	To study the clinical disorders caused by endocrine glands with the help of photographs: acromegaly, dwarfism, goiter, rickets, cushing syndrome.	
3.	To study human skeleton: A) Study of axial skeleton a) Skull bone b) Ossicles of middle ear c) Hyoid bone d) Rib cage e) Sternum B) Vertebral column	

	a) Cervical vertebrae b) Typical cervical vertebrae (3-6) c) Atlas or 1st cervical vertebra d) Axis or 2nd cervical vertebra e) 7th cervical vertebra f) Thoracic vertebrae (8-19) g) Typical lumbar vertebra (20-24) h) Sacral vertebrae and coccyx (synsacrum): Sacrum (25-29), Coccyx (30-33)	
4.	Observation of developing chick embryo -18 hours, 24 hours, 36 hours, 48 hours, 72 hours	
5.	To prepare temporary mounting of chick embryo up to 72 hours	
6.	To study the effect of temperature in the development of chick embryo upto 48 hours/ 72 hours	
7.	To study T.S. of integument: amphibian, reptilian, avian, mammalian	
8.	To study horns, antlers	
9.	To study different types of scales: dermal, epidermal	
10.	To study epidermal glands: mucous, sebaceous, sweat, poison, uropygial	
11.	To study special integumentary derivatives	

References:

Integumentary system and derivatives

- Comparative Anatomy of the Vertebrates; Ninth Edition; Kent, G.C. and Carr R.K.; The McGraw-Hill Companies; 2000
- Text book of chordates; Saras publication
- Modern text of zoology; Prof. R.L. Kotpal
- Integumentary system and its derivatives; Samuel D. Hodge

Endocrinology

- Text book of endocrinology; Williams
- Textbook of Endocrinology Hardcover; Dharmalingam; 2010
- Endocrinology; 6th Edition; Mac Hadley, Jon E. Levine
- Bailey's textbook of histology Hardcover; Frederick R Bailey
- Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.

Human Osteology

- Atlas of human anatomy -Vol I; R.D. Sinelnikov; Mr. Publishers Moscow
- A Guide Of Osteology (for medical students); Prakash kendra, Lucknow
- Text Book Of Comparative Anatomy And Physiology; Tortora
- Human osteology; Tim D.White
- Text Book of Human osteology; Singh Inderbir

- Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978

Experimental and Chick embryology

- Developmental biology; Gilbert
- Developmental biology; Patten
- Developmental biology; Wolpert
- Text book of embryology; N. Arumugam
- Chicken Development – Embryology; W.H. Freeman & B. Bracegirdle
- Practical Zoology; Second Edition; Dr. K.C. Ghose &Dr. B. Manna; New Central Book Agency Pvt.Ltd. , Kolkata; 1999

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MODALITY OF ASSESSMENT
(T.Y.B.Sc.)

A] Internal assessment - 40%: 40 marks

Sr. no.	Evaluation type	Marks
1.	One class test (Multiple choice questions)	20
2.	Two Assignments/ Case study/ Group Discussion	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	12	Unit I
Q.2) A, B, C	Any 2 out of 3	12	Unit II
Q.3) A, B, C	Any 2 out of 3	12	Unit III
Q.4) A, B, C	Any 2 out of 3	12	Unit IV
Q.5) 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: RUSZOO601

Course Title: Study of Animal type: Chordates

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Understand about the habitat and economic importance of the Vertebrates
CO 2	Analyse the external morphology and physiology of systems of vertebrate animal
CO 3	Compare and contrast between the differences and similarities of morphologies and physiologies of vertebrate animals
CO 4	Develop an overview of the evolutionary concepts including homology and homoplasy, and Detailed discussions of major organ systems.
CO 5	Apply their knowledge for doing research in allied fields.

