Resolution No. AC/II(23-24).2.RUS12

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for: T. Y. B. Sc.

Program: B.Sc.

Program Code: Zoology (RUSZOO)

(Choice Based Credit System for the academic year 2024–2025)

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.

GRADUATE ATTRIBUTES

Graduate attribute	A student completing a Bachelor's Degree in Science (B. Sc) program will be able to:
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.
2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
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.
4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
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.
6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
7	Follow ethical practices at the workplace and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
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 OUTCOMES

PO	Description **A student completing Bachelor's Degree in Science program in the subject of Zoology will be able to:**
PO 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.
PO 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.
PO 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.
PO 4	Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
PO 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.
PO 6	Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.
PO 7	Solve the environmental problems involving interaction of humans and natural systems at local or global level.
PO 8	Apply their knowledge in fields of Biostatistics and research methodology.
PO 9	Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within Zoology.
PO 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.
PO 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
T. Y. B. Sc.	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
	V	**RUSZOO504**	Endocrinology, Osteology and Embryology.	2.5
	V	**RUSZOOP501**	Practical based both RUSZOO501 and RUSZOO502	3
	V	**RUSZOOP502**	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**	Practical based both RUSZOO601 and RUSZOO602	3
	VI	**RUSZOOP602**	Practical based both RUSZOO603 and RUSZOO604	3

Course Code: RUSZOO501

Course Title: Study of animal types: Non-chordates

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Explain the economic importance of phyla Annelid to Echinodermata
CO 2	Describe the unique characters of phylum Annelid, Arthropoda, Mollusca, Echinodermata.
CO 3	Explain body organization, systematic position, habit and habitat, internal systems, and physiology of phylum Annelid to Echinodermata.
CO 4	Classify the non-chordate animal according to its systematic position.
CO 5	Justify the position of the non-chordate animal according to its position in the systematic hierarchy.
CO 6	Compare and state the differences between the different systems of non-chordates and link it with their evolutionary process.

Detailed syllabus

RUSZOO501	Title: Study of Animal types: Non-chordates	Credits/hours 2.5/60
Unit I	**Phylum- Annelid e.g. Earthworm**	
	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**	
	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**	
	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**	
	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:

1. Modern text-book of Zoology – Invertebrates; 11th Edition, Kotpal; Rastogi publication
2. Invertebrate Zoology; E.L. Jordan and P.S. Verma
3. A manual of Zoology - Part I, Invertebrata; Ayyar, M. Ekambaranath
4. Invertebrate Zoology – Volumes of different Phyla; Hyman L.H.
5. Invertebrate Zoology for Degree students; V. K. Agarwal; S.Chand Publication; 2012
6. Invertebrate Zoology - Vol 1; Parker and Haswell
7. Biology of Invertebrates; J.A.Pechnik, Fourth Edition; Tata Mcgraw Hill
8. A textbook of Zoology; T.J.Parker& W.A.Haswell; MacMillan
9. Invertebrate Zoology; Bares; Saunders
10. Practical Zoology; Second Edition; Dr. K.C. Ghose & Dr. B. Manna; New Central Book Agency Pvt. Ltd., Kolkata.

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Course Code: RUSZOO502

Course Title: Haematology and Immunology

Academic year 2024-25

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	Explain the components of immune system and its function in the protection of the body
CO 3	Describe various diagnostic tests performed in the pathological laboratories and recall their clinical significance.
CO 4	Give the reasons for prescribed autoimmune disease, immunodeficiency disease and describe various antigen-antibody reactions for diagnostic tests, type of vaccine and role of adjuvant in vaccine.
CO 5	Perform the total count of RBCs, WBCs and Hb level and correlate with blood disorders.

Detailed syllabus

RUSZOO502	Title: Haematology and Immunology	Credits/hours 2.5/60
Unit I	**Basic Haematology**	
	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**	
	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**	
	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**	
	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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Basic Heamatology

- 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
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• 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
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Basic Immunology

• Immunology - Introductory Textbook; Shetty, N.; New Age International; 2005
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• 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
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Course Code: RUSZOO503

Course Title: Molecular Biology and Biotechnology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Describe the general principals of gene organization expression gene analysis techniques, types of mutation, role of mutagenic agents and methods of DNA repair system.
CO 2	Describe the principles for gene regulation, genetic engineering, and cell division.
CO 3	Enumerate the importance and different methods of prenatal diagnosis to diagnose the diseased condition in a developing foetus.
CO 4	Explain the principles, advantages, and applications of animal tissue culture.
CO 5	Compare and state differences between the different culture media and optimum conditions required depending on the need of proliferating cells.
CO 6	Demonstrate the skills of performing different aseptic techniques.

