# Central University of Punjab
# Bathinda

## M.Sc. Zoology

## Academic Session: 2021–23

## Department of Zoology
## School of Basic Sciences

**Graduate Attributes:**

Through participation in theory and practical courses offered by the M.Sc. program of the department as well as through the research hands on training i.e. dissertation, graduates will be able to acquire in-depth-understanding of relevant concepts and develop research aptitude and critical thinking. They will also able to design scientific experiments and carry out research independently as well as in a team. We also believe that students will able to formulate scientific questions, exchange scientific ideas with fellow colleagues, analyze, troubleshoot and summarize the research data. Students will apply domain-specific knowledge to explore feasible solutions for relevant problems of national and global relevance associated with life science subjects.

**Semester – I**

| **Course Code** | **Course Title** | **Type of course** | **L** | **T** | **P** | **Cr** |
|---|---|---|---|---|---|---|
| | **Core Courses** | | | | | |
| **ZOL.508** | Biochemistry | **Core** | 3 | 0 | 0 | 3 |
| **ZOL.511** | Cell Biology | **Core** | 3 | 0 | 0 | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **ZOL.516** | Animal Evolution and Classification | **Core** | 3 | 0 | 0 | 3 |
| **ZOL.517** | Ecological Principles | **Core** | 3 | 0 | 0 | 3 |
| **ZOL.520** | Lab Course (Practical) – I | **SB** | 0 | 0 | 10 | 5 |
| | **Discipline Elective (Opt any one)** | | | | | |
| **ZOL.514** | Animal Cell Culture and Applications | **DE** | 3 | 0 | 0 | 3 |
| **ZOL.525** | Nanobiology | **DE** | 3 | 0 | 0 | |
| **ZOL.527** | Essentials of Genetics | **DE** | 3 | 0 | 0 | |
| **MME.527** | Stem Cell and Regenerative Medicine | **DE** | 3 | 0 | 0 | |
| **HGE.527** | Human Embryology and Developmental Genetics | **DE** | 3 | 0 | 0 | |
| | **Interdisciplinary (ID) Course** | | | | | |
| **ZOL.515** | Fundamentals of Cell Biology (for students of other departments) | **IDC** | 2 | 0 | 0 | 2 |
| **ZOL.528** | Basics in Neuroscience (for students of other departments) | **IDC** | 2 | 0 | 0 | |
| **ZOL.560** | Basics in Nanobiology (for students of other departments) | **IDC** | 2 | 0 | 0 | |
| **XXX.XXX** | For our department students | **IDC** | 2 | 0 | 0 | |
| | **Total Credits** | | | | | **22** |

**L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; IDC: Interdisciplinary Course; SB: Skill based Course**

MOOCs may be opted up to 40% of the total credits (excluding dissertation credits). MOOC may be opted in lieu of any course but content of that course should match a minimum 70%. Mapping will be done by the Department, and students may be informed accordingly.

**Semester – II**

| Course Code | Course Title | Type of course | L | T | P | Cr |
|---|---|---|---|---|---|---|
| | **Core Courses** | | | | | |
| **ZOL.521** | Animal Physiology | **Core** | 3 | 0 | 0 | 3 |
| **ZOL.522** | Immunology | **Core** | 3 | 0 | 0 | 3 |
| **ZOL.523** | Molecular Biology | **Core** | 3 | 0 | 0 | 3 |
| **ZOL.574** | Animal Behavior | **Core** | 3 | 0 | 0 | 3 |
| **ZOL.540** | Lab Course (Practical) – II | **SB** | 0 | 0 | 10 | 5 |
| | **Discipline Elective (Opt any one)** | | | | | |
| **ZOL.529** | Genetic Engineering | **DE** | 3 | 0 | 0 | 3 |
| **ZOL.554** | Neurobiology and Degenerative pathophysiology | **DE** | 3 | 0 | 0 | |
| **ZOL.553** | Vascular Biology | **DE** | 3 | 0 | 0 | |
| **ZOL.572** | Endocrinology | **DE** | 3 | 0 | 0 | |
| **LBI.526** | Biomolecular Structure Modelling and Drug Designing | **DE** | 3 | 0 | 0 | |
| | **Value Added Course** | | | | | |
| **ZOL.559** | Scientific writing | **VAC** | 2 | 0 | 0 | 2 |
| | **Total Credits** | | | | | **22** |

**L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; IDC: Interdisciplinary Course; SB: Skill-based Course.**

MOOCs may be opted up to 40% of the total credits (excluding dissertation credits). MOOC may be opted in lieu of any course but content of that course

should match a minimum 70%. Mapping will be done by the Department and students may be informed accordingly.

**Semester – III**

| Course Code | Course Title | Type of course | L | T | P | Cr |
|---|---|---|---|---|---|---|
| | **Core Courses** | | | | | |
| **ZOL.513** | Techniques in Life Sciences | **Core** | 3 | 0 | 0 | 3 |
| **ZOL.551** | Developmental Biology | **Core** | 3 | 0 | 0 | 3 |
| | **Discipline Elective (Opt any one)** | | | | | |
| **ZOL.552** | Cancer Biology | **DE** | 3 | 0 | 0 | 3 |
| **ZOL.577** | Reproductive Physiology | **DE** | 3 | 0 | 0 | |
| **ZOL.578** | Insect Biology | **DE** | 3 | 0 | 0 | |
| **BCH.526** | Clinical Diagnostics | **DE** | 3 | 0 | 0 | |
| **HGE.555** | Biosafety, Bioethics and Intellectual Property Rights | **DE** | 3 | 0 | 0 | |
| | **Compulsory Foundation Courses** | | | | | |
| **ZOL.556** | Research Methodology | **CF** | 3 | 0 | 0 | 3 |
| **ZOL.557** | Basic Statistics for Sciences | **CF** | 3 | 0 | 0 | 3 |
| **ZOL.558** | Entrepreneurship | **CF** | 1 | 0 | 0 | 1 |
| | **Discipline Enrichment course** | | | | | |
| **ZOL.575** | Career Prospects in Life Sciences | **DEC** | 2 | 0 | 0 | 2 |
| **ZOL.600** | Research Proposal | **SB** | - | - | 8 | 4 |
| | **Total Credits** | | | | | **22** |

**L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; VB: Value-based Course; SB: Skill-based course; #CF: Compulsory Foundation Course**

MOOCs may be opted up to 40% of the total credits (excluding dissertation credits). MOOC may be opted in lieu of any course but content of that course should match a minimum 70%. Mapping will be done by the Department and students may be informed accordingly.

**Semester – IV**

| **Course Code** | **Course Title** | **Type of course** | **L** | **T** | **P** | **Cr** |
|---|---|---|---|---|---|---|
| **ZOL.600** | Dissertation | **SB** | 0 | 0 | 40 | 20 |
| | **Total Credits** | | | | | **20** |

**L: Lectures; T: Tutorials; P: Practical; Cr: Credits; SB: Skill-based Course**

**Students will have an option to carry out dissertation work in industry, national institutes or Universities in the top 100 NIRF ranking.**

**Total Credits Distribution:**

| S.N. | Types of Courses | Total Credits |
|---|---|---|
| 1 | Core | 30 |
| 2. | Skill based including Dissertation/Internship | 34 |
| 3. | Value based | 02 |
| 4. | Discipline Elective | 09 |
| 5. | Discipliner Enrichment | 02 |
| 6. | Interdisciplinary (ID) | 02 |
| 7. | Compulsory Foundation | 07 |
| | **Total** | **86** |

**Evaluation Criteria for Theory Courses: 100 marks**

**A. Continuous Assessment: 25 Marks**

**B. Mid Semester Test: 25 marks**

**C. End-Term Exam: 50 marks**

**Evaluation Criteria for Practical Courses: 100 Marks**

1. Internal Assessment **50 Marks**

- Attendance: 10 Marks
- Continuous assessment: 30 Marks
- Lab records: 10 Marks

2. End-semester exam **50 Marks**

- Major Question: 20 Marks
- Minor Question: 10 Marks
- Viva-voce: 20 Marks

**Evaluation Criteria for Research proposal and Dissertation: 100 Marks**

The evaluation of the dissertation proposal will carry 50% weightage by supervisor and 50% by HoD and senior-most faculty of the department.

| Research Proposal/ Dissertation (Third and Fourth Semester) | | |
|---|---|---|
| | Marks | Evaluation |
| Supervisor | 50 | Dissertation proposal and presentation |

| | | |
|---|---|---|
| HoD and Senior Faculty of the department | 50 | Dissertation proposal and presentation |

## SEMESTER – I

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Code: ZOL.508**
**Course Title: Biochemistry**
**Teaching hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Define fundamentals and basics of biochemistry
- Illustrate a thorough knowledge of the intersection between the disciplines of biology and chemistry
- Explain advanced aspects of biochemistry such as nutrition and metabolism associated with human physiology and diseases
- Develop a comprehensive knowledge of the theory and practice of modern biochemistry and its application to solve chemical problems

**Unit I** **12 Hours**

Bioenergetics and Biomolecules: Thermodynamics, Internal Energy Enthalpy, Entropy, Concept of free energy, standard free energy. Relationship between equilibrium constant and standard free energy change. Biological oxidation-

reduction reactions. Classification, structure, general properties and functions of polysaccharides, Lipids, Proteins and Nucleic acids.

**Exercise:** Brainstorming, Presentation, Quizzes, Paper discussion

**Unit II** **11 Hours**

Enzymology: Historical perspective, general characteristics, nomenclature, IUB enzyme classification, measurement and expression of enzyme activity, enzyme assay, factors influencing enzyme activity, active site, Michaelis-Menten equation and its importance. Definitions of IU, Katal, enzyme turnover and specific activity. Industrially and clinically important enzymes.

**Exercise:** Brainstorming, Presentation, Quizzes, Paper discussion

**Unit III** **11 Hours**

Carbohydrate and Lipid Metabolism: Glycolysis, gluconeogenesis, TCA cycle, hexose monophosphate (HMP) shunt, disorders of carbohydrate metabolism. Biosynthesis and oxidation of saturated and unsaturated fatty acids, and disorders of lipid metabolism.

**Exercise:** Brainstorming, Presentation, Quizzes, Paper discussion

**Unit IV** **11 Hours**

Amino Acid and Nucleic Acid Metabolism: Biosynthesis of protein, general catabolism of amino acids, deamination, transamination, urea cycle, disorders of amino acid metabolism. Biosynthesis of purine and pyrimidine nucleotides, disorders of purine and pyrimidine metabolism.

**Exercise:** Brainstorming, Presentation, Quizzes, Paper discussion

**Mode of Transaction**

**The classroom learning would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brainstorming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2010). Biochemistry. W.H. Freeman & Company. USA.
2. Mathews, C. K., Van Holde, K. E. and Ahern, K. G. (2000). Biochemistry. Oxford University Press Inc. New York.
3. Nelson, D. and Cox, M. M. (2008). Lehninger Principles of Biochemistry. BI publications Pvt. Ltd. Chennai, India.
4. Shukla, A. N. (2009). Elements of Enzymology. Discovery Publishing. New Delhi, India.
5. Voet, D. and Voet, J. G. (2008). Principles of Biochemistry. CBS Publishers & Distributors. New Delhi, India.