RUSZOO601	Title: Study of Animal Type- Chordates	Credits- 2.5
Unit I	**Class- Pisces e.g. *Scoliodon***	**15 lectures**
	Systematic position, Habit and habitat External characters and sexual dimorphism Exoskeleton and Endoskeleton Digestive system- food and feeding Physiology of digestion Respiratory system, Mechanism of respiration Circulatory system and its mechanism Nervous system and sense organs Male and Female Urinogenital System Economic importance	
Unit II	**Class – Amphibian e.g. Frog**	**15 lectures**
	Systematic position, Habit and habitat External characters and sexual dimorphism Endoskeleton Digestive system, food and feeding, physiology of digestion Respiratory system- Mechanism of respiration Circulatory system and its mechanism. Nervous system and Sense organs Male and Female Urinogenital system	
Unit III	**Class- Aves e.g. Pigeon**	**15 Lectures**
	Systematic position, Habit and habitat External characters Exoskeleton and Endoskeleton Muscular system Digestive system, food, feeding and physiology of digestion Respiratory system and its mechanism, Role of air-sacs Circulatory system and its mechanism Nervous system and Sense organs Male and Female Urinogenital system	
Unit IV	**Class Mammalia e.g. Rat**	**15 Lectures**
	Systematic position, Habit and habitat External characters Epidermal Derivatives Digestive system, food, feeding and physiology of digestion Nervous system and Sense organs Respiratory system and its mechanism Circulatory system and its mechanism Excretory system and its mechanism Male and Female Reproductive systems **Assignment-** Model – Animal Systems	

RUSZOOP601	PRACTICALS	Credits-03
	STUDY OF ANIMAL TYPES- CHORDATES	
1.	**Study of *Scoliodon*** a) Morphology b) Digestive system c) Nervous system (cranial nerves) including brain d) Circulatory system e) Male and female urinogenital system f) Mounting of placoid scales and chondrocytes	
2.	**Study of Frog** a) Morphology b) Digestive system c) Nervous system d) Circulatory system (arterial & venous) e) Male and female urinogenital system	
3.	**Study of Pigeon** a) Morphology b) Digestive system c) Respiratory system- air sacs d) Nervous system e) Circulatory system (arterial & venous) f) Male and female urinogenital system	
4.	**Study of Rat** a) Morphology b) Digestive system c) Respiratory system d) Urinogential system of Male and Female e) Nervous system f) Circulatory system (arterial & venous)	
5.	**Anatomical study of Hen's head so as to study its** a) Brain b) Columella auris c) Hyoid apparatus d) Mounting of Blood (Blood cells)	
6.	**Study of flight muscles of Hen**	
	Note: Visit to National Parks.	

References:

- Modern text book of Zoology – Vertebrates; Professor R.L. Kotpal; Rastogi publication; Third Edition
- Vertebrate Zoology; E.L. Jordan and P.S. Verma
- A manual of Zoology, Vol. II Vertebrata; Ayyar, M. Ekambaranath
- Vertebrate Zoology – Volumes of different Phyla; Hyman L.H.
- Vertebrate Zoology for Degree students; V. K. Agarwal; S.Chand Publication; 2012

- Vertebrate Zoology, Vol.II; Parker and Haswell
- Minor phyla – General information; Professor R.L. Kotpal; Rastogi Publication; Fifth Edition
- Vertebrate Comparative Anatomy, Function, Evolution; K.V.Kardong; Fourth Edition; Tata McGraw Hill
- The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press
- Practical Zoology; Second Edition; Dr. K.C. Ghose &Dr. B. Manna; New Central Book Agency Pvt. Ltd., Kolkata; 1999

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Course Code: RUSZOO602

Course Title: Physiology, Histology and Pathology

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 nomenclature and mechanism of enzyme, enzyme inhibition and regulatory enzymes.
CO 2	Draw graph and calculate optimum pH, temperature, Vmax and Km value for enzyme and find out competitive and non-competitive enzyme inhibition from graph.
CO 3	Appreciate the therapeutic and industrial application of enzymes.
CO 4	Describe importance of homeostasis, mechanisms by which it is achieved and comprehend the adaptive responses of the animals to the changes in environmental temperature, availability of ions and water in the environment.
CO 5	Identify microscopically histological layer of the organs and develop skills useful for doing research in the same field.
CO 6	Gain knowledge of various terminologies for pathological conditions in body and the application of pathology in Forensics.
CO 7	Develop interest and skills which will be helpful for research in animal studies.

