

SYLLABUS FOR THE
MPhil/Pre-PhD Coursework and
Dissertation in ZOOLOGY
Two Semester Course (MPhil)
One Semester Course (Pre-PhD)



DEPARTMENT OF ZOOLOGY
SCHOOL OF LIFE SCIENCES
RAVENSHAW UNIVERSITY
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Sr. No	Course Code/Paper Code	Title	Semester	Maximum marks
1.	1.1.1	Research Methodology	1 st	100
2.	1.1.2	Intensive paper a. Aquatic Biology b. Redox Biology c. Applied micro Biology d. Neurobiology	1 st	100
3.	1.1.3	Research and Publication Ethics	1 st	50
4.	1.1.4	Review of Literature	1 st	50
5.		Dissertation (MPhil)	2 nd	300

(Dissertation-200
Viva-Voce-100)

**TOTAL
MARKS- 600**

ZO-1.1.1 RESEARCH METHODOLOGY

Objectives

- Develop basic concepts of research designing, appropriate literature search tools, and publication ethics.
- Acquaint learners with IPR and associated treaties, ethical issues in biological studies.
- Equip students with knowledge of instrumentation and techniques in Biology.
- Familiarize scholars with aspects of animal tissue culture & histochemistry.
- Impart knowledge tools on the biostatistics and informatics in research.

Outcomes

- Well equipped with fundamental knowledge underpinning research.
- Familiarity with techniques used in research.
- Understanding gained in validating results through biostatistics.

Unit-I Research Design Literature and IPR

Basic and applied research, Objective formation, Research design, Literature collection for research, Bibliography, Indexing and literature citation, Publication of papers in Journals, Proceedings, chapters in books, Components of research paper-the IMRAD system, IPR and IPR issues, international treaties on Patents, Paris Convention, Patent Co-operation Treaty, Budapest Treaty, Animal care, ethical issues in biological studies.

Unit-II Instrumentation and Techniques in Biology

Principle. operation and application of: Potentiometry, Centrifugation, Chromatography including HPLC, LC-MS, Electrophoresis, Spectrophotometry. Spectro fluorimetry, Spectroscopy (Nuclear Magnetic Resonance, Infra-Red, Atomic Absorption), MALDI-TOF.

Unit-III Animal tissue culture & Histochemistry

Equipment and materials for animal cell cultures: Design and layout of culture room, basic equipment's used in cell culture, Sterilization and aseptic techniques, Studying animal cells: Confocal microscopy, Flow cytometry, Culture media: Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture, Serum free media, Primary culture and its maintenance, techniques of tissue disaggregation, Monolayer and suspension cultures, Products from animal tissue culture.

Unit-IV Biostatistics

Sampling, Normal distribution. Probability. Test of hypothesis: Non-parametric (Mann-Whitney test, Kruskal Wallis test); Parametric test (ANOVA and MANOVA). Post-hoc test (LSD, Tukeys, Newman-Keul's, Duncan's New Multiple Range and Dunn's Test).

Unit-V Computer application and Bioinformatics

Introduction to Bioinformatics. Biological databases, pairwise sequence alignments: Sequence homology versus sequence similarity, Sequence similarity versus sequence identity, Methods, Scoring matrix and significance, BLAST, FASTA, Protein motif and domain prediction. Molecular phylogenetics, Protein structure databases and Universal repository Servers (EMBL, UniProt, ExPasy etc.).

Suggested Readings:

- Teece, D. J. (Ed.). (2008). *Transfer And Licensing Of Know-how And Intellectual Property, The: Understanding The Multinational Enterprise In The Modern World*. World Scientific.
- Sell, S. K., & Sell, S. K. (2003). *Private power, public law: The globalization of intellectual property rights (Vol. 88)*. Cambridge University Press.
- Xiong, J. (2006). *Essential bioinformatics*. Cambridge University Press.
- Wilson, K., & Walker, J. M. (Eds.). (2000). *Practical biochemistry: principles and techniques*. Cambridge University Press.
- Boyer, R. (2000). *Modern experimental biochemistry*. Pearson Education India.
- Chainy, G. B. N., Chainy, G. B. N., Mishra, G., & Mohanty, P. K. (2004). *Basic Biostatistics*. Kalyani Publishers.
- Das, D., & Das, A. (1980). *Statistics in Biology & Psychology*. Academic Publishers.
- Efron, B. (1998). RA Fisher in the 21st century. *Statistical Science*, 95-114.
- Freshney, R. I. (2015). *Culture of animal cells: a manual of basic technique and specialized applications*. John Wiley & Sons.
- Butler, M. (2004). *Animal cell culture and technology*. Taylor & Francis.
- Doyle, A., Griffiths, J. B., & Newell, D. G. (1998). *Cell & tissue culture: laboratory procedures (Vol. 3)*. Wiley.
- Attwood, T. K., & Parry-Smith, D. J. (2002). *Introduction to bioinformatics*.