Detailed syllabus

RUSZOO503	Title: MOLECULAR BIOLOGY AND BIOTECHNOLOGY	Credits/hours 2.5/60
Unit I	**Molecular Biology**	
	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**	
	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**	

	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**	
	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)	

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Molecular Biology

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Genetic Engineering

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- A textbook of Biotechnology; R.C.Dubey; S.Chand and Company Ltd., New Delhi
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Human Genetics

- iGenetics – A Molecular Approach; Third Edition; Peter J. Russell; Pearson Education, Inc. (Benjamin Cummings), San Francisco; 2010
- Cell and Molecular Biology; Eighth Edition; E.D.P. De Robertis, E.M.F. De Robertis Jr.; Info-Med Ltd.; 1988
- Genetics (Bios Instant Notes); Third Edition; G.I. Hickey, H.L. Fletcher and P. Winter; Taylor and Francis Group, New York; 2007
- Genetics – A Conceptual Approach; Third Edition; Benjamin A. Pierce; W.H. Freeman and Company, New York; 2008
- New Clinical Genetics; Second Edition; Andrew Read and Dian Donnai; Scion Publishing Ltd., UK; 2011
- Genetics; Third Edition; Robert F. Weaver and Philip W. Hedrick; Wm. C. Brown Publishers (The McGraw-Hill Companies, Inc.); 1997
- Human Molecular Genetics; Fourth Edition; Tom Strachan and Andrew Read; Garland Science, USA; 2011
- Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978
- Human Genetics – An Overview; Alice Marcus; Narosa Publishing House; 2010
- The Science of Genetics – An Introduction to Heredity; Fourth Edition; George W. Burns; Macmillan Publishing Co., Inc., New York; 1980
- https://www.ncbi.nlm.nih.gov/books/
- https://ghr.nlm.nih.gov/

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
- Animal cell culture – Concept and Applications; Shweta Sharma; Oxford book Company; 2012
- 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 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Explain the importance of epidermal and dermal derivatives and their functions.
CO 2	Enumerate the types & secretions of endocrine glands and their functions.
CO 3	Describe the structure, types, and functions of the human skeleton.
CO 4	Describe the processes involved in embryonic development, comparative embryology, and its application.
CO 5	Identify the different stages of growth of chick embryo by looking at its growth parameters
CO 6	Demonstrate the skill of permanent mounting of chick embryo and identify its stage.

Detailed syllabus

RUSZOO504	Title: Endocrinology, Osteology and Embryology	Credits/hours 2.5/60
Unit I	**Endocrine glands and regulation**	
	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**	
	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**	
	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**	
	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**
  - 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 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Explain the habitat and economic importance of the Vertebrates
CO 2	Describe the external morphology and physiology of systems of vertebrate animal
CO 3	Explain the evolutionary concepts including homology and homoplasy, and of major organ systems.
CO 4	Classify the chordate animal according to its systematic position.

CO 5	Justify the position of the chordate animal according to its position in the systematic hierarchy.
CO 6	Compare and state the differences between the different systems of chordates and link it with their evolutionary process

RUSZOO601	Title: Study of Animal Type- Chordates	Credits/Hours 2.5/60
Unit I	**Class- Pisces e.g. *Scoliodon***	
	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**	
	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**	
	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**	
	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 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Describe nomenclature and mechanism of enzyme, enzyme inhibition and regulatory enzymes.
CO 2	Enumerate the therapeutic and industrial application of enzymes.
CO 3	Describe the concepts of homeostasis and adaptive responses of the animals to the changes in environmental temperature.
CO 4	Describe the histological layer of the organs.
CO 5	Correlate the different pathological conditions in the body with the type of disease.
CO 6	Calculate optimum pH, temperature, Vmax and Km value for enzyme and find out competitive and non-competitive enzyme inhibition from graph.

Detailed syllabus

RUSZOO602	Title: Physiology, Histology and Pathology	Credits/Hours 2.5/60
Unit I	**Enzymology**	
	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 km, Vmax and kcat,	
	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)**	
	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**	
	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**	

	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, postmortem 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 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Explain different concepts of biostatistics, recognize, and give examples of different types of data gathered from public health, clinical studies etc.
CO 2	Describe different concepts of toxicology and ethical issues in drug toxicity.
CO 3	Enumerate concepts of bioethical issues including intellectual property rights and the concepts and practices of bioprospecting.
CO 4	Identify drugs of natural origin and their source.
CO 5	Analyse the method of self-medication and the application.
CO 6	Choose an appropriate test for comparing two different variables in different populations.
CO 7	Demonstrate the skill of using different softwares which can be used to extract the information from large databases.

Detailed syllabus

RUSZOO603	Title: TOXICOLOGY AND COMPUTATIONAL BIOLOGY	Credits/Hours 2.5/60
Unit I	**Basic Toxicology**	
	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**	
	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**	
	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**	
	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
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- 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
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- 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 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After successfully completing the course, the students will be able to:
CO 1	Explain the different methods of wildlife conservation.
CO 2	Describe the natural resources, their management and laws governing environment protection.
CO 3	Explain the role of useful and harmful insects in human life.
CO 4	Identify the different threats to wildlife and man animal conflicts around the local areas.
CO 5	Compare and state the differences between the different Zoogeographical realms and correlate the habitat with the existing flora and fauna.
CO 6	Interrelate between different environmental conditions and the fauna found in different zoogeographical areas.
CO 7	Demonstrate the skill of estimating COD, BOD, acidity, alkalinity, and phosphates from different water samples.

Detailed syllabus

RUSZOO604	Title: ENVIRONMENTAL ZOOLOGY AND ENTOMOLOGY	Credits/Hours 2.5/60
Unit I	**Environment management**	
	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**	
	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**	
	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 driftwood, 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**	

	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 the 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
- Structure & functions of Insects; 3rd edition; Chapman R.F.; ELBS London; 1983
- Entomology; Gillott; CedricPlenum Press New York; 1980
- The Science of Entomology; Romoser W.S.; 2nd edition, Macmillan Co. New York; 1981
- General Entomology; Mani M.S.; Reprint Oxford - IBH India; 1998
- 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%

- 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.

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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