Detailed syllabus

RUSZOO602	Title: Physiology, Histology and Pathology	Credits- 2.5
Unit I	**Enzymology**	**15 lectures**
	Definition, nomenclature and classification (based on Enzyme Commission) of enzymes, cofactors and coenzymes, the concept and properties of active site, Enzyme Specificity, Mechanism of enzyme action.	
	Factors affecting enzyme activity- pH, temperature and substrate concentration; concept of activation energy.	
	Enzyme kinetics, Concept of steady state, Derivation of Michaelis-Menton equation and Lineweaver-Burk plot, concept and significance of k_m, V_{max} and k_{cat},	
	Enzyme inhibitors- competitive, non-competitive, uncompetitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors Regulation of enzyme activity: allosteric regulation and regulation by covalent modification of enzymes; Zymogen (pepsinogen); Isozymes (LDH)	
	Clinical significance and industrial applications of enzymes	
Unit II	**Homeostasis (Temperature and Ionic regulation)**	**15 lectures**
	Homeostasis - External and internal environment; Acclimation and acclimatization; Control systems in biology: Feedback mechanism- negative feedback and positive feedback with suitable examples.	
	Thermoregulation -Cold blooded, warm blooded, poikilotherms, homeotherms, ectotherms, endotherms**,** relation between temperature and biological activities, temperature balance; heat production- shivering and non-shivering thermogenesis; brown fat – special thermogenic tissue in mammals, mechanisms of heat loss; adaptive response to temperature- daily torpor, hibernation, aestivation	

	Osmotic and Ionic regulation - osmoregulator, osmoconfomers, ionoregulators and ionoconfermers**,** maintaining water and electrolyte balance; ionic regulation in iso-osmotic environment; living in hypo-osmotic and hyper-osmotic environment; problems of living in terrestrial environment: water absorption, saltwater ingestion and salt excretion, salt glands, role of kidney in ionic regulation, metabolic water	
Unit III	**Histology**	**15 Lectures**
	Vertical section of skin-Layers and cells of epidermis; papillary and reticular layers of dermis; sweat glands, sebaceous glands and skin receptors.	
	Digestive System • Vertical Section of tooth – hard tissue – dentine and enamel; soft tissue –Dentinal pulp and periodontal ligaments, Transverse section of tongue – mucosal papillae and taste buds • Alimentary Canal – basic histological organization with reference to transverse section of oesophagus, stomach, duodenum, ileum and rectum of mammal. • Glands associated with digestive system-histology with reference to transverse section of salivary glands, liver, pancreas	
	Respiratory organs –transverse section (T.S.) of trachea and lung	
	Excretory system- L.S. of Kidney	
Unit IV	**General pathology**	**15 Lectures**
	Infectious diseases: aetiology and its types. Cell injury – causes and types	
	Retrogressive changes: Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (gross and microscopic changes)	
	Necrosis: Definition and causes; nuclear and cytoplasmic changes; Types: Coagulative, Liquefactive, Caseous, Fat and Fibroid. (gross and microscopic changes)	
	Gangrene: Definition and types-dry, moist and gas	

	gangrene (gross and microscopic changes)	
	Disorders of pigmentation: Endogenous: Brief ideas about normal process of pigmentation, melanosis, Inhaled, ingested and injected pigments	
	Circulatory disturbances: Causes and effects of Hyperaemia, Ischaemia, Thrombosis, Embolism, Edema and Infarction	
	Inflammation: Definition and causes, cardinals of inflammation; acute and chronic inflammation	
	Applied pathology and its application: Anatomical, clinical and molecular; investigating methods: biopsy and surgery (for pathological examination of tissue), autopsy, post mortem changes - Algor mortis - body cooling, Rigor mortis - stiffening of limbs, state of decomposition- autolysis (process of self-digestion) and putrefaction.	
	Tumour Pathology- Benin and Malignant	
	Assignment topic- Lab visit and report submission	
RUSZOOP602	**PRACTICALS**	**Credits-03**
PHYSIOLOGY, HISTOLOGY AND PATHOLOGY		
1.	Effect of pH on activity of enzyme Acid Phosphatase	
2.	Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase	
3.	Effect of varying substrate concentration on activity of enzyme Acid Phosphatase	
4.	Effect of inhibitor on the activity of enzyme Acid Phosphatase	
5.	Study of separation of LDH isozymes by agarose gel electrophoresis	
6.	To study the effect of enzymes in detergent	
7.	Study of mammalian tissues: a) V. S. of Skin b) V.S. of Tooth c) T.S. of Stomach d) T.S. of Ileum e) T.S. of Liver f) T.S. of Pancreas g) T.S. of Lung	
8.	Identification of following diseases or conditions (from slides or pictures) – Melesma, Vitiligo, Psoriasis, Bed	

	sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis	
9.	Widal's Test	
10.	Study and interpretation of pathological reports: Blood, Urine and Stool (faeces).	

