GENERAL INSRTUCTIONS
&
COURSE CURRICULUM

FOR

Ph.D. in Zoology

(Effective from Academic Session 2024-25 onwards)

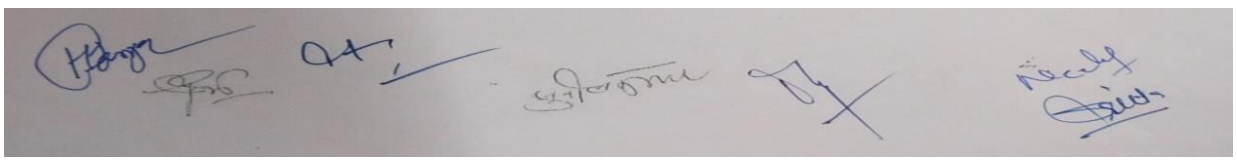
DEPARTMENT OF BIOSCIENCES

HIMACHAL PRADESH UNIVERSITY

(NAAC Accredited "A" Grade University)

SUMMERHILL, SHIMLA, 171005

HIMACHAL PRADESH, INDIA



(3) A Ph.D. scholar must obtain a minimum of 55% marks or its equivalent grade in the UGC 10-point scale in the course work to be eligible to continue in the programme and submit his or her thesis.

HIMACHAL PRADESH UNIVERSITY
(NAAC ACCREDITED "A" GRADE UNIVERSITY)
OFFICE OF THE DEAN OF STUDIES
SHIMLA-171005

No. 1-60/2023-HPU(DS)- Dated: Shimla-5, the 09th May, 2023

NOTIFICATION

On the recommendations of the Standing Committee of Academic Council vide item No.1 in its meeting held on 04.02.2023, the Executive Council vide Additional Supplementary Item No.6 of its meeting held on 06.04.2023 has approved the adoption of University Grants Commission (Minimum Standards and Procedures for Award of Ph.D. Degree) Regulations, 2022 dated 07.11.2022 and 10.11.2022 (Annexure "A") in toto for its implementation in HP University from the session 2023-24.

Dean of Studies

Endst. No.: 1-60/2023-HPU(DS)- Dated : Shimla-5, the 9th May, 2023

Copy for Information and necessary action to:-

1. All the Deans of Faculties, HPU, Shimla-5.
2. All the Chairpersons/Directors, Teaching Departments/Institutes, HPU, Shimla-5.
3. The Principal, H.P. University centre for Evening Studies, HPU, Shimla-5.
4. The Dean Students' welfare, HPU, Shimla-5.
5. The Director, International Students' Welfare, HPU, Shimla-5.
6. The Controller of Examinations, HPU, Shimla-5.
7. The Chief Warden, HPU, Shimla-5.
8. The Director ICDEOL/DIS,HPU, Shimla-5.
9. Director, H.P.U Regional Centre Khaniara, (Dharamshala), Distt. Kangra.
10. The Deputy Registrar (Secrecy), HPU, Shimla-5.
11. The Assistant Registrar (Admn) & Assistant Registrar (Academic), HPU, Shimla-05.
12. The Web Admn H.P University, Shimla-5 with the request to upload the same on the University website.
13. The Spl. P.S. to the Vice-Chancellor, HPU, Shimla-5 for the kind information of the latter please.

Dean of Studies

Annexure-I

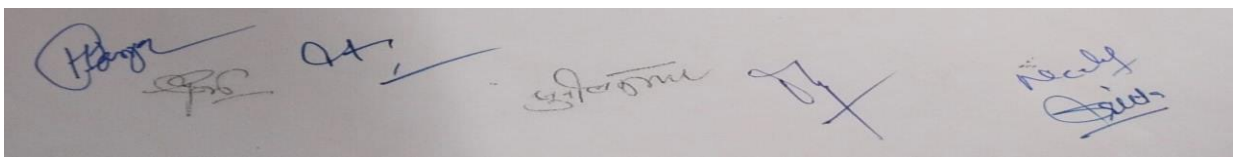
DEPARTMENT OF BIOSCIENCES
HIMACHAL PRADESH UNIVERSITY
SUMMER HILL, SHIMLA-171005
Ph.D. ZOOLOGY PROGRAMME

GENERAL INSTRUCTIONS/GUIDELINES FOR EXECUTION OF CURRICULUM

1. All candidates admitted to the Ph.D. program at the Department of Biosciences have to complete a minimum of 12 credits.
2. There will be four (4) courses in Ph.D. Zoology Programme. The students have to take 3 compulsory courses [PhDZL-101, PhDZL-102, PhDZL-103] and at least one additional course out of **elective courses [PhDZL-104(i-ix)]**.
3. A Ph.D. scholar must obtain a minimum of 55% marks or its equivalent grade in the UGC 10-point scale in the course work to be eligible to continue in the program and submit his or her thesis.
4. The detailed syllabi for the courses offered by the Department are appended with a list of suggested readings.

Outline of the Course Work for Ph.D. in Zoology

Code	**Title of Paper**	**Max Marks**	**Credits**
PhDZL-101 *(Common with all disciplines under Faculty of Life Sciences)*	Research Methodology	100	4Credits
PhDZL-102 *(Common with all disciplines under Faculty of Life Sciences)*	Research and Publication Ethics	50	2 Credits
PhDZL-103 *(Common with Botany)*	Techniques in Biological Research	50	2 Credits
Elect any one of the following i.e. PhDZL-104(i-ix) (Elective)		100	4Credits
PhDZL-104(i)	Advances in Animal Physiology		
PhDZL-104(ii)	Advances in Entomology		
PhDZL-104(iii)	Advances in Cytogenetics and Molecular Genetics		
PhDZL-104(iv)	Advances in fish and fisheries		
PhDZL-104(v)	Advances in Wildlife		
PhDZL-104(vi)	Advances in Biochemistry		
PhDZL-104(vii)	Advances in Parasitology		
PhDZL-104(viii)	Advances in Radiation Biology		
PhDZL-104(ix)	Advances in Microbial Physiology and Genetics		
Total Marks/Credits		**300**	**12 Credits**



PhD in Zoology (Compulsory Courses)

RESEARCH METHODOLOGY

Course Code: PhDZL-101	Credits: 4	MM: 100	L(4): T(0): P(0)	60Hours

Course objectives:
To provide basic framework and guidelines for researchers to clearly and define research problems, hypotheses, and objectives

Course learning outcomes:
i. Will help the researchers to identify the most appropriate research design, sampling technique, and data collection and analysis methods.
ii. Researchers will be able to understand and comprehend the basics of research methodology and apply them in their research.

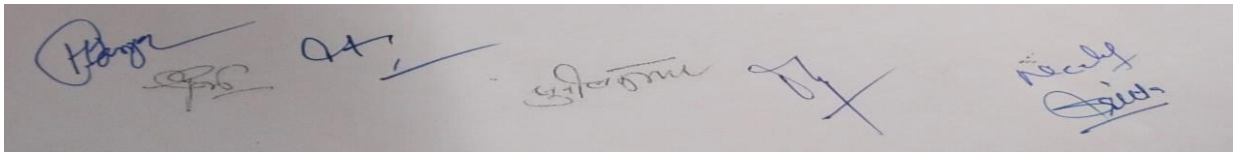
NOTE: Instructions for setting question paper
The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

UNIT-I **(15 Hours)**
Foundations of Research: Meaning, objectives of research; criteria of good research; basic steps of research; types of research.
Problem Identification & Formulation: selection of research problem.
Hypothesis: Qualities of a good Hypothesis, Null & Alternative Hypothesis, Hypothesis Testing, Logic & Importance
Review of related literature: Meaning, necessity and sources.

UNIT-II **(15 Hours)**
Research Process and Experiment Design: Concept and Importance in Research, features of a good research design, Exploratory Research Design concept, types and uses, Descriptive Research Designs concept, types and uses, Concept of Independent & Dependent variables.
Research Report: Writing preliminaries, main body of research, references and bibliography
Research and Development of Projects: Project formulation, National and international funding agencies for R & D projects, proposal submission, Intellectual Property Right (IPR).