**Web sources:**
**https://epgp.inflibnet.ac.in/Home**
**https://lms.cup.edu.in/course/index.php?categoryid=76**

**Course Code: ZOL.511**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Title: Cell Biology**
**Total Hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Define the structure and basic components of a cell
- Distinguish the structure of prokaryotic and eukaryotic cell
- Explain macromolecules, membranes, organelles and their related functions in cell and molecular biology
- Develop a basis for understanding the basic cell physiology and disease processes in which signaling is compromised

**Unit I** **12 Hours**

**Cell evolution and Membrane Structure and Function:** Evolution of the cell, molecules to cell, prokaryotes and eukaryotes, Models of membrane structure, membrane proteins, membrane carbohydrates, membrane transport types, passive, active transport, transport of small molecules and membrane transport of macromolecules.

**Exercise:** Brainstorming, Presentation, Quizzes, Paper discussion

**Unit II** **11 Hours**

**Structural Organization and Function of Intracellular Organelles:** Lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum and its types, Structure and function of mitochondria and nucleus.

**Exercise:** Brainstorming, Presentation, Quizzes, Asking Questions

**Unit III** **11 Hours**

**Cytoskeleton and Cell Communication:** The nature of cytoskeleton, intermediate filaments, microtubules, actin filaments, cilia and centrioles, organization of the cytoskeleton. Cell adhesions, cell junctions, cell-cell adhesion and communication and cell-extracellular matrix interaction.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit IV** **11 Hours**

**Cell Cycle and signaling pathways:** Mitosis and meiosis, cell cycle and their regulation, Introduction to cell signalling: signalling networks, protein phosphorylation/dephosphorylation, Intracellular signalling pathways: covering the major pathways in cells (MAPK, PI3K-AKT, JAK-STAT, and NF-kB) and key roles of protein kinases and phosphatases.

**Exercise:** Brainstorming, Presentation, Quizzes, Content Focus

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brainstorming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J. D. (2015). Molecular Biology of the Cell. Garland publishers, Oxford.
2. Celis, J. E. (2006). Cell Biology: A Laboratory Handbook, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P. K. (2012). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.
5. Gupta, P. K. (2005). Cell and Molecular Biology. Rastogi publications, Meerut, India. James, D. W., Baker, T.A., Bell, S.P., Gann, A. (2009). Molecular Biology of the Gene. Benjamin Cummings, USA.
6. Johnson, A., Lewis, J., Raff, M. (2007). Molecular Biology of the Cell. Garland Science, USA.

7. Lodish, H., Berk, A., Chris, A. K. and Krieger, M. (2008). Molecular Cell Biology. W.H. Freeman, USA.
8. https://epgp.inflibnet.ac.in/Home
9. https://www.vlab.co.in/
10. https://lms.cup.edu.in/course/index.php?categoryid=76

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Code: ZOL.516**
**Course Title: Animal Evolution and Classification**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe how life and organisms evolved, forces that drive the evolution and diversity of life forms
- Illustrate the evidence for evolution and its required corollaries
- Analyze the processes of evolution by mutation, migration, genetic drift, non-random mating and natural selection
- Develop knowledge on updated animal classification system

**Unit I** **12 Hours**

**Evolution:** Macroevolutionary concepts and processes, Microevolution: Darwin & the origin of species, Natural selection: Concept, Selection against recessive, recessive lethal, dominant & heterozygote advantage Genetic drift & Mutation: Founder and bottleneck effect. Mutation-Selection Balance, Drift balance, Genetic and Mutational load, Gene flow, Hardy Weinberg law: Speciation: biological species concept, allopatric, sympatric and parapatric speciation, concept of hybrid zone, latest evolutionary trends and research.

**Unit II** **10 Hours**

**Systematics:** Binomial nomenclature; three domain classifications; phylogenetic tree construction; applications of phylogeny; cladistics: monophyletic, paraphyletic and polyphyletic groups; shared and derived characters; homoplasy; parsimony analysis; molecular clocks.

**Unit III** **12 Hours**

**Non-chordates:** Phylums porifera, cnidarian, Platyhelminthes, Rotifera, Lopophorates, Mollusca, Annelida, nematode, Arthropoda, Echinodermata.

**Unit IV** **12 Hours**

**Chordates:** Overview of chordates: cephalochordate, urochordata, Myxini, Petromyzontida, Chondrichthyes, Actinopterygii, Actinistia, Dipnoi, Amphibia, Reptilia and Mammalia; Important concepts of Biodiversity and Indian Biodiversity and Conservation

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Flipped Classroom approach, Digital learning, Project Method, Activity-based, Field-based, Seminars, Group discussions, Focused group discussions, brainstorming sessions, E-tutoring, Dialogue Mode, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, textbook reading assignments and case studies.

**The following tools shall be used in teaching and practicals:**

Textbooks, GoI e-learning platforms, powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**


1. Evolution: Making sense of life by Carl Zimmer and Douglas Emlen, 2020, 3rd Edition
2. Evolution by Carl T. Bergstrom, Lee Alan Dugatkin, 2016. 2nd Edition
3. Modern textbook of Zoology: Vertebrates by R.L. Kothpal, 2019-20, 4th Edition
4. Modern textbook of Zoology: Invertebrates by R.L. Kothpal, 2019-20, 12th Edition
5. Mayr, E. & Ashlock, P.D., Principles of Systematic Zoology. 1991. 2nd edition. McGraw Hill International Edition
6. Relevant research articles and digital resources


| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Code: ZOL.517**

**Course Title: Ecological Principles**

**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe the process of interaction among the living organisms with their environment
- Explain energy flow and the movement and recycling of matter in communities and ecosystems
- Develop a broad understanding of the processes that shape the distribution and abundance of organisms

**Unit I** **10 Hours**

**Introduction to Ecology:** Habitat and niche, niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Adaptation, ecosystem, biotic and abiotic factors, food chain, food webs, trophic levels. Biomes: types (terrestrial and aquatic), distribution and unique features. Biomes: types (terrestrial and aquatic), distribution and unique features, Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Field visit

**Unit II** **12 Hours**

**Community ecology and biogeography**: Nature of communities; community structure and attributes; richness and evenness; keystone species, flagship species and umbrella species; dominant species, ecotone, edge effect, ecotypes, plant indicators; ecological succession – types and mechanism; MacArthur and Wilson's island biogeography equilibrium theory-limitations and modifications; colonization vs. extinction; species area relationship.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Field visit

**Unit III** **11 Hours**

**Ecosystem Dynamics:** Concept and components of ecosystem, ecological pyramids, energy flows in different ecosystems, energy models, ecosystem productivity. Types and characteristics of ecosystem- terrestrial (forest, desert, grassland) and aquatic (pond, marine), wetlands, estuaries, natural and manmade ecosystems, forest types in India. Biogeochemical cycles – cycling of water, nutrients.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Field visit

**Unit IV** **12 Hours**

**Population Ecology:** Population characteristics, population interaction; prey-predator relationships; Theories of population growth, population dynamics, regulation. Population growth curves; population regulation; life history strategies (*r* and *K* selection); Concept of metapopulation, demes and dispersal, niche-concept and types, interdemic extinctions, age structured populations

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Field visit

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching and practicals:**

Textbooks, GoI e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**


1. Urry, L. A. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
2. Smith, T. M. and Smith, R. L. (2015). Elements of Ecology. Benjamin Cummings Publishing Company, 9th edition.
3. Begon, M., and Townsend, C. R. (2021). Essentials of Ecology. Wiley Publishers, 5th edition.
4. Odum, E. and Barrett, G. W. (2005). Fundamentals of Ecology. Cengage Learning, 5th edition.
5. Relevant research articles and digital resources


**Course Code: ZOL.520**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 10 | 5 |

**Course Title: Lab Course (Practical) – I**

**Total Hours: 150**

**Learning Outcomes:** After going through the course the learners will be able to

- Acquaint students with a fundamental knowledge of the lab instrumentation and reagents preparation
- Illustrate biochemical estimation of biomolecules
- Demonstrate different techniques involved in biomolecule separation
- Illustrate techniques and procedures routinely used in the core courses offered in the semester

1. Laboratory instrumentation
2. Preparation of Buffers and Solutions
3. Biochemical estimation and analysis of Proteins, Lipids and Carbohydrates
4. SDS-and native polyacrylamide gel electrophoresis
5. Gel filtration and Ion-exchange chromatography
6. Cell structure: Compound, Fluorescence, and Electron microscopy
7. Histochemistry: Fixation, Sectioning, Embedding, Processing and Staining
8. Immunocytochemistry
9. Identification of cell mitosis and meiosis stages
10. Life cycles of Silkworm
11. Life cycle of the honeybee
12. Measurement Frequency and abundance of plant communities
13. Mark recaptures method
14. Isolation of Lymphocytes from whole blood

15. Cell trypsinization and Cell count (Hemocytometer)
16. MTT Assay
17. *In vitro* free radicals-based assays

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brainstorming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Sambrook, J. (2006). The Condensed Protocols from Molecular Cloning: A Laboratory Manual. Cshl Press. New York.
2. Sambrook, J. and Russell, D. W. (2000). Molecular Cloning: A Laboratory Manual (3 Vol-set). 3rd Edition, CSHL Press, New York.
3. **https://epgp.inflibnet.ac.in/Home**
4. **https://www.vlab.co.in/**
5. **https://lms.cup.edu.in/course/index.php?categoryid=76**


## Discipline Elective Courses:

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Code: ZOL.514**

**Course Title: Animal Cell Culture and Applications**

**Total hours: 45 hours**

**Learning outcomes:** After going through the course the learners will be able to

- Describe the foundational knowledge of cell culture techniques and competence in laboratory techniques
- Explain problems common to routine cell culture

- Develop a thorough knowledge on application of molecular techniques to *in vitro* conditions

**Unit I** **11 Hours**

**Introduction to Animal Cell Culture:** Historical background. Good Laboratory Practices (GLP), sterilization methods and techniques. Biology of animal cell and cell-cell interactions, growth environment and culture requirement. Culture, subculture, cell line, cell strain, cell clone. Importance of serum and serum-free media.

**Exercise:** Brainstorming, Presentation, Quizzes, Content Focus

**Unit II** **12 Hours**

**Cell Culture Types and Characterization:** Primary cell culture, tissue culture, organ culture, cell line immortalization, cell line preservation & characterization, karyotype analysis, cellular markers, commercial cell lines, and insect cell culture.

**Exercise:** Brainstorming, Presentation, Quizzes, Asking Questions

**Unit III** **12 Hours**

**Applications of Animal Cell Culture:** *In vitro* transfection of animal cells, cell-based assays, and cell differentiation and movement. Cancer Research, vaccine manufacture, gene and stem cell therapy, production of recombinant proteins, and toxicology studies.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit IV** **10 Hours**

**Translational Research Applications:** Animal cells as the applicable products (recombinants, hybridomas, stem cells and transplants). Focus on Rodent and murine models in scientific research associated with cancer and neurodegenerative diseases.

**Exercise:** Brainstorming, Presentation, Quizzes, Paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Freshney, R. I. (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 2010. 6th Edition.
2. Davis, J. M. (2008). Basic Cell Culture. Oxford University Press. New Delhi.
3. Davis, J. M. (2011). Animal Cell Culture. John Willy and Sons Ltd. USA.
4. Freshney R. I. (2005). Culture of Animal Cells. John Willy and Sons Ltd. USA.
5. Butler, M. (2004). Animal Cell Culture and Technology. Taylor and Francis. New York, USA.
6. **https://epgp.inflibnet.ac.in/Home**
7. **https://www.vlab.co.in/**
8. **https://lms.cup.edu.in/course/index.php?categoryid=76**


| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Code: ZOL.525**
**Course Title: Nanobiology**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Define the interdisciplinary knowledge of basic concepts of nanoscience and biomaterials
- Explain characterization of techniques and biomedical aspects of nanomaterials
- Apply learned knowledge to develop nanomaterials

**Unit I** **11 Hours**

**Nanoscience**: Definition and concepts, nanomaterials classification, properties, applications, Criteria for suitability of nanostructures for biological applications.