References:

Homoeostasis

- Comparative Animal Physiology; Knut Schmidt Nielson; Cambridge Press
- Comparative Animal Physiology; Prosser and Brown
- Comparative Animal Physiology; WilliamS Hoar
- Text book of Comparative Physiology; R Nagabhushanam,MsKodarkar, Sarojini R India BookHouse Pvt. Ltd.
- Animal Physiology; N.Arumugam,A.Mariakuttikan; SarasPublication

Enzymology

- Lehninger'sPrinciplesofBiochemistry; David Lee Nelson, A.L.Lehninger, Michael M Cox;W.H.Freeman, New York; 2008
- Biochemistry; 5th ed.; JM Berg, J L Tymoczko and LubertStryer ;W.H. Freeman, New York; 2002
- Biochemistry; 2ndedition; Donald Voetand Judith G Voet; J.Wiley and Sons, New York; 1995

Histology

- A Textbook ofHistology; Deshmukh,Shivaji; Dominant Pub.
- Colour Textbook ofHistology; Gartner, Leslie P.;Saunders
- A Textbook ofHistology; Mathur, Ramesh; Anmol Pub.
- A Textbook ofHistology and A Practical Guide;Gunasegaran, J.P.; Elsevier
- A Textbook ofHistology; Khanna, D. R.; SonaliPub.
- Practical Zoology; Second Edition;Dr. K.C. Ghose &Dr. B. Manna; New Central Book Agency Pvt.Ltd. , Kolkata; 1999

General pathology

- A Textbook OfVeterinary and General Pathology; Second edition; J. L. Vagad; IBDC Publishers
- Clinical Pathology; Guru G.; NCERT; 1988
- Clinical Pathology; Batra Neelam; Vikas Publishing House Pvt. Ltd.; Nov. 1982
- Essentials ofGeneral Pathology - Dr.SudhaShivraj, Dr. Satish Kumar Amarnath, Dr. Sheela Devi; Exclusively distributedby CBS Publishers &Distributors
- Textbook ofPathology;Harsh Mohan; JAPYEEpublishers
- Prescott'sMicrobiology; Ninth Edition;JoanneM. Willey,Linda M. Sherwood &ChristopherJ. Woolverton; McGraw-Hill Education; 2014

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Course Code: RUSZOO603

Course Title: Toxicology and Computational Biology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Understand different biological toxins, their good or bad effects on vertebrates, safe level of drugs and dose response relationship and ethical issues in drug toxicity.
CO 2	Understand ethical and philosophical concept of bioethical issues including intellectual property right and the concepts and practices of bioprospecting.
CO 3	Identify drugs of natural origin and their source and comprehend and analyse the method of self-medication and the application.
CO 4	Know different concepts of biostatistics, recognize and give examples of different types of data gathered from public health, clinical studies etc.
CO 5	Choose an appropriate test for comparing two different variables in different populations.
CO 6	Understand existing software which can be used effectively to extract the information from large databases.
CO 7	Identify, formulate and review research literature and the use of construction of the phylogenic tree.

Detailed syllabus

RUSZOO603	Title: TOXICOLOGY AND COMPUTATIONAL BIOLOGY	Credits- 2.5
Unit I	**Basic Toxicology**	**15 lectures**
	Introduction of Toxicology- Brief history, different areas of toxicology, Principles and scopes of Toxicology	
	Toxins and Toxicants • Phytotoxins (caffeine, nicotine) • Mycotoxins (aflatoxins) • Zootoxins • Cnidarian toxin • Bee venom • Scorpion venom • Snake venom	
	Site of exposure: Local reactions of exposure and Routes of exposure	
	Types of toxicity – Acute toxicity, subacute toxicity, sub-chronic toxicity, chronic toxicity, immediate toxicity, delayed toxicity, reversible toxicity, irreversible toxicity, local toxicity, systemic toxicity	
	Concept of LD50, LC50, ED50	
	Dose Response relationship • Individual/ Graded dose response • Quantal dose response • Shape of dose response curves • Therapeutic index • Margin of safe Dose translation from animals to human – Concept of extrapolation of dose • NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)	
	Basics of Regulatory toxicology • OECD guidelines for testing of chemicals (an overview) • CPCSEA guidelines for animal testing center • Ethical issues in animal studies • Animal models used in regulatory toxicology studies • Alternative methods in toxicology (in vitro test)	
Unit II	**Bioethics, Bioprospecting and Zoopharmacognosy**	**15 Lectures**