UNIT-III **(15 Hours)**
Sampling: Meaning and types of sampling; Probability and Non-Probability, Practical considerations in sampling and sample size.
Tools and Techniques of Data Collection: questionnaire, schedule, interview, observation, case study, survey *etc*. statistics and its significance in research.
Data Analysis: Frequency distribution, measures of central tendency, measures of dispersion, correlation, regression analysis, test of significance (Z-test, t-test, Chi-square test, F-test).

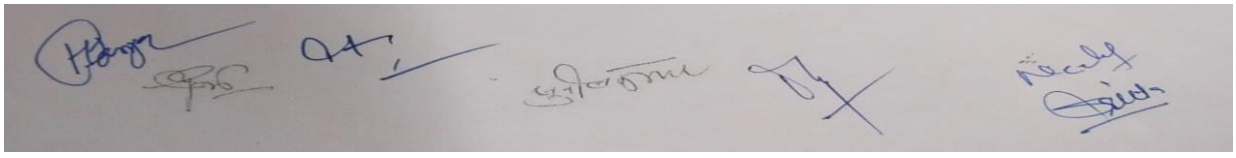


UNIT-IV **(15 Hours)**

Use of Tools / Techniques for Research: Search engines: NCBI, PubMed, Google Scholar, Thomson Reuters, SCI etc, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office. Bioinformatics tools and applications

Suggested Readings

1. Council of Biology Editors –CRE Style Manual, American Institute of Biological Sciences, Washington. D.C.
2. Effective Writing for Engineers, Managers, Scientists: Tichy AJ.
3. Scientific and Technical papers: Tribcase SF.
4. How to write and publish a scientific paper: Day RA.
5. Kothari, C. R. (2004). Research Methodology- Methods and Technique (New Age International, New Delhi)



RESEARCH AND PUBLICATION ETHICS

Course Code: PhDZL-102	Credits: 2	MM:50	L(2):T(0): P(0)	30 Hours

Course objectives:

i. To provide students with the fundamental knowledge of basics of philosophy of science, ethics in research and publication.
ii. Concept and understanding of predatory publication, indexing, citation databases, open-access publications and research matrices such as citations, h-index, i-index, impact factor, research interest score etc.
iii. Guide and mentor students in using plagiarism checking tools for a valid and ethical research.
iv. To prepare an evaluation report of a manuscript/ article.

Course learning outcomes:

The students will be able to know and practice ethical principles involved in research work and in publication that will help in maintaining integrity and credibility of scientific literature.

NOTE: Instructions for setting question paper

The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing ten parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (10 marks each).

Course Content

UNIT-I **(8 Hours)**

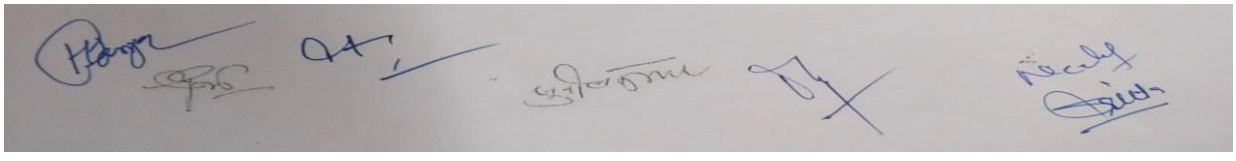
Philosophy, ethics and scientific conduct: Introduction to philosophy: definition, nature and scope, concept, branches
Ethics: Definition, moral philosophy, Nature of moral judgements and reaction;
Scientific conduct: Ethics with respect to science research, intellectual honesty and research integrity; Scientific misconduct: Falsification, fabrication and plagiarism; Redundant publications: Duplicate and overlapping publications, salami slicing; Selective reporting & misrepresentation of data.

UNIT-II **(7 Hours)**

Publication ethics: Definition, introduction and importance, best practices/ standards setting initiatives and guidelines [COPE, WAME etc.], conflict of interest.
Publication misconduct: Definition, concept, problem that lead to unethical behaviour and vice versa, and types; conflict of interest; violation of publication ethics, authorship and contribution ship.; Identification of publication misconduct, complaints and appeals.

UNIT-III **(8 Hours)**

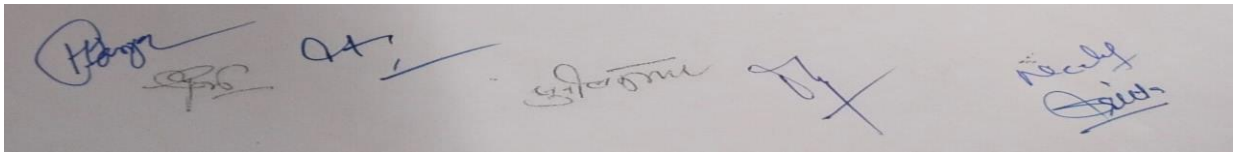
Open-access Publishing & publication misconduct: Open-access publications and initiatives, SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies, software tools to identify predatory publications developed by SPPU; journal finder/ journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal *etc*.



Publication misconduct: Group discussion: Subject specific ethical issues, FFP, authorship; Conflict of interest; complains and appeals: Examples and fraud from India and abroad.
Software tools: Use of plagiarism check software's like Turnitin, Urkund and other open-source software tools

UNIT-IV **(7 Hours)**
Databases and Research Matrices: Databases - Indexing databases, and Citation databases: Web of Science, Scopus *etc*.
Research Matrices: Impact factor of a journal as per citation report, SNIP, SJR, IPP, Cite Score & Research Interest (Research Gate).
Matrices: H-index, I-Index *etc*.

Suggested Readings
1. The Ethics of Teaching and Scientific Research by Miro Todorovich; Paul Kurtz, Sidney Hook.
2. Research Ethics Publication Approaches by Brbara H Stanley; Joan E, Sieber; Gary R. Midbow.
3. Research Methods in Applied Sciences: An Integrated Approach to Design and Analysis by; Morgan Lawrence Erlbaum Associates.
4. Ethics and Values in Industrial –Organizational Psychology by Joel Lefkowitz. Wiley Publishers.



TECHNIQUES IN BIOLOGICAL RESEARCH

Course Code: PhDZL-103	Credits: 2	MM: 50	L(2): T(0): P(0)	30 Hours

Course objectives:

i. To develop a deeper understanding of the principles involved behind the working of different instruments used in research.

ii. To make researchers able to utilize scientific learning to expand their research aptitude

Course learning outcomes:

i. Students will be able to learn all the basic and advanced techniques used in research.

ii. By using various tools, students will be able to identify, characterize, and quantify biomolecules with precision

NOTE: Instructions for setting question paper

The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing ten parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (10 marks each).

Course Content

Electron Microscopy and Electrophoresis (8 Hours)

Working principles, basic operation and application of Electron Microscopy

Scanning Electron Microscopy (SEM)

Transmission Electron Microscopy (TEM)

Principle of electrophoresis

Agarose gel electrophoresis and its limitations

Polyacrylamide gel electrophoresis and Cellulose acetate membrane electrophoresis

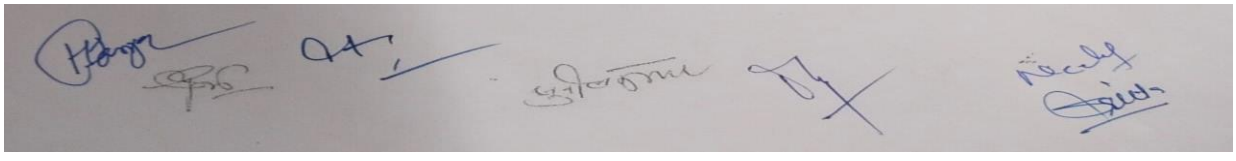
Isoelectric focusing (IEF), 2-D gel electrophoresis and Pulse field electrophoresis,

Histochemistry (7 Hours)

Historical perspective and Importance of histochemistry in biological research.

Principles of fixation; types of fixatives and their application

Principles and methods of histochemical localization of carbohydrates, lipids, proteins, nucleic acids and some enzymes (phosphorylase, sidolase, SDH, LDH-ases and lipase).



Immunological Techniques **(8 Hours)**

Radial immunodiffusion

Radioimmuno assay

Haemagglutination

Enzyme linked immunosorbent assay (ELISA)

Immunofluorescence

Remote Sensing **(7 Hours)**

History, evolution and mechanism of Remote Sensing

Advantages of Remote sensing and limitation of Remote sensing

LIDAR Remote Sensing and their different application in terrestrial and vegetation mapping

Suggested Readings:

1. Wilson, K. and Walker, J. Principles and Techniques of Practical Biochemistry Cambridge University Press.

2. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, W.H. Freeman and Company, San Fransisco.