INTENSIVE PAPER ZO-1.1.1 [A] AQUATIC BIOLOGY AND TOXICOLOGY

Objectives

- Foster elementary perceptions of the marine environment and settings.
- Provide information on coastal biodiversity and associated vulnerabilities.
- Familiarize beginners with under water sampling expertise.
- Conception of the basic techniques of marine biotechnology.
- Acquaint researchers with methods of toxicity tests and concepts of LD₅₀ and LC₅₀, dose effect and response mechanism of toxicant action and other related aspects.
- Apprise scholars on Environmental Impact Assessment techniques.

Outcomes

- Acquaintance strengthening research in aquatic biology.
- Understanding techniques of toxicology research and its importance.
- Comprehension of basic methods of research in marine biotechnology.
- Skills in EIA.

Unit-I Marine environment

Marine environment-An Introduction, Estuaries-types, biota, ecology.

Mangrove Ecosystem-Coastal Settings, types of mangrove forests, Ecological characteristics, Coastal and Marine Biodiversity of India-Flora and Fauna, Threats, Human Impact on the Sea-fisheries. mariculture. pollution. global warming and sea level changes.

Unit-II Shallow water Sub tidal benthos-techniques

Trawls and Dredges-Principles of Operation and Sample Processing, Variety of Systems Available. Data Interpretation-uni, multivariate analysis.

Grab Sampling-Principles of Operation and Sample Processing, basic requirements for quantitative benthic sampler, types of grabs.

Diver Surveys-Principles of Operation and Data Processing, Transect Surveying Techniques_ Quadrat Sampling Techniques. Diver Operated Cores, Photographic Sampling, Data Processing, interpretation.

Unit-III Techniques and Marine Biotechnology

MPN, Faecal coliform, Membrane filter method, Plankton sampling and preservation methods. Marine Enzymes-sources and their applications, Marine Lipids-sources and their applications, Extraction and Characterization of Bioactive Compounds with Health Benefits from Marine Resources, Mussel adhesive proteins.

Unit-IV Toxicology and Environment Impact Analysis

Toxicity tests and concepts of LD₅₀ and LC₅₀, Toxicant bioassay using fish, Dose — effect and response relationship, Mode of action of toxicants (metals, pesticides,

teratogens, environmental carcinogens, ionizing and non-ionizing radiations, biomagnification Environmental Impact Assessment (EIA):

Impact Assessment Methodologies, Components and objectives of EIA, Risk characterization, Case studies (At least two), Environmental Risk Assessment

Unit-V Biology and mechanisms of Toxicants

Pesticides-Classification of pesticides, Metals- Toxicity, Properties, Industrial uses, Toxicology of Aluminum, arsenic, cadmium, chromium, lead and mercury. Mutagenesis and carcinogenesis causing toxicants, Bioconcentrations, Biomagnifications, Biotransformation.

Suggested Readings:

- Odum, E.P. Fundamentals of Ecology. W.B. Saunders Company, Philadelphia.
- Pieulou, E.C. An Introduction to Mathematical Ecology. Wiley, Interscience, New York.
- Barnes R.S.K & Hughes R.N. An Introduction to Marine Ecology.
- Environmental Biotechnology theory and application, G. M. Evan, J. C. Furlong. John Wiley & Sons, Ltd, -/2503
- Environmental Biotechnology Principles and Applications. B. E. Rittmann, P. L. McCarty Mc Graw-Hill International Editions/Singapore, 2001.
- Environmental Biotechnology, B. C. Bhattacharya, and R. Banerjee, Oxford University Press.
- Fundamentals of Ecology- M.C Dash
- Marine ecology-concepts and applications- Martin R. Speight and P.A. Handerson.
- Environmental biotechnology, S.N. Jogdand
- Environmental biotechnology, T. Srinivas
- Fundamental of Toxicology- Adhikari and Upadhava
- Toxicology- Wallace Hayes
- Environmental Science- Santra and Santra
- Environmental chemistry - A.K. Dey
- Biotechnology- HD Kumar
- Alongi, D.M. (1998). Coastal Ecosystems Processes. CRC Press, Boca Raton. FL, USA.
- Methods for the study of Marine benthos by Anastasios Elftheriou