	Bioethics • Intellectual property rights and patenting • Forms of protection, patents, copyrights, trade secrets, trademarks, patenting biological materials, live forms, genes and DNA sequences	
	Bioprospecting • Traditional, modern bioprospecting • Chemical prospecting • Genetic prospecting • Bionic prospecting • Economic value and benefit sharing • Bioprospecting and conservation, pros and cons of bioprospecting	
	Zoopharmacognosy • Definition, history and types • Self-medication and its mechanism • Methods of self-medication through - Ingestion – ants and mammals, Geophagy – invertebrates and birds • Absorption and adsorption • Topical application – birds and mammals • Applications of zoopharmacognosy - Social and trans generational zoopharmacognosy, Value to humans.	
Unit III	**Biostatistics**	**15 Lectures**
	Probability Distributions - Normal, Binomial, Poisson distribution, Z-transformation, p-value, Probability - Addition and multiplication rules and their application	
	Measures of Central Tendency and Dispersion - Variance, standard deviation, standard error	
	Parametric and non-parametric tests - Parametric tests: two-tailed Z-test and t-test, Non-parametric test: Chi-square test and its applications	
	Regression and Correlation - Simple linear regression: main features, applications, Correlation coefficient and its significance	
	Testing of Hypothesis: Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis Levels of significance and testing of hypothesis	
Unit IV	**Bioinformatics**	**15 Lectures**

	Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI,ExPASy, OMIM, PubMed, OMIA)	
	Applications of Bioinformatics	
	Databases – Tools and their uses	
	Biological databases: Primary sequence databases: Nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ) Protein sequence data bases (UniProtKB, PIR, PDB)	
	Secondary sequence databases: Derived databases - PROSITE, BLOCKS	
	Sequence alignment methods • BLAST, FASTA • Significance of sequence alignment • Pairwise sequence alignment (Needleman & Wunsch, Smith & Waterman methods) • Multiple sequence alignment (PRAS, CLUSTALW)	
	Predictive applications using DNA and protein sequences • Evolutionary studies: Concept of phylogenetic trees, Parsimony and Bayesian approaches, synonymous and non-synonymous substitutions, convergent and parallel evolution • Pharmacogenomics: concept and applications • Protein Chips and Functional Proteomics: Different types of protein chip, detecting and quantifying; applications of Proteomics • Metabolomics: Concept and applications	
RUSZOOP603	**PRACTICALS**	**Credits-03**
Toxicology and Computational Biology		
1.	To calculate LC-50 value of the given toxicant.	
2.	To study the effect of paracetamol on the level of enzyme activity in liver on aspartate and alanine amino transferase (in vitro approach)	
3.	Study of Zoopharmacognosy with reference to Chimpanzees, African Elephants, Wild Boars and Parrots.	
4.	Following biostatistics practicals will be done using data analysis tool of Microsoft Excel: a) From the given data derive mean,	

	standard deviation b) Correlation, regression analysis using given data c) Problems based on Z test d) Problems based on t test e) Problems based on Chi square test f) Problems based on ANOVA	
5.	Exploring the integrated database system at NCBI server and querying (Querying a nucleotide sequence, querying a protein sequence, use of operators	
6.	Exploring tools on ExPASy (Querying a nucleotide sequence, querying a protein sequence, use of operators	
7.	Exploring BLAST tool (nucleotide sequence comparison)	
8.	Exploring Uniprot tool (protein sequence comparison)	
9.	Exploring bibliographic database PubMed (Data mining - Downloading a research paper on subject of interest, use of operators	
10.	**Case study** (Assignment- Based on Unit II)	

References:

Toxicology

- Casarett and Doulls Toxicology – The basic science of poisons; Edited by Curtis Klaassen; McGraw-Hill; 2001
- Toxicological testing handbook – Principles, applications and data interpretation; David Jacobson-Kram and Kit Keller; CRC Press; 2006
- Principles and methods of toxicology; A. Wallace Hayes; CRC Press; 2007
- Toxicology – principles and methods; M.A. Subramanian; MJP Publishers, Chennai; 2004
- Fundamentals of Toxicology; Kamleshwar Pandey and JP Shukla; New Central book agency Ltd., Kolkata; 2011
- Elements of Toxicology; Kamleshwar Pandey and JP Shukla; Wisdom Press, New Delhi; 2010
- Principles and Applications of Toxicology; Lahir Y.K.; Seekay Publications; 2013
- Essentials of Clinical Toxicology; Lall S.; Narosa Publishing House; 1998

Bioethics, Bioprospecting and Zoopharmacognosy

- Molecular biotechnology – principles and practices; Channarayappa
- Biotechnology; P.K. Gupta
- Biotechnology; B.D.Singh
- Biotechnology Fundamentals & Applications; S.S. Purohit
- Pharmacognosy and Pharmaco biotechnology; Ashutosh Kar
- Trease and Evans Pharmacognosy; Evans, W.C.