3. Holmeand, D. and Peck, H. Analytical Biochemistry. Longman

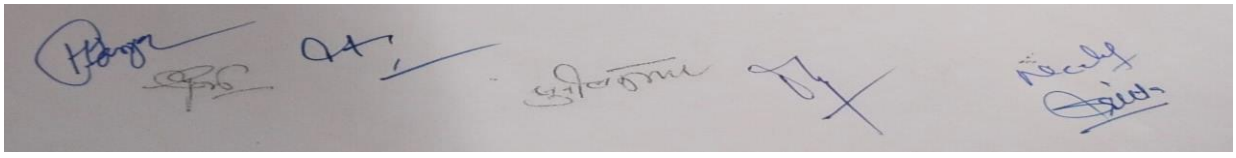
4. Scopes, R. Protein Purification - Principles and Practices. Springer Verlag

5. Bisen and Mathew. Tools and Techniques in Life Sciences. CBS Publishers and Distributors.

6. Thomas Lille sand & R.W. Keifer. Remote Sensing and Image interpretation. John Wiley and Sons.

7. Nandi, D. and Chattrejee, T. Text Book of Remote Sensing & Cartography. Kalyani Publication

8. Sabins, F. Remote Sensing: Principles and Interpretation. Freeman Publication



Ph.D. in Zoology (Elective Courses)

ADVANCES IN ANIMAL PHYSIOLOGY

PhDZL-104(i)	Credit: 4	MM: 100	L(4): T(0): P(0)	60 Hours

Course objectives:

To examine how biological processes function, how they operate under different conditions and how these processes are regulated

Course learning outcomes:

i. Broadly define the structure and function of animals and explain the mechanisms and regulation of animal life at different levels of organization from the cell to the whole organism.

ii. Take a rigorous approach to evaluating new questions in physiology or pathophysiology by navigating the scientific literature including databases.

iii. Design and analyze basic laboratory experiments probing physiological mechanisms at all levels of organization from genes to whole organisms.

NOTE: Instructions for setting question paper

The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

Cellular, Muscular, Neurophysiology and Hematology **(15 Hours)**

Fundamental principles of cellular physiology, membrane bioelectricity

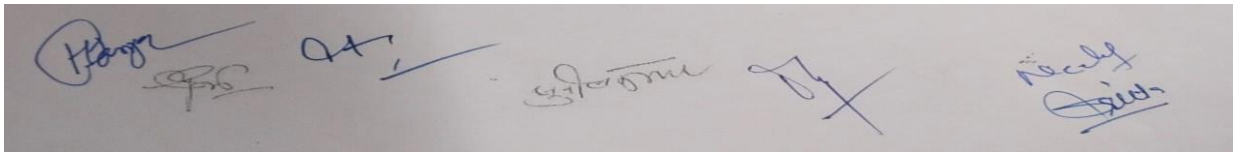
Ion channel physiology, Body fluids, and maintenance of homeostasis

Basics in hematology, Clinical hematology, Bone marrow, Blood & Blood cells

Bleeding disorders, Hematopoiesis, leukemia, leucopenia

Motor Functions of the Spinal Cord; the Cord Reflexes, Cortical and Brain Stem Control of Motor Function, States of Brain Activity - Sleep, Brain Waves, Epilepsy, Psychoses, and Dementia

Aviation, High Altitude physiology, acclimatization and Space Physiology, Physiology of Deep-Sea Diving and Other Hyperbaric Conditions, Effect of microgravity on cardiorespiratory performance and Physiological control measures



Cancer Pathophysiology and Gastrointestinal Physiology **(15 Hours)**

Cancer genetics and cell lines

Tumor immunology, Cancer therapeutics

Molecular techniques in cancer biology and available treatments

General Principles of Gastrointestinal Function

Mixing of Food in the Alimentary Tract, Secretory Functions of the Alimentary Tract

Digestion and Absorption in the Gastrointestinal Tract

Physiology of Gastrointestinal Disorders

Endocrinology and Reproduction **(15 Hours)**

Introduction to Endocrinology

Hormones and their mode of action

Reproductive and hormonal functions of the male and female reproductive system

Polycystic Ovarian Syndrome

Respiratory, Cardiac and Renal Physiology **(15 Hours)**

Physiology & regulation of respiration, pulmonary ventilation,

Respiratory Insufficiency - Pathophysiology, Diagnosis, Oxygen Therapy

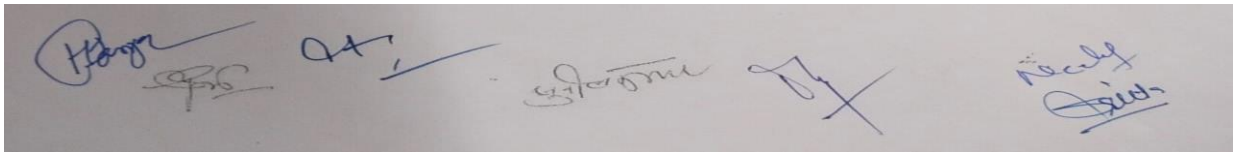
Cardiac cycle, cardiac output and stroke, Blood pressure & pulse

Coronary circulation, pulmonary & systemic circulation, Cardiovascular homeostasis

Kidneys in maintaining homeostasis, GFR, and Electrolyte balancing, Regulation of renal functions, Functions of ureters, bladder and urethra

Suggested Readings:

1. General and Comparative Animal Physiology, Hoar W. S. (ed), Prentice Hall, India
2. Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Dantzler, W.H. (ed.) Oxford University Press, New York, USA
3. Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed) Cambridge University Press, Cambridge, UK
4. Introduction to Anatomy & Physiology, David Sturgeon, Taylor & Francis, Henry Ling Ltd, NY
5. Introduction to Animal Physiology, Ian Kay. Taylor & Francis, Bios Scientific Publisher Ltd., Oxford, UK



ADVANCES IN ENTOMOLOGY

PhDZL-104(ii)	Credit: 4	MM: 100	L(4): T(0): P(0)	60 Hours

Couse Objectives:

i. To develop an understanding of the distribution and abundance of insects and their interaction with environment

ii. To learn modern techniques in insect science such as molecular biology etc.

Course Learning Outcomes:

i. Understand evolution and biodiversity generation through macro- and micro-evolutionary processes, including how these processes have formed and diversified insects.

ii. Attain a solid foundation in insect biology, including general entomology, basic systematics, morphology, physiology, and biodiversity.

iii. Understand evolution and biodiversity generation through macro- and micro-evolutionary processes, including how these processes have formed and diversified insects.

iv. Develop the ability to read and interpret scientific papers in entomology, and critically assess content.

NOTE: Instructions for setting question paper

The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

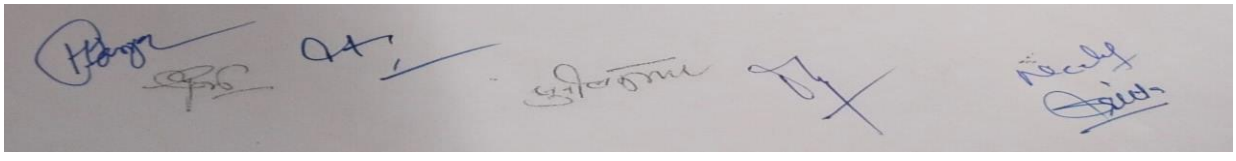
Insect Sociobiology, Insect Pheromones and Socio Chemicals (15 Hours)

Forms of social life. The organization of higher social communities of insects. Mutual Communication in search of food. Social homeostasis and insect superorganism.

Diversity of communication systems. Primers and releasers. Socio-chemicals of bees and ants. Allomones.

Insect Toxicology, Behavioral Physiology (15 Hours)

Chemistry and mode of action of organophosphates of insecticidal resistance. and carbamates. Physiology Insecticides and environmental pollution.



The physiological causes of behaviour. Hormonal releasers of behaviour Hormonal Switches of behavioural states. Higher control of hormonal causes of behaviour. Effects of behaviour on physiology.