**Unit II** **12 Hours**

**Nanomaterials**: Synthesis, biofunctionalization and characterization techniques like electron microscopy (scanning and transmission), atomic force microscopy; nanoparticle analyzer, zeta potential measurement, flow cytometry, spectroscopic techniques including spectrophotometer, spectrofluorimeter & FTIR.

**Unit III** **11 Hours**

**Materials in Medicine**: Biomaterials, Theranostics, Nanostructures for drug delivery and therapeutics, biosensor, electrochemical biosensor, bioimaging and point-of-care diagnostics tools including flow immunoassay and microfluidic devices.

**Unit IV** **11 Hours**

**Nanotoxicity**: Effect of nanomaterials on human health, nanomaterial-cell interaction and characterization, *in vitro* nanotoxicity assays, recent progress and challenges in the risk assessment of nanomaterials.

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Bagchi, D., Bagchi, M., Mariyama, H. and Shahidi, F. (2013).BioNanotechnology: A Revolution in Food, Biomedical and Health Sciences. Wiley–Blackwell publication.
2. Rai, M., Duran, N. and Southam, G. (2011). Metal Nanoparticles in Microbiology. Springer publication.
3. Udupa, N., Gupta, P. D. (2009). Nanotechnology in Health Care. Shyam Prakashan publication.
4. Xie, Y. (2012). The Nanobiotechnology Handbook. CRC Press.
5. Murty, B. S., Shankar, P., Raj, B., Rath, B. B.and Murday, J. (2013). A Textbook of Nanoscience and Nanotechnology. Tata Mc Graw Hill Publication.


**Course Code: ZOL.527**

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**Course Title: Essentials of Genetics**

**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Comprehensive understanding of the molecular basis of heredity
- Distinguish Mendelian and Non-Mendelian genetics

- Explain how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc

**Unit I** **12 Hours**

**Mendelian Principles and Concept of Gene:** Dominance, segregation, independent assortment, allele, multiple alleles, pseudoallele, complementation tests Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

**Unit II** **12 Hours**

**Gene Mapping Methods:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by somatic cell hybrids, development of mapping population.

**Human Genetics:** Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders. **Quantitative Genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping.

**Unit III** **11 Hours**

**Gene Concept:** Fine structure of gene, Benzer's experiments, complementation analysis and recombination. **Recombination:** Sitespecific, homologous, transposition and non-homologous end joining (NHEJ). **Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, applications in reverse and forward genetics, mutations and Hardy Weinberg equilibrium, molecular basis of spontaneous and induced mutations.

**Unit IV** **10 Hours**

**Extra-Chromosomal Inheritance:** Chloroplast and mitochondrial inheritance, structural and numerical alterations of chromosomes: deletion, duplication, inversion, translocation, Ploidy and their genetic implications.

**Mode of Transaction**

**The classroom learning/practical/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**

1. Anthony, J. F., Miller, J. A., Suzuki, D. T., Richard, R. C., Gilbert, W. M. (1998). An Introduction to Genetic Analysis. W.H. Freeman publication, USA.
2. Atherly, A. G., Girton, J. R., Mcdonald, J. F. (1999). The Science of Genetics. Saundern College publication.
3. Snusted, D. P., Simmons, M. J. (2010 Hours). Principles of Genetics. John Wiley & Sons, New York.
4. Gupta, P. K. (2009). Genetics. Rastogi publications, Meerut, India.
5. Gupta, P. K (2008). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.

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**Course Code: MME.527**
**Course Title: Stem Cell and Regenerative Medicine**
**Total Hours: 45**

**Learning Outcomes:** On successful completion of the course the student will be able to:
● Understand basics of cell culture
● Understand basic stem cell biology.
● Gain conceptual knowledge about requirements for tissue engineering.
● Know regenerative medicine and its potential applications.

**Unit 1** **11 Hours**
Basics of cell culture and media, Culturing primary cells and cell lines, suspension and adherent cultures, cell growth, growth inhibition and apoptotic studies, Embryo culture, transplantation and teratogens, teratomas, stem cell culture, organ culture.

**Unit 2** **12 Hours**
**Stem Cells:** Stem cells and their properties, classification of stem cells, *in-vitro* culture techniques, isolation, identification and characterization of stem cells, stem cells in various organs and in disease conditions.

**Unit 3** **12 Hours**
**Tissue Engineering:** Principles of tissue culture, tissue and organ culture, extracellular matrices, bioreactors, ethical issues related to stem cell therapies, stem cell banks, bone marrow transplantation.

**Unit 4** **11 Hours**

**Regenerative Medicine:** Modes of tissue and organ delivery, tissue Engineering and transplantation techniques, immuno isolation techniques, regeneration of bone and cartilage, Islet cell transplantation and bio-artificial pancreas, lung regeneration

**Transactional Modes:** Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

**Internal assessment shall be through any of the following:** Group discussions, Surprise Tests, case analysis, simulated problem solving, classroom assignments, term paper, presentations and discussions.

**Suggested Reading:**


1. Lanza, R., Gearhart,J. (2016). Essential of Stem Cell Biology. Elsevier Academic Press.
2. Lanza, R., Klimanskaya, I. (2018). Essential Stem Cells Methods. Academic Press.
3. Mao, J. J. & (2017). Translational approaches in tissue engineering and regenerative medicine. Artech House.
4. Lanza, R. (2017). Principles of Tissue Engineering, 3rd Edition. Academic Press
5. Stein, G. S., Borowski, M., Luong, M. X., Shi, M. J., Smith, K. P., & Vazquez, P. (Eds.). (2011). Human stem cell technology and biology: A research guide and laboratory manual. John Wiley & Sons.
6. Lanza, R., Blau, H., Gearhart, J., Hogan, B., Melton, D., Moore, M., ... & Weissman, I. (Eds.). (2014). Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells. Elsevier.


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**Course Code: HGE.527**
**Course Title: Human Embryology and Developmental Genetics**
**Total Hours: 45**

**Learning Outcomes:** On successful completion of the course the student will be able to

- Conceptualize basics of reproductive physiology.
- Correlate genetic regulation in different embryonic developmental stages
- Evaluate the role of biomolecules in embryonic development.
- Know different genetic and environmental triggers for post-natal development, ageing and senescence.

**Unit I** **12 Hours**

Basic concepts of development: Gametogenesis; fertilization; embryogenesis: gastrulation and implantation of embryo; fetal membrane and placenta; potency, commitment, specification, induction, competence, determination, and

differentiation. Role of *Sry, Sox9 and WNT4 and DAX1* in early gonad differentiation

**Unit II** **11 Hours**

Gene expression regulation in development: Basics of gene expression regulation during early embryogenesis; homeotic genes, P granules, role of key developmental genes: polycomb gene, *SOX*, *HOX*.

**UNIT III** **11 Hours**

Stem Cell and Organogenesis: Stem cell: embryonic and adult; cell-cell communication; neural crest cells and axonal specificity; vertebrate eye and central nervous system development; hematopoiesis.

**Unit IV** **11 Hours**

Post-natal Development, Aging and senescence: Environmental and genetic factors during maturations, Sex linked changes, Deciduous and primary teeth, Clinical death. Teratology: Teratogens, introduction to toxicogenomic.

**Transactional Modes:** Lecture**;** Demonstration**;** Tutorial**;** Virtual classrooms; Lecture cum demonstration; Problem solving; Self-learning.

**Internal assessment shall be through any of the following:** Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Seminars, term papers, discussions, and presentations.

**Suggested Readings:**


1. Gilbert, S.F. (2013). Developmental Biology. Tenth Edition.
2. Slack, J.M.W. (2012). Essentiel Developmental Biology. Third Edition.
3. Moody, A.A. (2014). Principles of Developmental Genetics. Second Edition.
4. Slack, J.M.W. (2018). The Science of Stem Cells. First Edition.
5. Milunsky, J. & Milunsky, A. (2010). Genetic Disorders and the Fetus: Diagnosis, Prevention & Treatment. Willey Blackwell India, New Delhi.
6. Prakash, G. (2007). Reproductive Biology. Narosa Publication House Pvt. Ltd., New Delhi.
7. Sadler, T.W., Tosney, K., Chescheir, N.,C., Imseis, H., Leland, J. and Sadler-Redmond, S.,L.(2011) .Langman's Medical Embryology (Longmans Medical Embryolgy). Lippincott Williams and Wilkins.
8. Keith L. Moore BA, T. V. N. Persaud MD., Mark G. Torchia (2019 The Developing Human Clinically Oriented Embryology, Elsevier, Netherlands


**Inter-Disciplinary Course**

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**Course Code: ZOL.515**
**Course Title: Fundamentals of Cell Biology**
**Total hours: 30**

**Learning outcomes:** After going through the course the learners will be able to

- Define the basic unit of life: the cell, its structure, composition and function
- Explain macromolecules, membranes, and organelles and their related functions in cell and molecular biology
- Develop a basis for evaluating the human cell physiology and disease processes

**Unit I** **8 Hours**

**Basic unit of Life:** Life at the cellular and molecular level. Introduction to the topics include cellular energetics, membrane phenomena, genetics, and molecular biology.
**Exercise:** Brainstorming, Paper discussion, Asking Questions

**Unit II** **7 Hours**

**Introduction to the Cell:** The evolution of the cell, from molecules to first cell, from prokaryotes to eukaryotes, prokaryotic and eukaryotic genomes, from single cell to multicellular organism.
**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit III** **8 Hours**

**Membrane Structure and Function:** Biomembrane at a glance**,** membrane models: structure and composition, and membrane transport.
**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit IV** **7 Hours**

**Structural Organization of Intracellular Organelles:** Introduction of subcellular organelles: lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum, nucleus, mitochondria, and chloroplast.
**Exercise:** Brainstorming, Presentation, Quizzes, Content Focus

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self Learning, and Case studies.

**The following tools shall be used in teaching:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Gupta, P. K. (2015). Cell and Molecular Biology. Rastogi publications, Meerut, India.
2. James, D. W., Baker, T.A., Bell, S.P., Gann, A. (2009). Molecular Biology of the Gene. Benjamin Cummings, USA.
3. Johnson, A., Lewis, J., Raff, M. (2007). Molecular Biology of the Cell. Garland Science, USA.
4. Lodish, H., Berk, A., Chris, A. K. and Krieger, M. (2008). Molecular Cell Biology.
5. W.H. Freeman, USA. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010). Molecular Biology of the Cell. Garland publishers, Oxford.
6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.
7. **https://epgp.inflibnet.ac.in/Home**
8. **https://www.vlab.co.in/**
9. **https://lms.cup.edu.in/course/index.php?categoryid=76**


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**Course Code: ZOL.528**
**Course Title: Basics in Neuroscience**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe the role of human nervous system and its control over the entire body
- Explain the properties of individual cells to their function in organized neural circuits and systems
- Develop testable scientific hypotheses and generate research plans to test these hypotheses

**Unit I** **7 Hours**

**Introduction to Nervous System:** Basic anatomy, parts of central nervous system & peripheral nervous system.

**Exercise:** Brainstorming, Presentation, Quizzes

**Unit II** **8 Hours**

**Introduction to Neurons:** The neuron doctrine, Nissl and Golgi stains, components of neurons, classification and types of neurons, cytology of neurons, dendrite's structure and function, axons structure and functional aspects, ultrastructure, myelination and synapses.