- Pharmacognosy; Kokate, C.K A and Purohit, A.P
- Practical Pharmacognosy; Gokhale, S.B and Kokate, C.K
- Text book of Pharmacognosy; T.E.Wallis

Biostatistics

- Biostatistics – The Bare Essentials; Third Edition; Geoffrey R. Norman, David L. Streiner; B.C. Decker, Inc., Hamilton; 2008
- Fundamentals of Biostatistics; Second Edition; Veer Bala Rastogi; Ane Books Pvt. Ltd., New Delhi; 2009 (Reprint 2010)
- Fundamentals of Biostatistics; Second Revised Edition; Irfan Ali Khan and Atiya Khanum; Ukaaz Publications, Hyderabad; 2004
- Instant Medical Biostatistics; Dr. Ranjan Das and Dr.Papri N. Das; Ane Books Pvt. Ltd., New Delhi; 2009
- Primer of Biostatistics; Fifth Edition; Stanton A. Glantz; McGraw-Hill Companies, Inc.; 2002
- Basic Biostatistics – Statistics for Public Health Practice; Second Edition; B. Burt Gerstman; Jones and Bartlett Learning Burlington; 2015
- Biostatistics – A Guide to Design, Analysis, and Discovery; Second Edition; Ronald N. Forthofer, Eun Sul Lee and Mike Hernandez; Elsevier, Inc., (Academic Press), USA; 2007
- Statistics in Biology and Psychology; Sixth Edition; Debajyoti Das and Arati Das; Academic Publishers, Kolkata
- Introduction to Statistical Method (Parts I & II); B.C. Brookes & W.F.L. Dick; Heinemann Educational books Ltd., London; 1961
- The Fundamentals of Statistical Reasoning; M.H. Quenouille; Charles Griffin & Company Limited, London; 1965
- Advanced Statistical Methods in Biometric Research; C. Radhakrishna Rao; John Wiley & Sons, Inc.; 1952

Bioinformatics

- Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi & others; CBS Publishing; 2003
- Bioinformatics - A practical guide to analysis of Genes & Proteins; Andreas D Baxevanis and B F Francis; John Wiley; 2000
- Introduction to Bioinformatics; 1st Edition; T K Attwood, D J parry-Smith; Pearson Education, 11th Reprint; 2005
- Bioinformatics; 1st Edition; C S V Murthy; Himalaya Publishing House; 2003
- Bioinformatics sequence and genome analysis; David W. Mount; Cold spring harbor laboratory press; 2004
- Basic Bioinformatics; S. Ignacimuthu, S.J.; Narosa Publishing House; 1995
- An Introduction to Bioinformatics Algorithms; Neil C. Jones and Pavel A. Pevzner; MIT Press, First Indian Reprint; 2005
- Bioinformatics - Managing Scientific Data; Zoe Lacroix, Terence Critchlow; Morgan Kaufmann Publishers (Elsevier Science); 2003 (for the V unit)
- Phylogenetics: Theory and Practice of Phylogenetic Systematics; Second edition; Bruce S. Lieberman; Wiley-Blackwell; 2011
- Molecular Evolution: A Phylogenetic Approach; Roderick D.M. Page, Dr Edward C. Holmes; Well Publishing; 1998
- Essential Bioinformatics; JinXiong; Cambridge University Press; 2006