Bio-Chemistry of Insect Flight, Nervous System and Synaptic Transmission (15 Hours)

Pathways for the utilization of carbohydrates, amino acids and fats in flight muscle. control of flight muscle mitochondrial and metabolism. Respiratory fuels- carbohydrates, lipids and their metabolism.

Nervous integrity and transmission of Bioelectrical events. Chemically mediated transmission-synaptic transmission and chemical transmitters at neuromusclar junctions. Nervous system control.

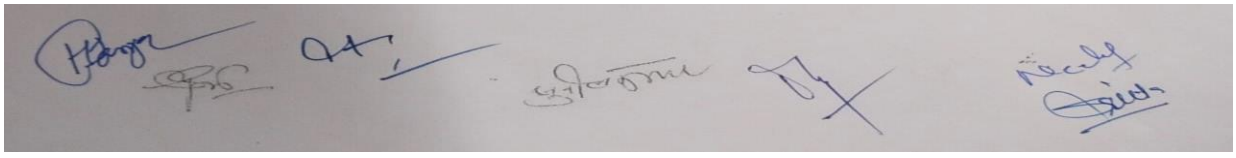
Insect Thermoregulation and Diapause (15 Hours)

Behavioural and physiological mechanisms of thermoregulation. Regulation of temperature in the nests of social insects.

Endocrine mediation of diapause. Morphological, Physiological expression and behavioural diapauses and its Significance.

Suggested Readings:

1. Fundamentals of Insect Physiology-Murrary S. Blum. John Wiley & sons. New
2. Insect Biochemistry and Furnction-D.L.Cancdy London. and B.A,Kilby. Chapman and Hall
3. The Biochemistry of Insects-Darcy Gilmour. Academic Press , New. York and London.
4. 5. An Introduction to insect Physiology-s Bursell Academic Press, New Yorcandondon.
5. The Principles of Insect Physiology- V. B. Wigglesworth, English Language book Society and Chapman and Hall, London.
6. The Insects structure and Function -R-F Chapman. The English Language book society and The English University Press, London.
7. Introductory Insect Physiology-Robert L. Patton, (Saunders. Toppan Publisher)



ADVANCES IN CYTOGENETICS AND MOLECULAR GENETICS

PhDZL-104(iii)	Credit: 4	MM: 100	L(4): T(0): P(0)	60 Hours

Course Objectives:

i. To understand chromosomes' structure, function, and behaviour during cell division and their role in genetics and development.
ii. To learn the mechanisms of chromosomal inheritance and the genetic basis of chromosomal disorders.
iii. To Understand the principles of evolutionary theory, including natural selection, genetic drift, gene flow, and mutation.
iv. To learn about the history of life on Earth and the processes that drive evolutionary change.

Course Learning Outcomes:

i. Understand the role of chromosomes in genetic inheritance and cellular processes.
ii. Analyze and interpret chromosomal abnormalities, including numerical and structural changes.
iii. Understand the principles of taxonomy and classification of organisms based on evolutionary relationships.
iv. Understand the role of genetic variation and adaptation in evolution.
v. Apply cytogenetic knowledge to medical genetics, prenatal diagnosis, and genetic counselling.

NOTE: Instructions for setting question paper
The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

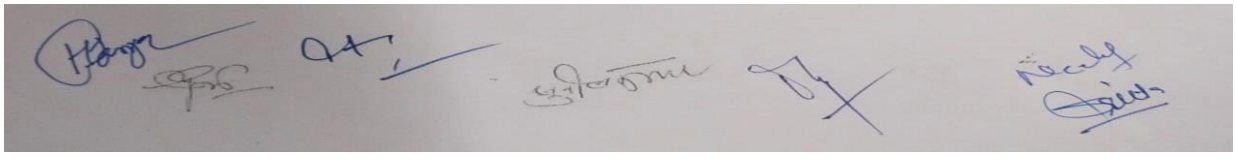
Genomics **(15 Hours)**

Structural Genomics: Sequence Organization, Assigning Loci to Chromosomes, High Resolution Specific Genomes, Chromosome Maps, Physical Mapping of Genome Functional Sequencing, Use of Genome Maps in Genetic Analysis. Analysis, DNA genomics: Microarrays.

Functional genomics: Characterization of Proteome by Open Reading Frame Analysis, DNA Microarrays.

Cytogenetic Techniques **(15 Hours)**

Karyotyping: Centromeric Index, Arm Ratio, Relative length, Idiogram.



Chromosome Mapping.

Banding Techniques: Giemsa staining, Giemsa C banding, Giemsa G banding, Quinacrine (Q) banding, R banding and Silver staining,

Measuring nuclear DNA: Micro-densitometry, The Feulgen Reaction

Human Pedigree Analysis

Molecular Tools **(15 Hours)**

Molecular Probes.

Florescence in situ Hybridization

Discrete Genetic Markers as Probes for studying Populations.

Use of PCR as a Tool to Study Races.

Evolutionary Genetics **(15 Hours)**

Evolution of Multigene Families.

Neutrality, Molecular Clocks

Use of mt DNA in Studying Genetic Relationships.

Human Evolution: The Origin of Major Human Groups.

Discrete Genetic Markers as Probes for studying Populations.

Use of PCR as a Tool to Study Races.

Suggested Readings

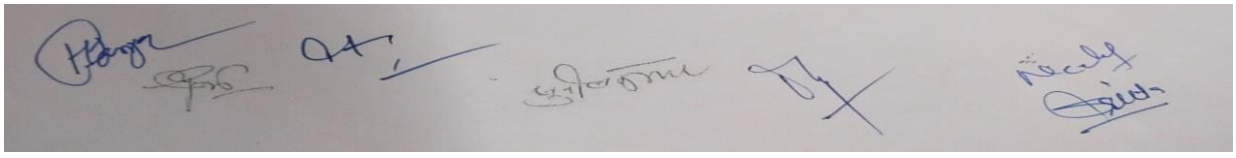
1. Gardener, E.J., Simmons, M.J. and Snustad, D.P, Principles of Genetics. John Wiley & Sons.

2. Griffiths, A.JF.; Gelbar, W.M.; Miller, J.H. ad Lewontin, R.C. Modem Genetic Analysis. W. H.Freeman & Company.

3 McGregor, H.C.and Varley, J.M. Working With Animal Chromosomes. John Wiley & Sons.

4. Mitra, S. Genetics-A Blueprint of Life. Tata MCGraw-Hill Publishing Company. .

5. Dover, G.A. and Flavell, R.B. Genome Evolution. Academic Press.



ADVANCES IN FISH & FISHERIES

PhDZL-104(iv)	Credit: 4	MM: 100	L(4): T(0): P(0)	60 Hours

Course Objectives:

This course will provide students with an understanding of how fisheries operate and how fish reach human communities. This course has been designed to understand the identification and classification of commercially important fishes and other aquatic vertebrates by the students. The course objectives are to provide the students with an advanced knowledge of fish.

Course Learning Outcomes:

i. Critically evaluate the literature on fishes, their management
ii. underpins approaches to fisheries exploitation and management
iii. It will give a broad overview of different fisheries and the way they are managed, offering a clear view of the nature and scope of challenges in delivering greater sustainability against a background of rapid anthropogenic environmental change.
iv. It will equip students with the knowledge and skills necessary to take on management and monitoring roles in fisheries, such as in Inshore Fisheries and Conservation

NOTE: Instructions for setting question paper

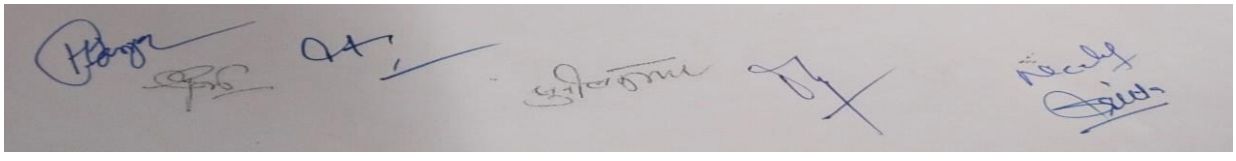
The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

Evolution and Ecology, Advances in Fish Physiology (15 Hours)

Evolutionary strategies in fishes, gene and genome duplication, evolutionary genetics, biogeographical distribution, methods employed in phylogenetic studies and fish Identification. Fishes and their relationship with abiotic and biotic factors.