**Exercise:** Brainstorming, Presentation, Quizzes, Asking Questions, Paper discussions

**Unit III** **8 Hours**

**Structure and Function of Glial Cells:** Different types of glial cells: astrocytes, oligodendrocytes and Schwann cells, types of astrocytes, importance of astrocytes in glutamate metabolism and blood brain barrier, functions of other glial cells: oligodendrocyte and microglial cells, microglial phenotypes, overview of glial and neuronal relationship in the CNS, glial neuronal interplay in the CNS.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit IV** **7 Hours**

**Action Potential & Neurotransmitters:** Action potentials & channels responsible for action potential, all or none law, Nernst equation; neurotransmitters: excitatory neurotransmitters & inhibitory neuro transmitters.

**Exercise:** Brainstorming, Presentation, Quizzes, Content Focus

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Guyton. (2007). Textbook of Medical Physiology.11th Edition. Elsevier India Pvt. Ltd. New Delhi.
2. Hill, R. W, Wyse, G. A. and Anderson, M. (2008). Animal Physiology. Sinauer Associates Inc. USA.
3. Tyagi, P. (2009). A Text Book of Animal Physiology. Dominant Publishers and distributors, New Delhi, India.
4. Levitan, I. B., Kaczmarek, L. K. (2015). The Neuron: Cell and Molecular Biology. Oxford University Press, USA; 4th edition.
5. Kandel, E. R., Schwartz, J. H., Jessell, T. M. (2012). Principles of Neural Science. McGraw-Hill Companies; 5th edition.

6. https://epgp.inflibnet.ac.in/Home
7. https://www.vlab.co.in/
8. https://lms.cup.edu.in/course/index.php?categoryid=76

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**Course Code: ZOL.560**
**Course Title: Basics in Nanobiology**
**Total hours: 30**

**Learning outcomes:** After going through the course the learners will be able to

- Define the interdisciplinary knowledge of basic concepts of nanoscience and biomaterials
- Explain characterization of techniques and biomedical aspects of nanomaterials
- Apply learned knowledge to develop bioinspired nanomaterials

**Unit I** **7 Hours**

**Nanoscience**: Definition and concepts, nanomaterials classification, types, properties and applications

**Unit II** **9 Hours**

**Nanomaterials synthesis and Characterization**: Nanomaterial synthesis methods, biofunctionalization and characterization techniques like electron microscopy (scanning and transmission), atomic force microscopy; nanoparticle analyzer, Flow cytometry, spectroscopic techniques including spectrophotometer, spectrofluorimeter & FTIR.

**Unit III** **7 Hours**

**Materials in Medicine**: Biomaterials, Theranostics, Nanostructures for drug delivery, biosensor, electrochemical biosensor, bioimaging and point-of-care diagnostics tools including lateral flow immunoassay and microfluidic devices.

**Unit IV** **7 Hours**

**Nanotoxicity**: Effect of nanomaterials on human health, nanomaterial-cell interaction, *in vitro* nanotoxicity assays, and challenges in the risk assessment of nanomaterials.

**Mode of Transaction:**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Workshop, Group discussions, Team teaching, Brainstorming, E- tutoring, Scientific discussion, Mobile teaching, Collaborative learning, Quiz, Experimentation, Tutorials, Problem solving, Debates, sample analysis and identification.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1) Bagchi, D., Bagchi, M., Mariyama, H. and Shahidi, F. (2013).BioNanotechnology: A Revolution in Food, Biomedical and Health Sciences. Wiley–Blackwell publication.
2) Rai, M., Duran, N. and Southam, G. (2011). Metal Nanoparticles in Microbiology. Springer publication.
3) Udupa, N., Gupta, P. D. (2009). Nanotechnology in Health Care. Shyam Prakashan publication.
4) Xie, Y. (2012). The Nanobiotechnology Handbook. CRC Press.
5) Murty, B. S., Shankar, P., Raj, B., Rath, B. B.and Murday, J. (2013). A Textbook of Nanoscience and Nanotechnology. Tata Mc Graw Hill Publication.

## SEMESTER – II

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**Course Code: ZOL.521**
**Course Title: Animal Physiology**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe physiology of human and other animals.
- Differentiate Digestive, Respiratory, excretory and musculoskeletal systems
- Relate chemical and biological processes occurring at the different organizational level in animal and human species.

**Unit I** **12 Hours**

**Digestive System:** Digestive System: Hunger and thirst mechanisms, Feeding strategies, Foregut, midgut, and hindgut fermentation in animals, ruminant and monogastric digestive system, absorption, metabolic energy balance, and BMR.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion

**Unit II** **11 Hours**

**Excretory System:** Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion

**Unit III** **12 Hours**

**Respiratory System:**- Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion

**Unit IV** **10 Hours**

**Musculoskeletal System:** Bones of the skeleton, muscles, cartilage, tendons, ligaments, joints and other connective tissues, The basic mechanism of muscle contraction and muscle fatigue.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Problem solving, Debates and Case studies.

**The following tools shall be used in teaching:**

Textbooks, GoI e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**


1. Guyton. (2007). Textbook of Medical Physiology. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
2. Hill, R. W, Wyse, G. A. and Anderson, M. (2016). Animal Physiology. 4th Edition. Sinauer Associates Inc. USA.
3. Murray, R. K. (2009). Harper's Illustrated Biochemistry. Jaypee Publishers, New Delhi.
4. Tyagi, P. (2016). A Textbook of Animal Physiology. Dominant Publishers and distributors, New Delhi, India.
5. Relevant research articles and digital resources


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**Course Code: ZOL.522**

**Course Title: Immunology**

**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Define the basics of immune system
- Illustrate the components and molecules of immunity
- Explain various immune responses at the cellular level that work together to protect the host

**Unit I** **12 Hours**

**Introduction to Immune System:** Recognition of self and non-self, primary and secondary lymphoid organs, innate and adaptive immunity, Cells involved in immune responses, Professional phagocytes, Non-professional phagocytes, Natural Killer cells, Antigen Presenting cells, T lymphocyte and B lymphocytes, Cytokines, Interferons and interleukins.

**Unit II** **12 Hours**

**Complement System, Major Histocompatibility Complex and Immunoglobulins:** Complement system structure, function, activation pathways and its biological consequences, Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system. Antigen processing and role of MHC molecules in antigen presentation, Immunoglobulins: basic structure, classes and subclasses, structural and functional relationship, Molecular mechanisms of antibody diversity and class switching.

Exercise: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit III** **11 Hours**

**Hypersensitivity:** Types, features and mechanisms of immediate and delayed hypersensitivity reactions, immunity to microbes, immunity to tumors, AIDS and immune-deficiencies, hybridoma technology, Auto-immune disorders.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit IV** **10 Hours**

**Monoclonal Antibodies and Diagnostic Immunology:** Production, characterization and applications in diagnosis, therapy, quantitative and qualitative methods for immunoglobulin determination, antigen and antibody reactions, agglutination-precipitation, immunoflourescence and immunoblotting, assessment of human allergic and hormonal diseases.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Seminars, Workshop, Group discussions, Team teaching, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Quiz, Experimentation, Scientific discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Kindt, T. J., Osborne, B. A. and Goldsby, R. A. (2007). Kuby Immunology. 7th Edition. W.H. Freeman, USA.
2. Abbas. (2008). Cellular and Molecular Immunology. CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J. R. (1994). Immunobiology: The Immune System in Health and Disease. Blackwell Publishing, USA.
4. Delves, P. J., Roitt, I. M. and Seamus, J. M. (2006). Roitt's Essential Immunology (Series–Essentials). Blackwell Publishers, USA.
5. Elgert K. D. (2009). Immunology: Understanding the Immune System. Wiley-Blackwell, USA.
6. Paul, W. E. (1993). Fundamental Immunology. Raven Press, SD, USA.


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**Course Code: ZOL.523**
**Course Title: Molecular Biology**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Synthesize the bird's eye view of the molecular processes of a cell
- Detailed understanding and updated knowledge on prokaryotic and eukaryotic replication, transcription, translation, and regulation of gene expression
- Apply the gene expression and regulation concept in the context of various diseases

**Unit I** **12 Hours**

**Genome Organization, Structure and Conformation of Nucleic Acids:** Chromosome structure, chromatin and its regulation, nucleosome and its assembly, nucleolus, repetitive DNA, Structure of DNA, denaturation and renaturation, Various conformations of nucleic acids including non-B DNA structures.

**Unit II** **11 Hours**

**DNA Replication:** Prokaryotic and eukaryotic DNA replication, mechanism of DNA replication, enzymes and accessory proteins involved in DNA replication, replication errors, DNA repair and genome editing.

**Unit III** **12 Hours**

**Transcription and mRNA Processing:** Types of RNA, prokaryotic & eukaryotic transcription, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, transcriptional and posttranscriptional gene silencing: initiation, elongation & termination of transcription, capping, polyadenylation, splicing, editing, mRNA stability.

**Unit IV** **10 Hours**

**Translation:** Genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, co- and post-translational modifications, epigenetics, control of gene expression at transcription and translation level.

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Flipped Classroom approach, Digital learning, Project Method, Activity-based, Field-based, Seminars, Group discussions, Focused group discussions, brainstorming sessions, E-tutoring, Dialogue Mode,Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, textbook reading assignments and case studies.

**The following tools shall be used in teaching and practicals:**

Textbooks, GoI e-learning platforms, PowerPoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**


1. Molecular Biology of the Gene by James D. Watson, 2013, Seventh Edition
2. Molecular Biology: Principles and Practice by M.M. Cox, 2016, 2nd Edition
3. Molecular Biology by Robert Weaver, 2012, 5th edition
4. Latest review and research articles along with digital resources


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**Course Code: ZOL.574**
**Course Title: Animal Behavior**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Define Animal Behavior

- Explore variety of different behaviors found in a broad range of animal groups, using a scientific and evolutionary approach
- Analyze the behaviour in animals including humans

**Unit I** **11 Hours**

**Approaches and methods in study of behavior:** Conceptual, theoretical and empirical; proximate and ultimate causation; altruism and evolution group selection, kin selection, reciprocal altruism, co-operation.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion

**Unit II** **11 Hours**

**Cognition:** Neural basis of learning, memory, cognition, sleep and arousal; biological clocks; development of behavior.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion

**Unit III** **12 Hours**

**Sociality:** Social communication; social dominance; use of space and territoriality; mating systems, courtship behavior, parental investment and reproductive success; parental care; aggressive behavior.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion

**Unit IV** **11 Hours**

**Foraging:** Habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioral changes, ageing and disease, animal personalities.

**Exercise:** Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Field visits, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Debates and Case studies.