PAPER ZO-1.1.2 [B] REDOX BIOLOGY

Objectives

- Introducing the general concepts of redox reactions and their role in biological systems.
- To understand the properties of free radicals, reactive oxygen species (ROS) & reactive nitrogen species (RNS) and their physiological and cellular importance.
- To know the mechanism of oxidative damage to the macromolecules, and the role enzymatic and non-enzymatic antioxidants to combat the deleterious effects of free radicals
- To make the students' understanding the importance of ROS in cell signalling, growth, development and aging.

Outcomes

- Student can acquire knowledge and understanding on how oxygen can act as double-edged sword for aerobes.
- Deciphering the knowledge and understanding on the mechanism Respiratory burst plays an important role in the immune system.
- Obtaining the knowledge on physiological conditions and consequences of oxidative stress, and protective role antioxidant defences in cellular level.
- Understanding the involvement of mitochondria in production of ROS and its role in aging process.

Unit-I

Oxygen and living system (anaerobes and aerobes), Oxygen toxicity and its chemistry; Free radicals; Chemistry of biologically important non-radicals; Production and sources of reactive oxygen Species (ROS) and reactive nitrogen Species (RNS) in living system (intrinsic and extrinsic)

Unit-II

Pro-oxidants, oxidative stress and its responses; Oxidative damage to biomolecules: Lipid, DNA, and proteins, Method to detect oxidative damage.

Unit-III

Antioxidant Defences: Non-enzymatic (Reduced glutathione, Ascorbic acid, Vitamin- E, carotenoids, flavonoids, Thio-redoxin, etc.) and enzymatic (Super oxide dismutase, Catalase, Glutathione peroxidase, Glutathione reductase, Glutathione-S-transferase and Peroxidases). Applications of antioxidants.

Unit-IV

Redox couples, Redox regulation: Apoptosis, Ion metabolism (Calcium, Iron and Copper); Heat shock and relevant stress inducing proteins and cross-talk with ROS; Respiratory Burst; Redox and cell signaling.

Unit-V

Reactive Oxygen Species and Pathophysiology; Impact on development & aging; Reproduction and environmental adaptations.

Suggested Readings:

- Halliwell, B., & Gutteridge, J. M. (2015). *Free radicals in biology and medicine*. Oxford university press, USA.
- Buettner, G. R. (1993). The pecking order of free radicals and antioxidants: lipid peroxidation, α -tocopherol, and ascorbate. *Archives of biochemistry and biophysics*, 300(2), 535-543.
- Winterbourn, C. C. (2008). Reconciling the chemistry and biology of reactive oxygen species. *Nature chemical biology*, 4(5), 278-286.
- Wardman, P., & von Sonntag, C. (1995). [3] Kinetic factors that control the fate of thiyl radicals in cells. *Methods in enzymology*, 251, 31-45.
- Sturgeon, B. E., Sipe, H. J., Barr, D. P., Corbett, J. T., Martinez, J. G., & Mason, R. P. (1998). The fate of the oxidizing tyrosyl radical in the presence of glutathione and ascorbate: implications for the radical sink hypothesis. *Journal of Biological Chemistry*, 273(46), 30116-30121.
- Thomas, S. R., & Stocker, R. (2000). Molecular action of vitamin E in lipoprotein oxidation:: Implications for atherosclerosis. *Free Radical Biology and Medicine*, 28(12), 1795-1805.
- Winterbourn, C. C., & Metodiewa, D. (1999). Reactivity of biologically important thiol compounds with superoxide and hydrogen peroxide. *Free Radical Biology and Medicine*, 27(3-4), 322-328.
- Forman, H. J., Fukuto, J. M., & Torres, M. (2004). Redox signaling: thiol chemistry defines which reactive oxygen and nitrogen species can act as second messengers. *American Journal of Physiology-Cell Physiology*, 287(2), C246-C256.
- Sies, H. (2007). Total antioxidant capacity: appraisal of a concept. *The Journal of nutrition*, 137(6), 1493-1495.