Physiology of bimodal gas exchanges: Oxygen sensing; respiratory control, concept of fluid dynamics across respiratory structures. Environmental influences of fish cardiovascular physiology; cardiac plasticity in fish. Physiology of ion transport and excretion: Functional morphology of branchial ionocytes; understanding growth in fish: myogenic cells and growth; muscle satellite cells; muscle fiber dynamics, genetic and environmental factors regulating muscle growth; diversity and plasticity in muscle fiber. Reproduction and Fertility: formation



of eggs and spermatozoa; Vitellogenin: structure, synthesis, and transportation to oocytes; egg envelop proteins; gonadal steroidogenesis; physiology of fertilization.

Stock Assessment and Management, Aquaculture and Role of Genetics in Aquaculture

(15 Hours)

Marketing, tagging and population enumeration, length-weight relationship, age and growth, fecundity estimation, bio-indicators and biomonitoring. Application of statistical methods in fisheries, fish conservation and fishing laws. Fishing techniques: Remote sensing, sonar, radar; crafts and gears. Fishways and screens.

Aquaculture systems, harvesting and BMP. Evolution of intensive culture technologies, need for intensification in aquaculture, potential and innovative strategies for the development of cold-water aquaculture in India. Genetics in broodstock management of commercially important fish and shellfish, assembling base population, choosing selection objectives and criterion, pedigree identification, concept of inbreeding and its management, inbreeding depression and heterosisin; application of population genetics in fish resource conservation,

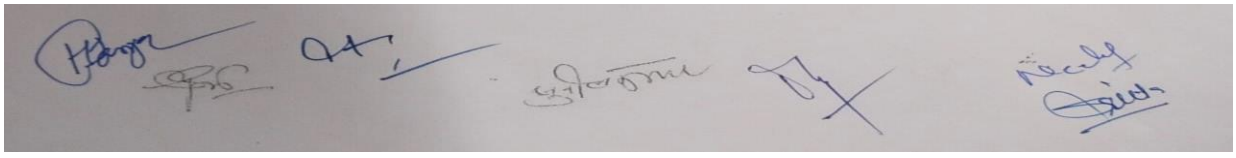
Fish Nutrition **(15 Hours)**

Energy requirements of fish: principles and methods; factors affecting energy requirement; energy budgeting, metabolic rate and factors affecting it. Bioenergetics of spawning, relationship between feeding and maturation. Energy relationship between egg and hatchlings. Role of probiotics and prebiotics in fish nutrition. Feed formulation: least cost formulation, linear programming; quality of feed ingredients and their biochemical composition; protein and energy supplements; vitamins and minerals premixes. Feed evaluation: Feed Conversion Ratio (FCR); Feed Efficiency Ratio (FER); Protein Efficiency Ratio (PER), Net Protein Utilization (NPU) and Biological Value (BV).

Toxicological Methods of Drugs Used in Aquaculture, Bioinformatics in Fish Industry

(15 Hours)

Impact of toxicants on fish health: Algal blooms, Important mycotoxins, Icthyotoxins, chemical toxins, and other toxicants and their effects on fish health. Principles of drug action and assay; dose-response curves and their analysis; residual effects and withdrawal period of potential drugs. Specific toxicity tests, immunotoxicity, and carcinogenicity; types of toxicity and its measurement; acute, sub-acute or chronic and its manifestations; acute toxicity; Use of cell culture for toxicity assays; different assays for toxicity testing. Measurement of TD50/TC50; measurement of LD50/LC50; test for acute, sub-acute and chronic toxicity; protocols and

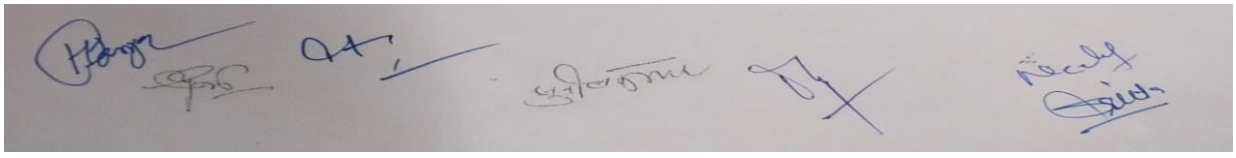


various specific toxicity tests; cell culture assay for chemical toxins; cell culture assay for biological toxins.

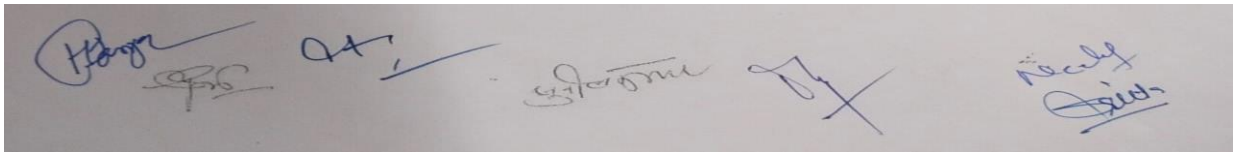
Bioinformatics related to genomics, proteomics or metabolomics. DNA barcoding – Species substitution, detection – mini barcodes, databases – fish trace, fish gen, AFLP, fish DB, RFE. Fish protein adulteration – protein-based methods- electrophoresis and immunological.

Suggested Readings

1. Allan, G. and Burnell, G. 2013. Advances in Aquaculture Hatchery Technology. Woodhead Publishing Limited.
2. Andrews C, Excell A and Carrington, N. 1988. The Manual of Fish Health. Salamander Books
3. ASTM Standards on Aquatic Toxicology and Hazard Evaluation 1993. ASTM, Philadelphia.
4. Bhat, I. A., Bhat, R. A. H. and Yousuf, D.J. 2021. A Textbook of Fish Toxicology, Narendra Publ. House, Delhi, (India).
5. Black, K.D. 2001. Environmental Impacts of Aquaculture. CRC Press
6. Burnell G, Allan, G. 2009. New Technologies in Aquaculture. 1st Edition. Woodhead Publishing Limited.
7. Cody R.P. and Smith, J.F. 1997. Applied Statistics and SAS Programming Language. Elsevier.
8. Dodds, Walter, K. 2002. Freshwater Ecology: Concepts and environmental applications. Academic Press, U.S.A.
9. Evans, D.H. and Claiborne, J.B. 2009. Physiology of Fishes. Fourth edition. CRC press.
10. Gjedrem Trygve et al. 2005. Selection and Breeding Programs in Aquaculture. Springer.
11. Gunderson, D.R. 1993. Surveys of Fisheries Resources. John Wiley and Sons, New York.
12. Halver and Hardy 2002. Fish Nutrition. An imprint. 3rd ed. Acad. Press.
13. Herwig, N. 1979. Handbook of Drugs and Chemicals used in the Treatment of Fish Diseases. Charles C Thomas, Springfield.
14. Hoboken, N.J. 2010. A Textbook of Modern Toxicology. John Wiley and Sons.
15. Jayaram, K.C. 2010. The freshwater fishes of the Indian Region. IInd edition. Narendra Publ. House, Delhi, (India).
16. Jhingran V.G. and Sehgal, K.L. 1978. Cold Water Fisheries of India. J. Inland. Fish. Soc. India. Sp. Publ.
17. Jhingran, V.G. 1975. Fish and Fisheries of India.
18. Kirpichnikov, V.S. 1981. Genetic Basis of Fish Selection. Springer-Verlag
19. Kocher, TD and Carol, A.S. (Edts.). 1997. Molecular Systematics of Fishes. Academic Press.
20. Liu, Zhanjiang (John). editor. 2017. Bioinformatics in Aquaculture: Principles and Methods 2017), Wiley Blackwell Publications.



21. Lynwood, Smith, S. 2003. Introduction to fish physiology. Narendra Publ. House, Delhi (India).
22. McGinn, N.A. editor. 2002. Fisheries in a changing climate. American Fisheries Society Symposium 32, Bethesda, MD.
23. Megrey, B. A. and Moksness, E. 2009.Computers in Fisheries Research. Springer, USA.
24. Mishra, B.K. 2007. Disease Management in Freshwater Pisciculture. Geeta Somani, Udaipur.
25. Pandey, B.N. 2011. Fisheries and Fish Toxicology. A. P. H. Publishing Corporation, New Delhi
26. Pillay, T.V.R. 1996. Aquaculture Principles and Practices. Blackwell Publishing, USA.
27. Purdom, C.E. 1993. Genetics and Fish Breeding. Chapman and Hall.
28. Wallingford, 2010. Fish Diseases and Disorders 2010. CABI, UK.
29. Welch, P.S. 1952. Limnology. McGraw Hill Book Co., New York.