**The following tools shall be used in teaching and practicals:**

Textbooks, GoI e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**


1. Alcock, J. (2013). Animal Behavior: An Evolutionary Approach. Sinauer Associates, 10th Edition
2. Dugatkin, L.A. (2020). Principles of Animal Behavior. The University of Chicago Press, 4th edition.
3. Breed, M and Moore, J. (2012). Animal Behaviour. Academic Press, 2nd edition.
4. Nichollas et al. (2012). From Brain to Behavior. Sinauer Associates, 5th edition.
5. Griffith et al. (2004). Introduction to Genetic Analysis. W H Freeman & Co Ltd, 8th Revised edition.
6. Relevant research articles and digital resources


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**Course Code: ZOL.540**
**Course Title: Lab Course (Practical) – II**
**Total hours: 150**

**Learning outcomes:** After going through the course the learners will be able to

- Describe parameters toward understanding the pathophysiology of various human disease
- Apply techniques involved in identification and quantification of protein expression
- Demonstrate various molecular biology techniques.
- Illustrate techniques and procedures routinely used in the core courses offered in the semester

1. Measurement of vital parameters: Blood pressure, Blood glucose, Heartbeat (ECG), Pulse Rate, and Glucose tolerance test.
2. DigiFrog: Online animal dissection modules.
3. Spirometry
4. ELISA
5. Western blotting
6. Dot blot technique
7. Double immunodiffusion
8. Determination of BOD/COD
9. RNA isolation

10. DNA isolation
11. Polymerase Chain Reaction
12. cDNA synthesis and RT-PCR analysis
13. Gene cloning: Primer designing, Restriction digestion, ligation, transformation and screening.
14. Animal handling: mice/rat/rabbit (tutorials only)
15. Animal Perfusion
16. Polyclonal antibody raising
17. Immunohistochemistry
18. Cell cycle monitoring by flow cytometry
19. Microscopic examination of human parasite life cycles (amoeba, cestodes, nematodes, and plasmodium)
20. Animal cell transfection (lipid based and electroporation)

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Sambrook, J. (2006). The Condensed Protocols from Molecular Cloning: A Laboratory Manual. Cshl Press. New York.
2. Sambrook, J. and Russell, D. W. (2000). Molecular Cloning: A Laboratory Manual (3 Vol-set). 3rd Edition, CSHL Press, New York.
3. **https://epgp.inflibnet.ac.in/Home**
4. **https://www.vlab.co.in/**
5. **https://lms.cup.edu.in/course/index.php?categoryid=76**


**Discipline Elective Courses:**

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**Course Code: ZOL.529**

**Course Title: Genetic Engineering**

**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe versatile tools and techniques employed in recombinant DNA technology
- Formulate knowledge required to design, execute, and analyze the results of genetic experimentation in animal model systems
- Develop a thorough knowledge on methodological repertoire that allows students to innovatively apply in basic and applied fields of biological research

**Unit I** **11 Hours**

**Tools of Genetic Engineering:** Restriction enzymes, Enzymes in genetic engineering, recombinant cloning vectors & their biology (Plasmid-, Phage-, and yeast-based), transformation and selection, genomic and cDNA library construction & DNA-sequencing techniques.

**Unit II** **12 Hours**

**Recombinant Expression Systems & Mutagenesis:** prokaryotic (Fusion proteins, surface display, removal of selectable marker genes, secretion into periplasm & medium) & eukaryotic (*Sachharomy cescerevisiae* & Mammalian cell expression system), oligonucleotide-directed and site directed mutagenesis.

**Unit III** **11 Hours**

**Molecular Biotechnology of Microbial Systems:** Vaccines (subunit-, peptide-, attenuated-, DNA- and vector-based), Enzymes, Antibiotics, Bioremediation, and Gene therapy.

**Unit IV** **11 Hours**

**Molecular Biotechnology of Eukaryotic Systems:** Engineering of plants (Ti-based system), Transgenic animals (Transgenic rodents), Regulation of recombinant DNA technology, Concerns about safety of consuming genetically modified foods, concerns about the impact of genetically modified organisms on the environment.

**Suggested Readings:**


1. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard J. Glick, Jack J. Pasternak, Cheryl L. Patten, 4th edition. 2010 Hours
2. Principles of Gene Manipulation by Sandy B. Primrose, Richard Twyman, Bob Old Seventh edition.2008
3. An introduction to genetic engineering, Third edition by Dr. Desmond S.T. Nicholl. 2011
4. Molecular cloning by R. Green and Joseph Sambrook, 4th Edition, CSHL Press. 2013

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**Course Code: ZOL.554**
**Course Title: Neurobiology and Degeneration**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe Human Nervous system and Neurobiology
- Illustrate major degenerative diseases affecting the nervous system
- Distinguish physiological and molecular features of human neurobiology and degeneration

**Unit I** **11 Hours**

**Nervous System:** Gross neuroanatomy of the human brain and spinal cord, blood brain barrier, central and peripheral nervous system, Neurons, Neuroglial cells, action potential, neurotransmitters, neural control of muscle tone and posture. **Sense Organs:** Vision, hearing and tactile response.

**Exercise:** Brainstorming, Presentation, Quizzes, Asking Questions

**Unit II** **12 Hours**

Metabolic functions of the Brain; Energy Requirements; Oxidative stress; Factors contributing to the neurodegeneration. **Alzheimer's disease (AD):** Mechanism(s) of AD pathogenesis and pathophysiology, e.g. amyloid cascade hypothesis, tau, and the therapeutic approaches. Review of recently completed clinical trials and treatment prospects.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit III** **11 Hours**

**Parkinson's Disease (PD):** genetics - alpha synuclein, parkin, DJ1, PINK1, and LRRK2. Gene therapy for PD. Huntington's Disease, multiple sclerosis, clinical overview of frontotemporal degeneration (FTD) and amyotrophic lateral sclerosis (ALS).

**Exercise:** Brainstorming, Presentation, Quizzes, Content Focus

**Unit IV** **11 Hours**

**Therapeutic intervention:** Current treatment strategies including Pharmaceutical and Natural products-based therapies for various human neurodegenerative diseases.

**Exercise:** Brainstorming, Presentation, Quizzes, Paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

**The following tools shall be used in teaching:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Guyton. (2007). *Textbook of Medical Physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
2. Hill, R. W, Wyse, G. A. and Anderson, M. (2008). *Animal Physiology*. Sinauer Associates Inc. USA.
3. Tyagi, P. (2009). *A Textbook of Animal Physiology*. Dominant Publishers and distributors, New Delhi, India.
4. Mason, P. (2011) Medical Neurobiology. OUP USA publishers; 1st edition.
5. Charney, Dennis, S., (2013) Study guide for Neurobiology of Mental Illness. Cram 101 Publishers.
6. Dennis S. Charney, Nestler, E. J., Sklar, P., and Buxbaum, J. D. (2013). Neurobiology of Mental Illness. OUP USA publishers; 4th edition.
7. Zigmond, M. J, Coyle, J. T., and Rowland, L. P. (2014). Neurobiology of Brain Disorders: Biological Basis of Neurological and Psychiatric Disorders. Academic Press; 1st edition.
8. **https://epgp.inflibnet.ac.in/Home**
9. **https://www.vlab.co.in/**
10. **https://lms.cup.edu.in/course/index.php?categoryid=76**


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**Course Code: ZOL.553**

**Course Title: Vascular Biology**

**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe vascular system and cardiovascular biology
- Illustrate vascular dysfunction
- Classify vascular disorders

- Categorize antiplatelet drugs and diagnostics methods
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**Unit I** **12 Hours**

**Vascular Biology**: Introduction, structure and function of the vascular system. Vascular dysfunction in various pathophysiological states including endothelial dysfunction, inflammation, atherosclerosis and diabetes.

**Unit II** **12 Hours**

**Cardiovascular Biology**: Basic cardiovascular physiology, cardiovascular system including blood coagulation system, platelet biology, haemostasis & thrombosis and signalling pathways involved in thrombus biology.

**Unit III** **10 Hours**

**Vascular Disorders:** Peripheral vascular disease, stroke, platelet in cardiovascular diseases, diseases of the circulatory system including lymphatic diseases.

**Unit IV** **11 Hours**

**Vascular Medicine:** Novel drugs including antiplatelet drugs, diagnostic methods including vascular angiography, imaging modalities, and other therapeutic approaches to better diagnose, prevent, or treat cardiovascular diseases.

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brainstorming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self Learning, and Case studies.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Michael, R. J. and Christopher, J. W. (2011).Vascular Disease: Diagnostic and Therapeutic Approaches. Cardiotext Publishing. 1st Edition.
2. Minar, E. and Schillinger, M. (2013). Peripheral Vascular Disease: Basic & Clinical Perspectives. Future Medicine Ltd.
3. Rasmussen, T. E.,Clouse, W. D., and Tonnessen, B. H. (2008). Handbook of Patient Care in Vascular Diseases. Lippincott Williams & Wilkins. 5th Edition.
4. Bhatt, D. L. (2008). Platelets in Cardiovascular Disease. Imperial College Press.

5. Kirali, K. (2015). Coronary Artery Disease – Assessment, Surgery, Prevention. InTech Publication.
6. Bozic-Mijovski, M. (2015). Thrombosis, Atherosclerosis and Atherothrombosis – New Insights and Experimental Protocols. InTech Publication.

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**Course Code: ZOL.572**
**Course Title: Endocrinology**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Define the role of the endocrine system in maintaining homeostasis and different feedback mechanism.
- Explain the knowledge of the major endocrine disorders and future challenges.
- Develop an advanced knowledge on future clinical problems of the endocrine system

**Unit I** **12 Hours**

**General Introduction to Hormone:** History, endocrine glands, hormones as chemical messengers, stimulus for hormone release: change in homeostasis, Neurosecretion and neuroendocrine system. **Hormones:** Structure, receptor type, regulation of biosynthesis and release (including feedback mechanism like short, long and ultra-feedback system).

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit II** **10 Hours**

**Reproductive Hormones**: Male and female sex hormones. Hypothalamic hormones: CRH, TRH, GnRH, PRL/PRIH, GHRH/GHRIH. Pituitary hormones - Anterior and posterior pituitary hormones. Molecular mechanism of origin of GnRH cells, migration and site of release, reproductive cycles in females. Role of different guidance molecules involved during early GnRH development and adult GnRH System. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation: Different pathologies and genes involved. Breeding in animals, including knockout/conditional knockout/wild type animals.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit III** **11 Hours**

**Hormone Biosynthesis and Mode of Action:** The hypothalamo- hypophyseal axis. Hypothalamo-vascular system. Hormones from hypothalamus: chemistry and physiology of releasing and release inhibiting hormones; Regulation of hypothalamic hormone secretion. Thyroid hormones, growth hormones, adrenal hormones and catecholamines, glucocorticoid hormones Neurohypophysis: synthesis and storage of oxytocin and vasopressin

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit IV** **12 Hours**

**Other endocrine organs:** Regulation of the release of neurohypophyseal hormones; Other organs with endocrine function: heart (ANP), kidney (erythropoietin), liver (angiotensinogen, IGF-1), adipose tissue (leptin, adiponectin).

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Problem solving, Debates and Case studies.

**The following tools shall be used in teaching and practicals:**

Textbooks, GoI e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**


1. Norris, D. O., and Carr, J. A. (2012). Vertebrate Endocrinology, 5th Edition. Academic Press.
2. Nelson, D. L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry, 5th Edition. WH Freeman & Company, New York
3. Widmaier, E. P., Raff, H., and Strang, K. T. (2013).Vander's Human Physiology, 13 Hours Hoursth Edition. McGraw-Hill Higher Education
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., and Scott, M. P. (2012). Molecular Cell Biology, 7th Edition. W.H. Freeman.
5. Goswami, M. P. (2013). Endocrinology and Molecular Cell Biology.
6. Relevant research articles and digital resources


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**Course Code: LBI.526**
**Course Title: Biomolecular Structure Modelling and Drug Designing**
**Total Hours: 45**

**Learning Outcomes:** On completion of the course the student should be able to:

1. describe different types of protein–ligand interactions and characterise binding pockets
2. use different search methods to find compounds with specific properties in large compound databases
3. set up, perform and evaluate different virtual screening methods using large datasets
4. account for and set up molecular dynamics simulations and free energy calculations

**Unit I** **10 Hours**

Basics of Biomolecules: Principles of protein and nucleic acid structure: Primary, Secondary, Tertiary structure and Quaternary structure. Protein secondary structure: Introduction, Hydrogen bond, Defining a secondary structure element, Methods for predicting secondary structure.