Objectives

- The course has been designed for research scholars to introduce them towards the microbial world. The study module in Unit I includes the study on microbial propagation, growth kinetics with utilization of various carbon and nitrogen sources as growth mediums along with their maintenance and preservation strategies.
- The module in Unit-II has been elaborated about the types of fermenters and their designs with scale-up and down stream processing. The production of antibiotics from microbes and their application in production of beverages, organic solvents and acids has been introduced in Unit-III.
- Similarly, the overview on microbial disease and their control in host parasitic relationship has been established in Unit-IV and the need of probiotics for human health and animals as well as biotransformation and bioremediation strategies for nutraceuticals and bioremediation has been well explained in Unit-V, respectively.

Outcomes

- The course elaborates the learner on preliminary knowledge on screening and isolation of pure microbial culture, measurement of growth kinetics and their maintenance with being exposed to various techniques for microbial propagation.
- The modules also explain about the various types of fermenters designs along with studies on various rheological parameters through on-line consoles modules with scale-up and down stream processing.
- Simultaneously, the course appraises about the industrial production of antibiotics, beverages along with various metabolites along with vitamins, amino acids, enzymes and exopolysaccharides.
- The course also describes about microbial diseases of bacteria and viruses, relationship between host-parasite relationships and mechanism of host defenses. It also gives overviews on application of microbe as probiotics in human and animal health through biotransformation of nutraceuticals, microbial remediation of environmental contaminants along with studies on intellectual property rights and their various amendments.

UNIT-I

Methods for isolation of pure culture methods for measurement of microbial growth, manipulation of environment, nutrition and genetic parameters for overproduction of metabolites, maintenance and preservation of microbes (Pure culture). Formulation of nutrient media, preparation of inoculum, alternative carbon and nitrogen sources, carbon pretreatment and measurement of growth kinetics.

UNIT-II

Fermentation: Types of fermenters, fermenter designs, aeration, agitation, sterilization of gases and liquids, monitoring of rheological parameters by one-line and offline methods, scale-up and down stream processing.

UNIT-III

Industrial Microbiology: Production of antibiotics (Penicillin/Streptomycin), beverages (Wine/Beer), Organic solvents and acids (Alcohols, vinegar and citric acids), secondary metabolites, and

recombinant products. Vitamins (B12), Amino acids (Tryptophan), Enzymes (Amylase/Protease), Exopolysaccharides (Xylans).

UNIT-IV

Microbial diseases and control: Normal microbiota of human body, overview of host resistance, Host-parasite relationship, Pathogenesis of bacterial and viral diseases, Microbial mechanism of host defences.

UNIT-V

Probiotics of human and animals. Biotransformation of nutraceuticals and bioremediation of crude oils and industrial wastes by microbes. IPR and related amendments,

Suggested Readings:

1. Microbiology by Prescott, Harley and Klein, 5th Edition, The McGraw Hill Companies, 2002.
2. Microbiology Demystified by Tom Betsy, D.C and Jim Keogh, The McGraw Hill Companies, Inc.
3. Applied Dairy Microbiology by Elmer H. Marth and James L. Steele, 2nd Revised and Expanded Edition, Marcel Dekker, Inc, New York.
4. Modern Food Microbiology by James M. Jay, 6th Edition, Aspen Publisher, Inc (Wolter Kluwer's), Maryland.

PAPER ZO-1.1.2 [D] NEUROBIOLOGY

Course Objectives

- To understand the mechanism of synaptic transmission.
- To have an understanding of different classes of neurotransmitters, their synthesis and release.
- To acquire knowledge about cell lineage, fate determination and development of behaviour pattern.
- To learn about neuroanatomy and physiology, mechanism of learning and memory
- To learn the signs and symptoms of neurological diseases and age- related disorders.

Course Outcomes

- Have understanding of chemical transmission and role of connectome in relay of impulses.
- Providing broad and deep understanding on molecular basis of release of neurotransmitters and neuromodulators.
- Familiarize the learners with anatomical basis and physiological aspects of different regions of brain and their functions.
- To impart knowledge and understanding on the progression of neuro degeneration and associated with ageing.