ADVANCES IN BIODIVERSITY AND WILDLIFE

PhDZL-104(v)	Credit: 4	MM: 100	L(4):T(0): P(0)	60 Hours

Course Objectives:

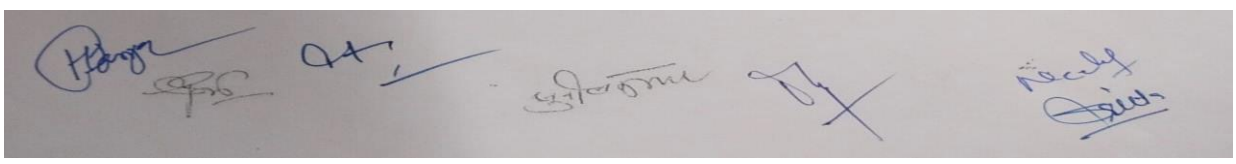
1. To provide students with a comprehensive understanding of the concepts, levels, patterns, and scales of biodiversity, emphasizing species distribution, abundance, evenness, and richness.
2. To Explore the significance of wildlife, including physiological adaptations, social organization, and the impact of wildlife on human welfare.
3. To Identify and analyze the various threats to biodiversity and wildlife, including habitat destruction, invasive species, and climate change.
4. To Equip students with the practical skills and ethical considerations necessary for conducting field studies on biodiversity and wildlife.
5. To Examine historical and contemporary conservation efforts, policies, and projects aimed at preserving biodiversity and wildlife in India and globally.
6. To Understand the legal and institutional frameworks supporting biodiversity and wildlife conservation nationally and internationally.

Course Learning Outcomes:

After successful completion of the programme, students will be able to:

1. Describe India's status as a megadiverse country, identifying biodiversity hotspots and biogeographic zones within the country.
2. Analyze the physiological adaptations of wildlife, including hibernation, migration, mimicry, and habitat-specific adaptations.
3. Critically assess the major threats to biodiversity and wildlife, including habitat destruction, climate change, and human-wildlife conflict.
4. Demonstrate proficiency in planning and conducting field surveys, employing various sampling methods, and using field equipment and techniques ethically and effectively.
5. Utilize qualitative and quantitative methods to record and evaluate field data, applying relevant statistical software and GIS tools.
6. Evaluate different conservation strategies, both in situ and ex situ, and understand the significance of national parks, wildlife sanctuaries, and other protected areas.
7. Summarize the key features of major environmental laws and regulations in India, and explain the roles of national and international conservation organizations.
8. Get the concepts of ecotourism and the importance of traditional knowledge and practices in biodiversity and wildlife conservation.
9. Develop critical thinking skills to propose innovative solutions to current conservation challenges, considering ecological, social, and legal perspectives.

NOTE: Instructions for setting question paper



The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

Biodiversity and Wildlife **(15 Hours)**

Concepts, definition, Levels of Biodiversity, Patterns and scales of Biodiversity (alpha, beta, and gamma), Concept of species distribution, Species abundance, species evenness and richness, Values and Importance of Biodiversity, Biodiversity Hot Spots, India as megadiverse country, Brief idea of Biogeographic zones of India, Biomes of world, Zoogeography

Basic concept, importance and significance of Wildlife, Wildlife and Human welfare

Physiological Basis of: Hibernation, Aestivation, Circadian rhythms, Mimicry, Migration (Fish and Bird), Social Organisation in Animals (Honey bee and Primates).

Adaptations to Habitats; Animal adaptations to water, temperature, salinity, predation, Deep Sea & diving adaptations in animals, High-altitude adaptation.

Keystone species, Umbrella species and Flagship species.

Wildlife of India, Endangered and Endemic faunal species of India,

Wildlife of Himachal Pradesh.

Threats to Biodiversity and Wildlife **(15 Hours)**

Habitat Destruction, Habitat Fragmentation, Impact of Invasive Species, Pollution, Over Exploitation, Poaching and Illegal Trade of Wildlife.

Major wildlife diseases and their control, Human-wildlife conflict.

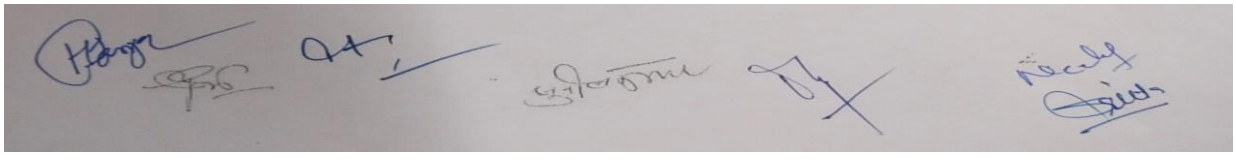
Global climate change and its effect on wildlife.

Methods to Study Biodiversity and Wildlife **(15 Hours)**

Planning and execution of Field surveys: Field surveys & observations, Sampling methods and identifying study sites, Different methods of transects & quadrates, Techniques of field observation Camouflages & Observation stations Non-intruding / non-interfering techniques of field observations

Indirect Evidence such as Pugmark, Scat and Pellet, Dung and Droppings, Camera trap methods Recording & Evaluation of Data: Field notebook and its records, Qualitative & Quantitative data, Field kit and its usage: Cameras, Binoculars, Camera traps etc.

Ethics in Field Studies: Dos & Don'ts in field studies, Regulatory permissions for field observations, Field collections and Field preservations



Methods to avoid Human-wildlife conflict: Electric Fencing, Trench Design, Line trapping, Mist netting and Pocket netting

Statistical software used in ecological studies: PAST, FLOCKER or any other software uses.

Introduction of GPS, Map making, QGIS (Open source GIS), Remote Sensing

Laws, Legislation and Statuary Bodies for Conservation of Biodiversity and Wildlife

(15 Hours)

History of Wildlife management and conservation in India

IUCN Threatened Categories, Threatened Wildlife Species of India and

Himachal Pradesh, Biodiversity and Wildlife Conservation: *In situ* conservation, National Parks,

Wildlife Sanctuaries, Biosphere Reserves, Community Reserve and

Conservation Reserve, Ramsar Sites. , *Ex situ* conservation, Gene Bank, Sperm

and Ova Bank, Seed Bank, Botanical Garden and Zoo, Captive Breeding

(e.g. Western Tragopan)

Protected Area Network in India and Himachal Pradesh.

Special projects for the conservation of Wildlife in India: Project Tiger, Project

Rhino, Project Elephant, Gir Lion Project, an account of conservation

measures for Snow Leopard and River Dolphin in India

Salient Features of Indian Forest Act 1927, Wildlife Project Act 1972, Biological

Diversity Act 2002.

Role of WWF, IUCN, Red Data Book. Convention on International Trade in

Endangered Species of Wild Fauna and Flora (CITES), ZSI and Wildlife Institute

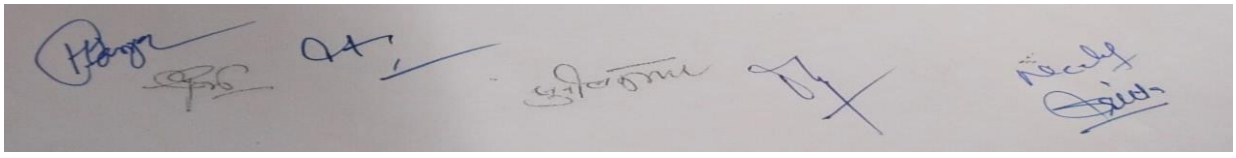
of India in the conservation of Biodiversity and Wildlife, Ramsar Convention.

Concept of Ecotourism, Traditional Knowledge, Practices for conservation

of Biodiversity and Wildlife.