**Unit II** **12 Hours**

Protein tertiary structure modeling: Basic concepts, Protein folding and Energetics, Comparative modeling, Threading, Ab initio modeling, Modeling protein sidechains, CASP: A blind protein structure prediction competition, CAPRI, Protein Structure Initiative (PSI).

**Unit III** **12 Hours**

Introduction to drug designing, ADMET, drug metabolism, toxicity and pharmacokinetics. lipinski rule of 5, Identification and validation strategies. Drug Target classification, Concept of Pharmacophore, Functional group considered as pharmacophore, Structure-based drug design, docking, QSAR

**Unit IV** **11 Hours**

Modelling macromolecular structure: Homology modelling, *ab-initio* structure modeling; Molecular Recognition: Prediction of Protein-ligand interaction sites, Prediction of Protein-protein interaction sites, Prediction of Protein-membrane interaction sites, Prediction of Protein-nucleic acid interaction sites

**Transactional Modes:** Lecture, Laboratory based Practical, Seminar, Group discussion, Team teaching, Self-learning, Online tools.

**Suggested Readings**

1. Hybrid Biomolecular Modeling. (2019): Frontiers Media SA. ISBN:9782889456994

2. Biomolecular Modelling and Simulations. (2014). United Kingdom: Elsevier Science.ISBN:9780128007891
3. Molecular Modeling of Proteins. (2017). United States: Springer New York. ISBN:9781493954919
4. Biomolecular Simulations in Structure-Based Drug Discovery. (2019). Germany: Wiley. ISBN:9783527342655
5. Schneider, Gisbert; Baringhaus, Karl-Heinz; Kubinyi, Hugo Molecular design : concepts and applications Weinheim: Wiley-VCH, c2008
6. Andrew R.Leach Molecular Modelling Principles and applications. (2001) II ed. Prentice Hall

**Web Resources**
https://www.uniprot.org/
bioinformatics.org/molvis/phipsi/

**Value Based Course:**

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**Course Code: ZOL.559**
**Course Title: Scientific Writing**
**Total hours: 30**

**Unit I** **8 hours**
Survey of Literature and review articles, Methods of literature review, Process of summarizing, synthesizing and presentation of reviewed literature, Presentation of primary research from Peer-reviewed journal articles.

**Unit II** **8 hours**
Identifying and formulating a research problem, writing a research problem, Steps in designing a research problem, Formulation of research questions, research objectives and construction of a hypothesis, Designing an experiment.

**Unit III** **8 hours**

Goal of data analysis, Collection, processing and interpretation of data, Presentation, visualization of results, Analysis and reporting of results, Basics of citation and bibliography/reference preparation styles.

**Unit IV** **6 hours**
Writing a grant proposal, Technology requirements in scientific writing, Ethics in writing and scientific misconduct, Patents and copyrights.

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:** Lecture, Demonstration, Project Method, Seminars, Group discussions, E- tutoring, Dialogue Mode, Panel discussion, Tutorials, Problem solving, Debates and Case studies.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks and e-conten

**Suggested Readings:**


1. Kumar, R. (2014): Research Methodology – A Step-By-Step Guide for Beginners, 4th ed., Sage Publications.
2. Pagano, M. and Gauvreau, K. (2018). Principles of Biostatistics. Chapman and Hall/CRC, 2nd edition.
3. Gupta, S. (2005). Research Methodology and Statistical Techniques. Deep & Deep Publications (p) Ltd. New Delhi.
4. Rockman, H. B. (2004). Intellectual Property Law for Engineers and Scientists. Wiley-IEEE Press, USA.
5. Shannon, T. A. (2009). An Introduction to Bioethics. Paulist Press, USA.
6. Kothari, C. R. and G. Garg (2014): Research Methodology: Methods and Techniques, 3rd ed., New Age International Pvt. Ltd. Publisher
7. Relevant research articles and digital resources


## SEMESTER – III

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**Course Code: ZOL.551**

**Course Title: Developmental Biology**

**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe mammalian development
- Illustrate developmental processes of vertebrates i.e. Blastulation, Gastrulation and different morphological movements
- Differentiate extra-embryonic developments and regenerative mechanism.

**Unit I** **12 Hours**

**Beginning of a new organism:** Principles of development, Oogenesis, Spermatogenesis, Fertilization, Polyspermy and prevention of polyspermy, Morula, Cleavage and its types, Blastulation and Gastrulation, Different movements occur during Gastrulation.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit II** **12 Hours**

**Early embryonic development:** Anatomical and morphological changes that occur during development, Early development of amphibians, Drosophila and mammals; axis formation in Drosophila and Amphibians.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit III** **11 Hours**

**Later embryonic development:** Central nervous system and the epidermis; Neural crest cells and axonal specificity; Endoderm, Mesoderm and Ectoderm.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit IV** **10 Hours**

**Regeneration:** Tetrapod limb development, metamorphosis, regeneration and ageing, teratogenesis.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Problem solving, Debates and Case studies.

**The following tools shall be used in teaching and practicals:**

Textbooks, Gol e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**

1. Lewis, W. (2011). Developmental biology: a very short introduction. Oxford University Press, 1st edition.

2. Hake, S. and Wilt, F. (2003). Principles of Developmental Biology. W.W. Norton & Company, New York, USA.
3. Lewin, R. (2004). Human Evolution - An Illustrated Introduction. WileyBlackwell, USA.
4. Baressi, M.J.F., Scott, F. and Gilbert, S. F. (2018). Developmental Biology. Sinauer Associates, Inc. USA. 11th edition.
5. Relevant research articles and digital resources

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**Course Code: ZOL.513**
**Course Title: Techniques in Life Sciences**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe analytical tools in Life Sciences.
- Distinguish spectroscopy, microscopy, molecular and immunological techniques.
- Apply analytical instruments in life science research
- Analyze experimental results.

**Unit I** **12 Hours**

**Spectroscopy and Chromatography Techniques:** UV-Vis, fluorimeter, circular dichroism, FTIR, mass spectroscopy, and NMR. Thin layer chromatography (TLC), gel filtration and ion exchange, affinity chromatography, GC, GLC and HPLC.

**Unit II** **10 Hours**

**Microscopy:** Light microscopy, phase contrast microscopy, fluorescent microscopy, confocal microscope, scanning electron microscopy (SEM), transmission electron microscopy (TEM) and live cell microscopy.

**Unit III** **12 Hours**

**Basic Molecular Biology Techniques:** Isolation, purification and analysis of protein and nucleic acids. Electrophoresis: Principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), agarose gel electrophoresis. Polymerase chain reaction (PCR): Principle, types and applications. Blotting techniques: Southern, Northern, Western analysis, *In situ* hybridization etc.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit IV** **11 Hours**

**Immunological and Cell Culture Techniques:** Perfusion, Fixation, different techniques of sectioning, MTT assay, Electrophysiological techniques like Patch clamp immunochemical techniques, immunocytochemistry, immunofluorescence, radioimmunoassay (RIA), Different enzyme linked immunosorbent assay (ELISA), immunoprecipitation, Cell and tissue culture techniques: Primary and secondary cultures.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Workshop, Group discussions, Team teaching, Brainstorming, E- tutoring, Scientific discussion, Mobile teaching, Collaborative learning, Quiz, Experimentation, Tutorials, Problem solving, Debates, sample analysis and identification.

**The following tools shall be used in teaching:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Goldsby, R. A., Kindt, T. J. and Osborne, B. A. (2018). Kuby Immunology. 6th Edition, W. H. Freeman & Company, San Francisco.
2. Gupta, P. K. (2015). Elements of Biotechnology. Rastogi Publications, Meerut.
3. Kothari, C. R. (2008) Research Methodology. New Age International (P) Ltd., New Delhi
4. Lewin, B. (2014). Genes X, CBS Publishers & Distributors. New Delhi.
5. Nelson, D. and Cox, M. M. (2016). Lehninger Principles of Biochemistry. W.H. Freeman and Company, New York.
6. Primrose. S. B. and Twyman, R. (2006). Principles of Gene Manipulation and Genomics. Blackwell Publishing Professional, U.K.
7. Sawhney, S. K. and Singh, R. (2005). Introductory Practical Biochemistry. Narosa Publishing House, New Delhi.
8. Wilson, K. and Walker, J. (2006). Principles and Techniques of Biochemistry and Molecular biology. 6th Edition, Cambridge University Press India Pvt. Ltd., New Delhi.


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**Course Code: ZOL.552**
**Course Title: Cancer Biology**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe Cancer biology
- Explain cause and progression of Cancer
- Classify Cancer
- Distinguish different forms of Cancer therapy

**Unit I** **12 Hours**

**Biology and Classification of Cancer:** Classification, phenotype of a cancer cell, causes of cancer, DNA tumor viruses, RNA tumor viruses, Different forms of cancers, screening and early detection, tumor markers and molecular tools for early diagnosis of cancer.

**Exercise:** Brainstorming, Presentation, Quizzes, Paper discussion

**Unit II** **11 Hours**

**Basis of Cancer:** Oncogenes, tumor suppressor genes, aberrations in signaling pathways, oncogenic mutations in growth promoting proteins, mutations causing loss of growth-inhibition DNA repair in cancer.

**Exercise:** Brainstorming, Presentation, Quizzes, Asking Questions

**Unit III** **12 Hours**

**Oncogenesis and Apoptosis:** Intracellular proteolytic cascade, cascade of caspase proteins, adapter proteins, Bcl-2, IAP family proteins, Extracellular control of cell division, tumor necrosis factor and related death signals.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit IV** **11 Hours**

**Metastasis and Cancer therapy:** Heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinase and tumor cell division, prediction of aggressiveness of cancer, different forms of cancer therapy (chemotherapy, radiotherapy, surgery, etc.), use of signal targets towards therapy of cancer and gene therapy.

**Exercise:** Brainstorming, Presentation, Quizzes, Content Focus

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Selflearning, and Case studies.

**The following tools shall be used in teaching:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Dimmock, N. J. and Primrose, S. B. (2005). Introduction to Modern Virology. Bookbarn International, UK.
2. Ford, C. H. J., Casson, A. G. and Macdonald, F. (2004). Molecular Biology of Cancer. Bios Scientific Publishers, USA.
3. King, R. J. B. and Robins M. W. (2006). Cancer Biology. Prentice Hall, USA.
4. Margaret, A. K. and Peter, J. S. (2005). Introduction to the Cellular and Molecular Biology of Cancer. Oxford University Press, USA.
5. Neoptolemos, L. J. (1994). Cancer: A Molecular Approach**.** Blackwell Publishing, USA.
6. Phillis, R., Goodwin, S. and Palladino, M. A. (2002). Biology of Cancer. Benjamin-cummings Publishing Company, USA.
7. **https://epgp.inflibnet.ac.in/Home**
8. **https://www.vlab.co.in/**
9. **https://lms.cup.edu.in/course/index.php?categoryid=76**


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**Course Code: ZOL.577**

**Course Title: Reproductive Physiology**

**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Provide in-depth knowledge of male and female reproductive systems along with the mechanistic aspects
- Illustrate various reproductive disorders which are cause of major concern in modern times i.e. obesity, PCOS and IHH

**Unit I** **11 Hours**

**Introduction:** Regulation of Anterior and Posterior Pituitary hormones, Puberty and mechanism of puberty, Neuroendocrine system and neurosecretion; Concept of neurogenesis, pruning and brain plasticity, Neuron glial endothelial tripartite interactions, Blood brain barrier, Homeostasis, Sexual behavior: Pheromones, Copulatory patterns; Hormones in sexual behavior; Control by different brain centers.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies

**Unit II** **12 Hours**

**Endocrine disorders:** Reproductive disorders: IHH and Kallmann syndrome, precocious and delayed puberty, Origin and causes of male sterility (azoospermia, oligozoospermia, varicocoele, cryptorchidism). Female sterility: Tubal factors; Premature ovarian failure; Luteal insufficiency; Endometriosis, PCOS.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies

**Unit III** **11 Hours**

**Male reproductive system:** Spermatogenesis and hormonal regulation; Oxidative stress and spermatogenesis; Seroli cells; Leydig cells; Cell-cell interaction Epididymis: Structure, function and regulation Male accessory sex glands: Structure, function and regulation Male sterility: Parameters of male sterility.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Unit IV** **11 Hours**

**Female reproductive system:** Oogenesis and hormonal regulation; Mechanism of ovulation; Reproductive cycles in female: Menstrual cycle; Control of seasonal reproductive cycle Follicular atresia Female accessory sex glands: Structure, function and regulation Assisted Reproductive Techniques (ART): Principle of ART and protocols; Types of ART; Cryopreservation of gametes.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Problem solving, Debates and Case studies.