- Proteomics - From Protein Sequence to Function; 12 S. R. Pennington, M. J. Dunn; First edition; Springer publications; 2001
- Proteomics; Timothy Palzkill; Springer; 2002
- Metabolomics - A Powerful Tool in Systems Biology; Jens Hřiriis Nielsen, Michael C. Jewett; Springer; 2007
- Systems Metabolic Engineering; Dr. Christoph Wittmann, Sang Yup. Lee; Springer; 2012
- Bioinformatics (Bios Instant Notes); Second Edition (Special Indian Edition); T. Charlie Hodgman, Andrew French and David R. Westhead; Garland Science (Taylor and Francis Group); 2010
- Understanding Bioinformatics; Marketa Zvelebil and Jeremy O. Baum; Garland Science (Taylor and Francis Group); 2008
- Bioinformatics Computing – The complete practical guide to bioinformatics for life scientists; Bryan Bergeron; Eastern Economy Edition; Prentice-Hall of India Pvt. Ltd., New Delhi; 2003
- Bioinformatics; Prakash S. Lohar; MJP Publishers, Chennai; 2009
- Introduction to Bioinformatics; First Edition; S. SundaraRajan and R. Balaji; Himalaya Publishing House, Mumbai; 2002
- Molecular Biology – Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013

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Course Code: RUSZOO604

Course Title: Environmental Biology and Entomology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Understand the natural resources, their management, laws governing environment and International treaties and conventions in environment protection.
CO 2	Understand the different methods of wildlife conservation and analyse about threats to wildlife.
CO 3	Apply their knowledge and undertake the wildlife habitat projects for animal protection and create awareness about Wildlife Conservation.
CO 4	Understand and compare between different Zoogeographical realms.
CO 5	Interrelate between different environmental conditions and the fauna found in different zoogeographical areas.
CO 6	Correlate the role of useful and harmful insects in human life and gain knowledge about its applications in diverse fields.
CO 7	Understand the scope and importance of Entomology.

Detailed syllabus

RUSZOO604	Title: ENVIRONMENTAL ZOOLOGY AND ENTOMOLOGY	Credits- 2.5
Unit I	**Environment management**	**15 lectures**
	Natural resources, their classification, modification and exploitation: Forest resources, water resources (surface and ground), mineral resources, food resources, energy resources: Renewable and non-renewable resources, Impact on climate, flora, fauna & mineral resources.	
	Concept of Carbon Audit, Carbon foot-printing and its application	
	Waste Management: 3 Rs (Reduce, Reuse & Recycle) of solid waste, e-waste, hazardous waste	
	Water management: Rain water harvesting, watershed management, effluent treatment, recycling plants, control and treatment of water	
	Laws governing environment (Environment Protection Act), Air (Prevention and Control of Pollution) Rules - 1982, Water (Prevention and Control of Pollution) Rules - 1978, Hazardous Wastes (Management and Handling) Rules - 1989. EIA (Environmental Impact Assessment), ISO18001	
	Role of government, NGOs, International treaties and conventions in environmental protection & conservation	
Unit II	**Wildlife Management**	**15 lectures**
	Threats to wildlife- Diseases (zoonosis and reverse zoonosis), hunting, poaching, Habitat loss (encroachment and deforestation), tourism, overgrazing, human animal conflict and climate change.	
	Techniques and methods of wildlife conservation Wildlife Census, conservation of wildlife - frozen zoo, schedules, rules, national and international conservation bodies; IUCN UNDP, FAO, ESA, INCPEN, CITES, CEEDS,WWF.	
Unit III	**Zoogeography and ethology**	**15 lectures**
	Introduction • Origins of Ocean and continents.	

	• Plate Tectonics and continental drift.	
	Distribution of animals in space and time • In-Space –Horizontal and superficial • In Time geological or durational • Patterns of animal distribution –Continuous, discontinuous, isolation and bipolarity • Theories of animal distribution.	
	Barriers of distribution animals – • Topographic, climate, vegetative, large water masses, land mass, lack of salinity and special characteristics habits like homing, instincts etc. • Means of dispersal – land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies.	
	Zoogeographical realms • Palearctic • Ethiopian • Oriental • Nearctic Australian • Neotropical and Antarctic.	
	Applied Animal Ethology: • Types of behaviours • Physiological basis of behaviour • Ecological basis of behaviour and behavioural adaptation • Behaviour and evolution • Animal training and companion animal	
Unit IV	**General Entomology**	**15 Lectures**
	Introduction, Importance & Scope of Entomology, Branches of Entomology: Definition, distinguishing features of insects, harmful and useful insects**,** Agricultural, Medical, Forest, Forensic & Industrial	
	General body structure of insects: a) Head - Mouth parts: cutting, chewing, lapping, sucking, sponging. b) Thorax – Structure and modification of wings, Modification of legs and wings in insects - e.g. honey bee, cockroach, beetle c) Abdomen	
	Metamorphosis in insects-Definition, types, hormones	
	Insect Communication: Definitions, types, significance • Insect pheromones • Bioluminescence • Sound production	