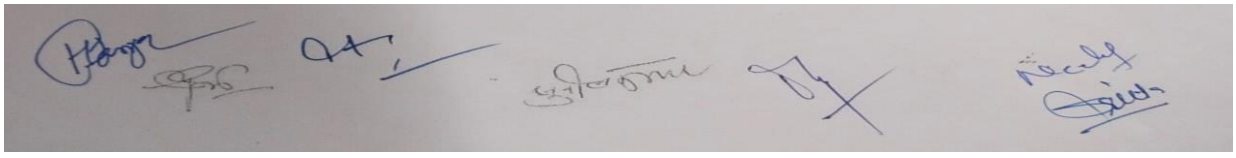
Suggested Readings:

1. Introduction to Biodiversity, Belsare DK, (2007) A. P. H. Publishing Corp. New Delhi.
2. A Textbook of Biodiversity, K.V. Krishnamurtys, 2003, Talor and Francis
3. Biodiversity, Wilson, E O (1998), National Academy Press, New York
4. Global Biodiversity: Status of Earth's Living Resources. Groombridge B. (2011) Chapman and Hall Publ. London
5. Threatened Animals of India, B.K. Tikadar. (1983) ZSI Publication, Calcutta.
6. Book of Indian Animals. Prater, S.H(1988) Bombay Natural History Society, Mumbai
7. Fauna of Himachal Pradesh, State Fauna Series, (2021). 26 (Part-1 and 2), Zool. Surv.



India, Kolkata)

8. Concepts in Wildlife Management. B. B. Hosetti. (2005) 2nd Revised & Enlarged Edn, 2005. Daya Publishing House, Delhi.
9. Wildlife Biology An Indian Perspective, Goutam Kumar Saha and Subhendu Mazumdar 2021, PHI Learning Private Ltd. Delhi
10. Zoogeography of India and Asia, Tiwari, S.K., CBS Publisher and Distributors, New Delhi.
11. Wildlife and Forest Conservation, Sinha, P.C., (1998) Anmol Publishing Pvt. Ltd., New Delhi.
12. Text Book of Wildlife Management, Singh, S.K. (2005) IBDC, Lucknow.
13. Wildlife and Forest Conservation, Sinha, P.C. (1998) Anmol Publishing Pvt. Ltd., New Delhi.
14. Remote Sensing: Principles and Applications, Sabbins, F.E., Freeman
15. Book of Indian Animals, Prater, S.H., Bombay Natural History Society, Mumbai.
16. The Ecology of Wildlife Diseases, Peter J. Hudson, Annapaola Rizzoli, Bryan T. Grenfell, Hans Heestrbeek and Andy P. Dobson (2002), Oxford University Press, Oxford
17. Handbook of Environment, Forest and Wildlife Protection Laws in India, Justice Kuldip Singh (1998), Natraj Publishers, Dehradun



ADVANCES IN BIOCHEMISTRY

PhDZL-104(vi)	Credit: 4	MM: 100	L(4):T(0): P(0)	60 Hours

Course Objectives:

The students will be able to undertake investigations and perform analyses that provide information about biochemical questions and help to solve biochemical problems.

Course Learning Outcomes:

Students may get knowledge about chemistry of life, including molecules and biochemical reactions Explain the physiopathological bases and the biochemical markers of the most prevalent diseases in our population.

NOTE: Instructions for setting question paper

The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

Covalent Properties of Proteins, **(15 Hours)**

Protein sequencing

Protein splicing

Covalent modifications.

Protein Structure and Folding **(15 Hours)**

Protein tertiary structure and folding.

Folding overview.

Condensation and molten globules.

Amino acid sequence variations and membrane proteins folding.

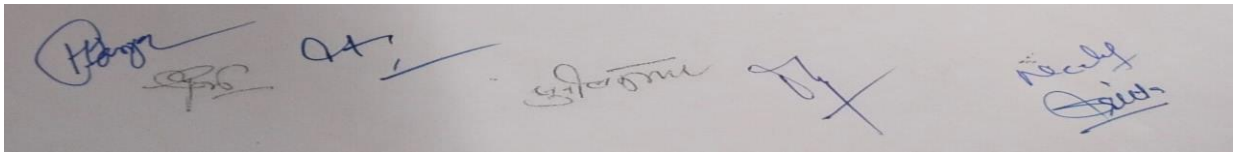
Chaperonin-assisted protein folding.

Enzyme **(15 Hours)**

Enzyme-substrate complementarity and the use of binding energy in catalysis.

The factors associated with catalytic, proximity and orientation distortion,

Enzyme purification by various methods and establishment of homogeneity



of purified enzymes.

Enzyme characterization, Allosteric enzymes, properties, Kinetics and co-operatively, hill and Scatchard plot.

Medical Biochemistry and Molecular Biology (15 Hours)

Digestive disorders; diseases of kidney and diseases of respiratory system

Diseases of cardiovascular system and diseases of respiratory system

Infectious diseuses.

Important prophylactic enzymes involve in various diseases.

Free radicals and antioxidant enzymes in various diseases with special reference to parasitic diseases.

Molecular markers in genome analysis; RELP, RAPD and AFLP analysis.

Application of RFLP m forensic disease prognosis.

DNA probes in diagnostic.

Suggested Readings

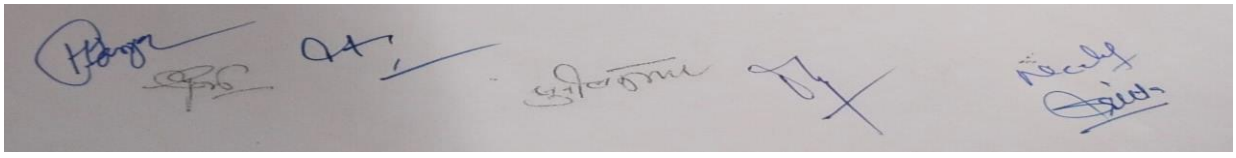
1. Clinical Biochemistry. Hawks

2. Enzymology, Dixon

3. Segel, LH.: Enzyme Kinetics, Wiley, NowYork1995.

4. White and Smith, Principals of Biochemistry. McGraw-Hill Now Yark, 1978.

5. Molecular Biology and Biotechnology, A Comprehensive desk references, R.A. Meyers, VCH Publishers, Now-York



ADVANCES IN PARASITOLOGY

PhDZL-104(vii)	Credit: 4	MM: 100	L(4):T(0): P(0)	60 Hours

Course Objectives:

The main objectives of this course is to make students capable of recognizing parasites which are important for human health and cause diseases.

Course Learning Outcomes:

i. Describe specific human and non-human parasitic diseases. Prepare and observe live parasitic specimens and test students' own seropositivity for a particular parasitic infection.

ii. Emphasis is placed throughout on the basic biology of the pathogens and their host-parasite relationships.

NOTE: Instructions for setting question paper

The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

Introduction to Parasitology **(15 Hours)**

Pathogenesis due to protozoan and helminth parasites.

In vitro culture of protozoan and helminth parasites

Parasitic Physiology **(15 Hours)**

Physiology of helminth parasites:

(a)feeding nutrition (b) carbohydrate, lipid and protein metabolism (c) electron transport.

Biology of egg and larval forms in helminths

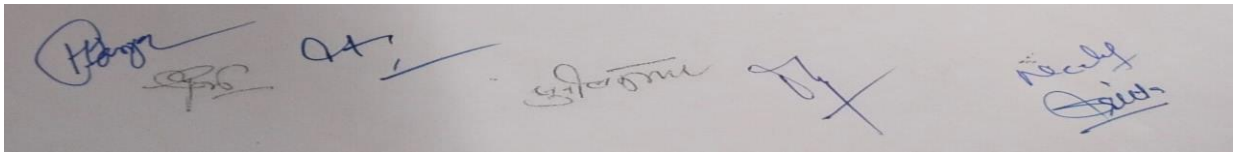
Exheating and hatching mechanism in helminth parasites.

Ecology of parasites **(15 Hours)**

Immunity to protozoan and helminth parasites.

Parasite Identification **(15 Hours)**

Identification of helminth parasites



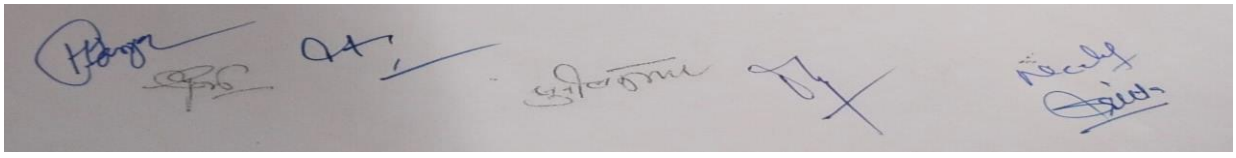
Characters of taxonomic importance

(ü) Problems in specialization in dioecious parasites

(iii) Rules of Zoological nomenclature.