Unit I

Introduction to the mammalian nervous system; Cellular properties of neurons and other excitable cells, Synaptic transmission; Synaptic plasticity; Sensory and motor systems.

Unit II

Neurotransmitters (acetylcholine; serotonin; dopamine and norepinephrine); Amino acid and peptide transmitters and neuromodulators like adenosine; Macromolecules that mediate neurotransmitter synthesis and release.

Unit III

Neural induction and pattern formation; Cell lineage and fate determination. Neuronal migration, Axon guidance, Synapse formation and stabilization, Activity-dependent development and critical periods, Development of behaviour, Connectome (general idea).

Unit IV

Structure and function of human brain, Functional neuroanatomy and neurophysiology, cellular and molecular mechanism of learning and memory, centrally programmed behaviour, Sleep and dreams, Motivation and reward, Four systems for Emotional activation, neocortex.

Unit-V

Signs and symptoms of neurological disease, Biochemical basis of neurological diseases (Alzheimer's disease, Parkinson's disease, Huntington's disease, Balint's syndrome, Amnesia, Cerebral stroke and its impact).

Suggested Readings:

- Schwartz, J. H., Jessell, T. M., & Kandel, E. R. (Eds.). (1991). *Principles of neural science* (pp. 173-193). New York: Elsevier.
- Squire, L., Berg, D., Bloom, F. E., Du Lac, S., Ghosh, A., & Spitzer, N. C. (Eds.). (2012). *Fundamental neuroscience*. Academic press.
- Brodal, P. (2004). *The central nervous system: structure and function*. oxford university Press.
- Rudy, J. W. (2008). *The neurobiology of learning and memory*. Sinauer Associates.
- Gluck, M. A., Mercado, E., & Myers, C. E. (2008). *Learning and memory: From brain to behavior* (p. 640). New York: Worth Publishers.
- Snell, R. S. (2010). *Clinical neuroanatomy*. Lippincott Williams & Wilkins.

Paper ZO 1.1.3 Research and Publication Ethics (RPE)

THEORY

- RPE 01: PHILOSOPHY AND ETHICS (10 Hours)
 1. Introduction to philosophy: definition, nature and scope, concept, branches.
 2. Ethics: definition, moral philosophy, nature of moral judgments and reactions.
 3. Intellectual honesty and research integrity.
 4. Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP).
 5. Redundant publications: duplicate and overlapping publications, salami slicing.
 6. Selective reporting and misrepresentation of data.

- RPE 02: PUBLICATION ETHICS (10 Hours)
 1. Publication ethics: definition, introduction and importance.
 2. Best practices/ standards setting initiatives and guidelines: COPE, WAME etc.
 3. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa types.
 4. Violation of publication ethics, authorship and contributorship.
 5. Identification of publication misconduct, complaints and appeals.
 6. Predatory publishers and journals.

PRACTICE

- RPE 03: OPEN ACCESS PUBLISHING (10 Hours)
 1. Open access publications and initiatives.
 2. Journal finders/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.
 3. Complaints and appeals: examples and fraud from India and abroad.
 4. Use of plagiarism software like Turnitin, Urkund and other open source software tools.
 5. Conflicts of interest.

References

1. Bird, A. (2006) *Philosophy of Science*, Routledge.
2. MacIntyre, Alasdair (1967) *A Short History of Ethics*, London.
3. P. Chaddah (2018) *Ethics in Competitive Research: Do not get scooped: do not get plagiarized*, ISBN:978-9387480865.
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009) *On Being a Scientist: A Guide to Responsible Conduct in Research*: Third Edition. National Academies Press.
5. Resnik, D.B. (2011) What is ethics in research & why is it important. *National Institute of Environmental Health Sciences*, 1-10. Retrieved from <https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>
6. Beall, J. (2012) Predatory publishers are corrupting open access. *Nature*, 489(7415), 179-179. <https://doi.org/10.1038/489179a>
7. Indian National Science Academy (INSA), *Ethics in Science Education, Research and Governance* (2019) ISBN: 978-81-939482-1-7. <http://www.insaindia.res.in/pdf/EthicsBook.pdf>