**The following tools shall be used in teaching and practicals:**
Textbooks, GoI e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Reading:**


1. Norris and Carr: Vertebrate Endocrinology (8thed, Vol 5, 2016, Academic Press)
2. Brooks and Marshall: Essentials of Endocrinology (1995, Blackwell Science)
3. Larson: Williams Textbook of Endocrinology (10thed, 2012, Saunders)
4. Knobil and Neill: Encyclopedia of Reproduction (Vol 1-4, 2018, Academic Press)
5. Leuang and Adashi: The Ovary (2004, Raven Press)
6. Strauss and Barbieri: Yen and Jaffe's Reproductive Endocrinology (6thed, 2009, Saunders)
7. Knobil and Neill: Encyclopedia of Reproduction (Vol 1-2, 2015, Academic Press)
8. Relevant research articles and digital resources


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**Course Code: ZOL.578**
**Course Title: Insect Biology**
**Total hours: 45**

**Learning outcomes:** After completion of the course the learners will be able to:

- Independently plan his career forward in the basic research using Drosophila model or applied research in the field of Integrated pest management or Vector Biology or in Ecology to study the intriguing insect behaviour and ecology in honey bees or wasps or chemical biology to understand chemicals and sensory and gustatory molecules/receptors or even a less known forensic entomology

- Explore to plan entrepreneurship through skill development opportunities in the field

**Unit I** **11 Hours**

**Basics of Insect Biology:** Insect classification, taxonomy, biodiversity, physiology, metamorphosis, evolution, reproduction, immunity, pheromones and other semiochemicals

**Unit II** **11 Hours**

**Avenues in Insect Biology: Agricultural Entomology:** Insects pests and beneficial insects **Medical Entomology:** Insect vectors of human and veterinary disease; Medically beneficial insects **Forensic entomology:** Medicolegal, urban, and stored product pests

**Unit III** **12 Hours**

**Insect models in research:** *Drosophila melanogaster*, *Manduca sexta*, *Bombyx mori*, female *Anopheles* sp., *Aedes aegypti, Apis mellifera, Musca domestica* and other non-model organisms.

**Unit IV** **11 Hours**

**Opportunities in Insect Biology:** Apiculture, Sericulture, Lac culture, Mass rearing of biocontrol agents, Vermiculture, Taxonomy, Ecology, Biology, Behaviour, and latest thrust research areas

**Mode of Transaction**

**The classroom learning/practicals/project work would be based on:**

Lecture, Demonstration, Flipped Classroom approach, Digital learning, Project Method, Activity-based, Field-based, Seminars, Group discussions, Focused group discussions, brainstorming sessions, E-tutoring, Dialogue Mode, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, textbook reading assignments and case studies.

**The following tools shall be used in teaching and practicals:**

Textbooks, GoI e-learning platforms, powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**


1. For Love of Insects. by Thomas Eisner.
2. Life on a Little Known Planet. by Howard Ensign Evans.
3. Introduction to the Study of Insects. by Charles Triplehorn and Norman F Johnson.
4. Encyclopedia of Insects. by Vincent H Resh and Ring T Cardé
5. The Insect Societies. by Edward O Wilson
6. Review and Research articles


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**Course Code: BCH.527**
**Course Title: Clinical Diagnostics**
**Total Hours:**

**Learning Outcomes:**
The students will be able to comprehend diverse methods in clinically diagnosing human diseases which will further help them to use these techniques in various applied fields of biological research.

**Unit I** **11 hours**

**Introduction to Clinical Diagnostics:** Philosophy and general approach to clinical specimens, Sample collection (Blood, urine, spinal fluid, synovial fluid, amniotic fluid) - method of collection, preservation, transport and processing of samples. Diagnosis – disease altered state, prognosis, direct and indirect, concept of antigen and antibody. Principles of validation of diagnostic assays for infectious diseases, Validation and quality control of polymerase chain reaction methods used for the diagnosis of infectious diseases.

**Unit II** **12 Hours**

**Protein based Clinical Diagnostics:** Antigen – Antibody Interaction, Lattice Theory, Precipitin Curve, Simple Immunodiffusion (Radial Immunodiffusion – Qualitative, Quantitative); Double Diffusion (Mechanism of Reaction of Identity, Partial Identity, and Non-Identity); Rocket Electrophoresis, Immunoelectrophoresis; Western Blot, Immunofluorescence, Radioimmunossay; ELISA – types and assay development; Agglutination – Antibody titer, Prozone Phenomenon, Direct and Indirect Agglutination, ABO Blood typing, Agglutination Inhibition; Advantages and limitation with respect to clinical diagnosis and research usage. Microparticle based antigen - Antibody interaction techniques. Monoclonal antibody – production, applications, novel approaches in detection, Humanized monoclonal antibodies.

**Unit III** **11 Hours**

**DNA based Clinical Diagnostics:** Nucleic acid extraction from clinical samples, quantization, digestion, hybridization, Amplification by PCR (Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, *In situ* PCR, Long-PCR, PCR-ELISA, iPCR, applications and limitations) DNA fingerprinting and polymorphism studies (SNP, RAPD, RFLP, VNTR, Mutation detection etc). Emphasis on interpretation of results and quality control.

**High-throughput Technologies and Pathological Diagnostics:** Microarray (protein, DNA), Real-Time PCR, Reporter assays. Biosensors – types, applications, examples (glucose etc), telemedicine. Fluorescence based techniques (FISH analysis, Flow cytometry, Fluorescent Microscopy) Mass spectrometry, Histopathology, Immunohistochemistry and Real-Time PCR. Microbiological Diagnosis and Hematology. Enzyme and hormone based diagnostic techniques

**Unit IV** **11 Hours**

**Case Studies:** Diagnosis of Infectious Diseases – some specific examples. Diagnosis of bacterial infection caused by *Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium tuberculosis.* Diagnosis of fungal infections. Dermatophytosis, Candidiasis and Aspergillosis. Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdoviruses, Hepatitis Viruses and Retroviruses.Diagnosis of Protozoan diseases: Amoebiasis, Malaria, Trypanosomiasis, Leishmaniasis, Filariasis and Schistosomiasis. Medical Genetics: Organization of human genome, Human Genome Project, Identifying human disease genes. Genetic Counselling. Genetic disorders: Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex –linked inherited disorders. Neonatal and Prenatal disease diagnostics.

**Suggested Readings:**

1. Burtis, Carl A, Ashwood, Edward R, Bruns, David E., "*Tietz textbook of Clinical Chemistry & Molecular Diagnostics*" USA: Saunders, 2006.
2. World Organization for Animal Health: "*Manual of Diagnostic Tests and Vaccines for Terrestrial Animals"* Volumes I & II, 6th Edition, 2010.
3. Rao, Juluri R, Fleming, Colin C., Moore, John E., "*Molecular Diagnostics: current technology and Applications"*, Horizon Bioscience, U. K., 2006.
4. Goldsby, Richard A., Kuby, Janis, "*Immunology*", New York: WH Freeman and Company, 2003.
5. Mahon, Connie R.; Lehman, Donald C. ; Manuselis, George "*Textbook of Diagnostic Microbiology*". USA: Saunders, 2007.

**Modes of transaction**

-Lecture
-Problem Solving
-Self-Learning
- Case study
-Group discussions

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**Course Code: HGE.555**
**Course Title: Biosafety, Bioethics, and Intellectual Property Rights**
**Total Hours: 45**

**Learning Outcomes:** On successful completion of the course the student will be able to

- Interpret the bioethical issues concerning biotechnological advancements like recombinant DNA
- technology, cloning, gene manipulation.
- Implement biosafety while carrying out research.
- Distinguish different types of Intellectual Property Rights.
- Describe the ways of protecting traditional knowledge from Biopiracy.

**Unit I** **11 Hours**

Biosafety: Good laboratory practices; Risk and safety assessment from genetically engineered organisms; special procedures for r-DNA based products; biological containment (BC) and physical containment (PC); CDC biosafety levels; biohazard management.

**Unit II** **11 Hours**

Bioethics: Ethical considerations during research, Use of Animals for clinical research, Embryonic and adult stem cell research, assisted reproductive technologies, cloning, MTP and Euthanasia; the element of informed consent; ethical issues of the human genome project.

**Unit III** **11 Hours**

Intellectual Property Rights (IPRs): Various forms of IP – patents, industrial designs, trademark, geographical indications, and plant breeder's right; copyright: fair use, plagiarism; protection of indigenous intellectual property.

**Unit IV** **12 Hours**

Patent system: Patent filing procedure in India and ways of patent protection in other countries: Determination of patentability of inventions, filing a patent application in India: timeline, procedure involved in the granting of a patent, patent cooperation Treaty (PCT).

**Transactional Modes:** Lecture**;** Demonstration**;** Virtual classrooms; Tutorial**;** Lecture cum demonstration; Problem solving; Case study; Self-learning.

**Internal assessment shall be through any of the following:**

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, Seminars, term papers, discussions, and presentations.

**Suggested Readings:**


1. Clarke, A (2012). *Genetic Counseling: Practice and Principles*. Taylor & Francis
2. Fleming, D.O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
3. Mahop, M.T. (2010). *Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries. Routledge*.
4. Shannon, T.A. (2009). *An Introduction to Bioethics*. Paulist Press, USA.
5. Thompson J and Schaefer, B.*D (2013).Medical Genetics: An Integrated Approach*. McGraw Hill.
6. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases*. Oxford University Press, UK.

7. WHO. (2005). *Laboratory Biosafety Manual*. World Health Organization.
8. Ahuja, V.K. (2017). *Law relating to Intellectual Property Rights.* LexisNexis, India. 3rd Edition.
9. Mahop, M.T. (2010). *Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries.* Routledge, USA.
10. Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
11. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

**Compulsory Foundation Courses:**

| L | T | P | Cr |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Code: ZOL.556**
**Course Title: Research Methodology**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe research methods and scientific ethics
- Write review of literature
- Classify various aspects of research methodology
- Apply bio-statistical tools in life science research
- Analyzing experimental data results
- Design research experiment

**Unit I** **12 Hours**

Literature survey and review, sources of literature, methods of literature review and techniques of writing the reviewed literature. Understanding a research problem, selecting the research problem, steps in formulation of a research problem, formulation of research objectives, and construction of a hypothesis.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit II** **11 Hours**

Basic principles of experimental designs, data collection, processing, and interpretation. Basics of citation and bibliography/reference preparation styles, report presentation.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit III** **11 Hours**

Good laboratory practices (GLP), biosafety issues for using cloned genes in medicine, agriculture, industry. Genetic pollution, risk and safety assessment from genetically engineered organisms.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Unit IV** **11 Hours**

Ethical theories, ethical considerations during research, ethical issues related to animal testing and human project. Intellectual property rights (IPRs), patents and copyrights, fair use, plagiarism and open access publishing.