Suggested Readings

1. Cheng, T.C. General parasitology Academic Press, Inc. (1986)
2. Noble, E.R. and Noble, G.A: Parasitology, The biology of Animal parasites Lea and Fabiger
3. Andeson, D.R.: Comparative Protozoology, Cambridge Uni. Press.
4. Chandler, A.C. and Read, C.P.; Introduction of Parasitology, Willy Eastern,
5. Belding, D.A. A text book of Prasitology, Meredith pub. Co.
6. Baker, J.R. Parasitic Protozoa, Academic Press
7. Grell, K.G. Protozoology, Springer Verlag



ADVANCES IN RADIATION BIOLOGY

PhDZL-104(viii)	Credit: 4	MM: 100	L(4):T(0): P(0)	60 Hours

Course Objectives:

Explain the principles of radiation protection for both ionizing and non-ionizing radiation. Understanding the dose-response curves.

Course Learning Outcomes:

i. Students also learn to evaluate patient for effects, reactions and therapeutic responses; demonstrate effective oral and written communication skills; apply basic research methods; and formulate methods for the pursuit of lifelong learning.

ii. To conduct basic and translational research to elucidate the molecular mechanisms underlying cellular responses to ionizing radiation and chemotherapy focusing on critical cellular responses that include DNA repair, cellular senescence, cell proliferation cell death and inflammation.

NOTE: Instructions for setting question paper

The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

Histopathology **(15 Hours)**

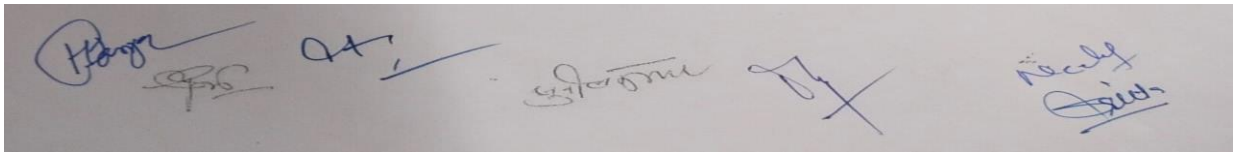
Histopathological studies on effects of Early radiation: lethal effects, Prodromal radiation; Gastrointestinal tract with syndrome, associated glands, haemopoietic system and blood, reproductive system, Life-shortening and cataractogenesis

Cell Kinetics **(15 Hours)**

Cell population kinetics, techniques of cell population kinetics and analysis of cell survival Curves, Imaging, Tomography, magnetic resonance imaging, radioimmunoassay.
Uses of various radioisotopes in therapy and diagnosis.

Clinical Radiotherapy **(15 Hours)**

Clinical radiotherapy- teletherapy, particle therapy, dose fractionation, oxygen effect, hyperthemia and chemicals in radiotherapy.



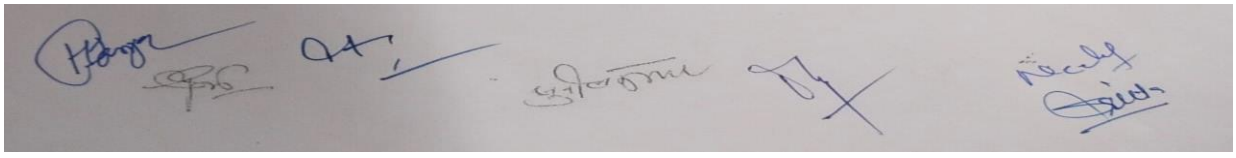
Application of Radio immune scintigraphy and Radio immuno therapy in the management of cancer.

Radiation Biology Laboratory **(15 Hours)**

Design of Radioisotope Laboratory: Floor and room plans, hood and glove box, remote handling of equipment, isotope, storage, isotope waste monitoring disposal, radiation equipment, and control of contamination.

Suggested Readings

1. Fundamentals in radiation biology by Susan B Klein (*Indiana University, USA*) and Marc S Mendonca (*Indiana University, USA & Purdue University, USA*)
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Biology: A Handbook for Teachers and Students, Training Course Series No. 42, IAEA, Vienna (2010)



ADVANCES IN MICROBIAL PHYSIOLOGY AND GENETICS

PhDZL-104(ix)	Credit: 4	MM: 100	L(4):T(0): P(0)	60 Hours

Course Objectives:

To demonstrate comprehensive knowledge and understanding of the structural and metabolic diversity of microorganisms

Course Learning Outcomes:

i. Demonstrate critical understanding of genetic and physiological regulation in microorganisms.

ii. Microbial genetics is also important for understanding molecular techniques used to modify genes and proteins, manipulate bacteria, archaea, and eukaryotic organisms for fundamental research as well as practical applications in diverse areas of medicine and biotechnology.

NOTE: Instructions for setting question paper

The examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

Course Content

Introduction **(15 Hours)**

Principles of Microbial nutrition, approximate elementary con position of microbial cells, requirements of Carbon, Nitrogen, Phosphorus, Sulphur, Oxygen and Principal micronutrients (elements). Nutritional categories or Microbes, glucose and amino acid transport in microbes.

Media Preparation **(15 Hours)**

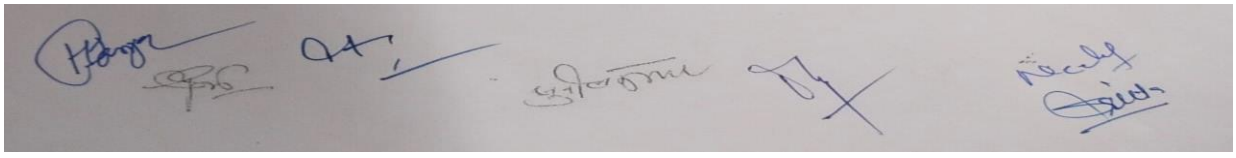
Composition of culture media, complex media, selective media, Mineral media, enrichment media, defined media, Isolation of pureline cultures, maintenance & Preservation of microbes, Microbial growth, phases of growth and measurement of growth.

Concept of Energy, Pathways involving substrate level phosphorylation, oxidative phosphorylation Photosynthesis, carbohydrate metabolism

Biochemical Metabolisms **(15 Hours)**

Protein metabolism, lipid metabolism, Purine and Pyrmidine metabolism.

Mutations & Mutagenesis: Types of mutagenesis, Biochemical basis of



mutations, spontaneous and induced mutations. Isolation of mutants, Replica plating, site directed mutagenesis. Conditional mutants, Reversion of mutations.

Recombination: General Recombination, site specific, recombination,

composite transposons, the tri-3-type transposons, transposable, Replication of transposable phage by transposition, transposable phage.

DNA Repair Mechanisms **(15 Hours)**

DNA repair mechanisms: DNA repair mechanism DNA damage in bacteria, photoreactivation, excision (dark repair, recombination, post replication repair, SOS repair system).

Structure of plasmid, Functions of plasmid, Replicator of Plasmids, Plasmid incompatibility, Conjugative plasmids, conjugation, DNA transfer, Integration and Hfr strains and F' factors.

Structure of bacteriophage, a typical phage life cycle, lysogenic life cycle, growth & assay for phage, RINA phage, single-stranded DNA phage, double standard DNA phage, Mn-whole mechanism of

Transfer of genetic material: Conjugation, transduction, transformation, Natural transformation, competence and uptake of DNA, Ame's test, Activation of carcinogens, treatment of *Salmonella typhimurium* cells with activated carcinogens, Reversion of mutants for histidine.

Transduction: Generalised and specialized transduction,

Types of transposons, detection of transposition in bacteria, Insertion

sequences, Excision of transposons, Genetic phenomena mediated by transposons in bacteria.

Suggested Readings:

1. Daniel Lim; Microbiology; 2nd edition, WCB McGraw Hill, 1998.

2. J. Nicklin: Instant notes on Microbiology, viva books Pvt. Ltd. 1999.