	Significance of insects as biological tool: Biological weapon; tissue culture; gene study; Productive insects - honey bee, silk worm, lac insect; insect products; insects pests (general): bollworm, rice weevil, *Tribolium sps*, flour moth, locust **Assignment** – Insect mouth parts and legs	
RUSZOOP604	**PRACTICALS**	**Credits-03**
Environmental Zoology and Entomology		
1.	To estimate phosphate phosphorus from sample water.	
2.	To estimate COD, BOD from sample water.	
3.	To estimate Nitrite Nitrogen and Nitrate Nitrogen from sample water.	
4.	To study the intensity of sound by Decibel meter.	
5.	To study acidity and alkalinity of sample water by methyl orange and phenolphthalein.	
6.	To observe the animals in the chart and place them in endangered, vulnerable category.	
7.	Indicate the distribution of genus/species/subspecies in the given world map with respect to its realm and comment on the pattern of distribution.	
8.	Indicate the realms and the fauna found in that realm on the given world map, justify.	
9.	To study different types of mouth parts: cutting, chewing, lapping, piercing and sucking, sponging Mounting of thoracic appendages-legs and wings (housefly, mosquito, cockroach)	
10.	To study metamorphosis in insects: ametabolic - lepisma, hemimetabolic - cicada, holometabolic - butterfly, mosquito.	
11.	To study mechanism of bioluminescence in insects. Insect pests and control: rice weevil, flour moth, aphids, tribolium	
	Report-Wildlife	

References:

Environment management

- Essentials of Environmental Science; N. Vasudevan; Narosa Publishing House Pvt . Ltd. New Delhi 110002
- Environmental Biology; P.S Verma, V.K Agarwal; S. Chand & company Ltd. New Delhi 110055
- A textbook of Environmental Science; Arvind Kumar; A P H Publishing Corporation New Delhi 110002
- Environmental Biotechnology - Basic Concepts and Application; Indu Shekhar Thakur; I.K.InternationalPvt.Ltd. New Delhi 110016

- Text book of environmental science; S.C.Santra

Wildlife Management

- Wild life management; Rajesh Gopal
- Wildlife Management and Conservation - Contemporary Principles and Practices; Paul R. Krausman and James W. Cain III
- Wildlife Ecology, Conservation, and Management; John M. Fryxell,Anthony R. E. Sinclair,GraemeCaughley

Zoogeography

- Zoogeography – The Geographical Distribution of Animals; Philip J. Darlington JR; Academic Publishers, Kolkata
- Animal geography; Newbegin
- Vertebrate paleontology; Romer
- Ecological animal geography; Allee, Park and Schmidt
- Zoogeography of India and South East Asia; Dr.S.K.Tiwari; CBS Publishers and Distributors, Delhi; 1985

General Entomology

- Imm's General Text book of Entomology Vol. I & II; Richards O.W. & Davis R.F., B.I. Pul; Indian edition New Delhi; 1993
- Principals of insect morphology; Snodgrass R.E.; Indian Reprint, SBS Pub. New Delhi; 1994
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- An Introduction to Entomology; Srivastava R.D. & Singh R.P.; Concept Pub. New Delhi; 1997
- General & Applied Entomology; Nayar K.K., T.N. Anantkrishanan& B.V. David;
- Tata McGraw Hill Pub. New Delhi; 1983
- Insects; Mani M.S.; Reprint NBT Pub. New Delhi; 2006.

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MODALITY OF ASSESSMENT
(T.Y.B.Sc.)

A] Internal assessment - 40%: 40 marks

Sr. no.	Evaluation type	Marks
1.	One class test (Multiple choice questions)	20
2.	Two Assignments/ Case study/ Group Discussion	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	12	Unit I
Q.2) A, B, C	Any 2 out of 3	12	Unit II
Q.3) A, B, C	Any 2 out of 3	12	Unit III
Q.4) A, B, C	Any 2 out of 3	12	Unit IV
Q.5) a, b, c, d, e	Any 3 out of 5	12	All Units
	TOTAL	**60**	

Practical Examination Pattern:

(C) Internal Examination

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

(D) 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

Course	501/601		502/602		503/603		504/604		Total per Course	Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External		
Theory	40	60	40	60	40	60	40	60	100	400
Practicals	20	30	20	30	20	30	20	30	50	200

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