**Exercise:** Brainstorming, Presentation, Quizzes, Discussions and Group Learning

**Mode of Transaction**

**The classroom learning would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Selflearning, and Case studies.

**The following tools shall be used in teaching and practical:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Gupta, S. (2005). Research Methodology and Statistical Techniques. Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C. R. (2008). Research Methodology (s). New Age International (p) Limited. New Delhi.
3. Fleming, D. O. and Hunt, D. L. (2006). Biological Safety: Principles and Practices. American Society for Microbiology, USA.
4. Rockman, H. B. (2004). Intellectual Property Law for Engineers and Scientists. Wiley-IEEE Press, USA.
5. Shannon, T. A. (2009). An Introduction to Bioethics. Paulist Press, USA.
6. Kothari, C. R. and G. Garg (2014): Research Methodology: Methods and Techniques, 3rd ed., New Age International Pvt. Ltd. Publisher
7. Kumar, R. (2014): Research Methodology – A Step-By-Step Guide for Beginners, 4th ed., Sage Publications.
8. Jerrold, H. Z. (2010): Biostatistical Analysis, Fifth ed., Pearson.
9. Sokal, R. F and Rohlf, F. J. (2011): Biometry, Fourth Ed., W.H. Freeman Publishers.

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**Course Code: ZOL.557**
**Course Title: Basic Statistics for Sciences**
**Total hours: 45**

**Learning outcomes:** After going through the course the learners will be able to

- Describe Statistical tools used in Life Sciences
- Interpret statistical variables and distributions
- Distinguish between parametric and non-parametric statistics
- Apply statistical parameters to available data

**Unit I** **7 Hours**

**Descriptive Statistics:** Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies

**Unit II** **7 Hours**

**Measures:** Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion, Self-learning and Case studies

**Unit III** **8 Hours**

Random variables and Distributions: Discrete and continuous random variables. Discrete Probability distributions like Binomial, Poisson and continuous distributions like Normal, F and student-t distribution.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion, Self-learning and Case studies.

**Unit IV** **8 Hours**

Differences between parametric and non-parametric statistics. Confidence interval, Errors, Levels of significance, Hypothesis testing. Parametric tests: Test for parameters of Normal population (one sample and two sample problems) z-test, student's t-test, F and chi-square test and Analysis of Variance (ANOVA). Non-Parametric tests: One sample: Sign test, signed rank test, Kolmogrov-

Smirnov test, run test. Critical difference (CD), Least Significant Difference (LSD), Kruskal–Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks.

**Exercise:** Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion, Self-learning and Case studies

**Mode of Transaction**

**The classroom learning would be based on:**

Lecture, Demonstration, Project Method, Seminars, Group discussions, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Problem solving, Debates and Case studies.

**The following tools shall be used in teaching and practicals:**

Textbooks, Gol e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

**Suggested Readings:**


1. Pagano, M. and Gauvreau, K. (2018). Principles of Biostatistics. Chapman and Hall/CRC, 2nd edition.
2. Rosner, B. (2015). Fundamentals of Biostatistics. Brooks Cole. 8th edition.
3. Das. D and Das. A. (2003). Statistics in Biology and Psychology. Academic Press, 3rd edition.
4. P. G. Hoel, Introduction to Mathematical Statistics, 1997.
5. Relevant research articles and digital resources


| L | T | P | Cr |
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**Course Title: Entrepreneurship**
**Course Code: ZOL.516**
**Total Hours: 15 Hours**

**Learning Outcomes:** Students will be able to:

- Understand the basic concepts of entrepreneur, entrepreneurship and its importance.
- Comprehend the opportunities, challenges and strategies required in entrepreneurship.
- Develop capabilities of preparing proposals for starting small businesses. Bring new ideas, patents, technologies and innovative services to the market.

**Unit I** **3 Hours**

Characteristics of an entrepreneur; Characteristics of entrepreneurship;

entrepreneurial traits and skills; innovation and entrepreneurship; Types of entrepreneurial ventures; enterprise and society in Indian context; Importance of women entrepreneurship

**Unit II** **4 Hours**

Why to start a small business; How to start a small business; opportunity analysis, external environmental analysis, legal requirements for establishing a new unit, raising of funds financial management for procurement of capital Collaborations & partnership, Establishing the venture - Project report preparation – format for a preliminary project report, format for a detailed/final project report.

**Unit III** **4 Hours**

**Road map from** Familiarization with Entrepreneurial development programs of public and private agencies (MSME, DBT, BIRAC, Make In India); Technology assessment, development & upgradation, Managing Quality control and technology transfer, Knowledge centers and Technology transfer agencies. Understanding regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

**Unit IV** **4 Hours**

**Innovation and** science-based ideas to business development within segments such as health & disease, agricultural, environmental and/or industrial value addition. Case studies and discussion sessions with successful science-based entrepreneurs

**Suggested Readings:**

1. Arora, Renu (2008). Entrepreneurship and Small Business, Dhanpat Rai & Sons Publications.
2. Chandra, Prasaaan (2018). Project Preparation, Appraisal, Implementation, Tata Mc-Graw Hills.
3. Desai, Vasant (2019). Management of a Small Scale Industry, Himalaya Publishing House.
4. Jain, P. C. (2015). Handbook of New Entrepreneurs, Oxford University Press.
5. Srivastava, S. B. (2009). A Practical Guide to Industrial Entrepreneurs, Sultan Chand & Sons.
6. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge, Routledge Studies in Innovation, Organizations and Technology (2018) 1st ed. Onetti, A, & Zucchella, A, CRC press, Taylor and Francis group. ISBN: 9781138616905.
7. Innovation, Commercialization, and Start-Ups in Life Sciences. (2014) 1st ed. Jordan, JF, CRC Press. Taylor and Francis group, ISBN: 9781482210125.

8. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences (2008) Adams, DJ, Sparrow JC, Bloxham, Scion, ISBN:1904842364.

**Modes of transaction:**
-Lectures and tutorials.
-Group-work
-Ideathons and design sprints
-Brain-storming sessions
-Group activities-learning by doing
**Tools used:** PPT, Video, Google drive

**Discipline Enrichment Course:**

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**Course Code: ZOL.575**
**Course Title: Career Prospects in Life Sciences**
**Total hours: 30**

**Learning outcomes:** After going through the course the learners will be able to

- Describe basic biological processes
- revisit and revise the courses offered
- Solve exercises, mock tests and practice tests for competitive examinations

**Unit I** **7 Hours**

**Life Sciences:** Scope, importance & career opportunities; classical zoology and basic animal biology; timeline of animal research.

**Unit II** **8 Hours**

**A revision of concepts in core courses**: Animal Evolution & Classification, Developmental Biology; Animal Physiology, Ecological Principles, Applied Zoology
Molecular Biology and Animal behavior**.**

**Unit III** **7 Hours**

**A revision of concepts in elective courses:** Genetic Engineering, Stem cell technology Hybridoma technology and Endocrinology, Animal Cell culture & Applications.

**Unit IV** **8 Hours**

Exercises, Mock Tests, Practice Tests from the previous year's related to UGC-CSIR – NET and ICMR - NET examinations and other competitive examinations.

**Mode of Transaction**

**The classroom learning would be based on:** Lecture, Demonstration, Project Method, Seminars, Group discussions, focused group discussions, Team teaching, Field visits, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Selflearning, and Case studies.

**The following tools shall be used in teaching and practicals:**

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

**Suggested Readings:**


1. Damron, W. S. (2012). Introduction to Animal Science. Prentice Hall. 5th Edition
2. Lisa AU. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
3. Voet, D. and Voet, J. G. (2008). Principles of Biochemistry. CBS Publishers & Distributors. New Delhi, India.
4. Urry, L. A. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
5. Smith, T. M. and Smith, R. L. (2012). Elements of Ecology. Benjamin Cummings Publishing Company, 8th edition.
6. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J. D. (2010). Molecular Biology of the Cell. Garland publishers, Oxford.
7. Guyton. (2007). Textbook of Medical Physiology. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
8. Alcock J. Animal Behavior: An Evolutionary Approach, 10th Edition
9. Lee Alan D. Principles of Animal Behavior (Third Edition)
10. Competitive examination papers.


**Web resources:**

**www.csirhrdg.res.in**

| L | T | P | Cr |
|---|---|---|---|
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**Course Code: ZOL.600**

**Course Title: Research proposal**

**Total hours: 120**

**Learning outcomes:**

- Critically analyze, interpret, synthesize existing scientific knowledge based on literature review
- Demonstrate an understanding of the selected scientific problem and identify the knowledge gap
- Formulate a hypothesis and design an experimental/theoretical work

Students will prepare a research proposal based on literature review and extensive student-mentor interactions involving discussions, meetings and presentations. Each student will submit a research/dissertation proposal of the research work planned for the M.Sc. dissertation with origin of the research problem, literature review, hypothesis, objectives and methodology to carry out the planned research work, expected outcomes and bibliography.

Students will have an option to carry out dissertation work in industry, national institutes or Universities in the top 100 NIRF ranking. Group dissertation may be opted, with a group consisting of a maximum of four students. These students may work using a single approach or multidisciplinary approach. Research projects can be taken up in collaboration with industry or in a group from within the discipline or across the discipline.

**Evaluation Criteria:**
The evaluation of the dissertation proposal will carry 50% weightage by supervisor and 50% by HoD and senior-most faculty of the department.

| Dissertation Proposal (Third Semester) | | |
|---|---|---|
| | Marks | Evaluation |
| Supervisor | 50 | Dissertation proposal and presentation |
| HoD and Senior Faculty of the department | 50 | Dissertation proposal and presentation |

**Modes of transaction**
Group discussions and presentations; Self-Learning; Experimentation

## SEMESTER – IV

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**Course Code: ZOL.600**
**Course Title: Dissertation**
**Total hours: 600**

**Learning outcomes**:

- Demonstrate an in-depth knowledge of scientific research pertaining to the area of study
- Demonstrate experimental/theoretical research capabilities based on rigorous hands-on training
- Critically analyze, interpret and present the data in light of existing scientific knowledge to arrive at specific conclusions
- Develop higher order thinking skills required for pursuing higher studies (Ph.D.)/research-oriented career options

Students will carry out their research work under the supervision of a faculty member. Students will interact with the supervisors through meetings and presentations on a regular basis. After completion of the research work, students will complete the dissertation under the guidance of the supervisor. The dissertation will include literature review, hypothesis, objectives, methodology, results, discussion, and bibliography.

**Evaluation Criteria:**

The evaluation of dissertation in the fourth semester will be as follows: 50% weightage for continuous evaluation by the supervisor which includes regularity in work, mid-term evaluation, report of dissertation, presentation, and final viva-voce; 50% weightage based on average assessment scores by an external expert, HoD and senior-most faculty of the department. Distribution of marks will be based on report of dissertation (30%), presentation (10%), and final viva-voce (10%). The final viva-voce will be through offline or online mode.

| Dissertation (Fourth Semester) | | |
|---|---|---|
| | Marks | Evaluation |
| Supervisor | 50 | Dissertation proposal and presentation |

| | | |
|---|---|---|
| HoD and Senior Faculty of the department | 50 | Dissertation proposal and presentation |