DISCIPLINE SPECIFIC CORE COURSE -19

Animal Models and Experimentation
Zoo-DSC-19

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	Tutorial	Practical Practice		
Animal Models and Experimentation **Zoo-DSC-19**	**04**	**02**	**0**	**02**	**As per the Program Eligibility**	**Basic understanding of Zoology**

Learning Objectives

The learning objectives of this course are as follows:

- To acquire an in-depth knowledge of the importance and applications of animal models in scientific research.
- To understand theoretical concepts, ethical principles and legal frameworks governing animal experimentation to assist in comprehending the quick response to pandemics in the form of vaccines.
- To gain theoretical and practical knowledge of experimental techniques using animal models.
- To develop skills to design experiments involving animal models for studies related to diseases, drug testing, and toxicity assessments/ Biomedical research.
- To explore alternatives to animal experimentation and their role in modern research.

Learning Outcomes

By studying this course, students will be able to:

- Have a better understanding of the concepts of the selection criteria, types, and applications of animal models in research.
- Demonstrate competence in handling, restraining, and administering treatments to animals in a humane and ethical manner.
- Analyze and interpret data generated from animal experiments.

- Critically evaluate the ethical considerations in using animals for research and propose alternatives when feasible.
- Design small-scale experiments using appropriate animal models to investigate scientific hypotheses.

SYLLABUS OF DSC-19

THEORY 30 hrs

UNIT 1: Introduction to Animal Models 6 hrs

Definition and Importance, Historical perspective and significance in biomedical research. Types of Animal Models: Inbred, outbred, transgenic, and knockout models. Criteria for Selecting an Animal Model: Relevance to human biology. Ethical considerations.

UNIT 2: Experimental Design and Techniques 10 hrs

Design of Experiments (DoE):Importance of hypothesis-driven research.Sample size estimation and randomization. Tissue collection and processing. Gene Editing in Animal Models: CRISPR-Cas9 and its applications.Creating knockout and knock-in models.

UNIT 3: Application of Animal Models 8 hrs

Disease Models:Oncology - Induced tumour models.Neurological disorders: Alzheimer's and Parkinson's models.Metabolic disorders: Diabetes and obesity models.Infectious diseases: Models for tuberculosis, malaria, and viral infections.Drug Discovery and Toxicology:Role of animal models in preclinical trials.Acute and chronic toxicity studies. Use of animals in stem cell research.

UNIT 4: Ethical and Regulatory Aspects of Animal Experimentation 6 hrs

Ethics in Animal Experimentation: Importance of humane treatment of animals. Principles of the 3Rs: Replacement, Reduction, and Refinement. Regulatory Frameworks: CPCSEA (India) and International Guidelines. Role of Institutional Animal Ethics Committees (IAECs). Good Laboratory Practices (GLP) for animal studies. Alternatives to Animal Testing: *In-vitro* models, organoids, and computational models. Advantages and limitations of alternatives.

PRACTICALS 60 hrs

(Laboratory periods: 15 classes of 4 hours each)

1. Selection and Handling of Animal Models: Basic handling and restraint techniques for mice, rats, and zebrafish. Observation of behavior and physiological parameters.
2. Techniques in Experimental Research: Induction of disease models, Behavioral testing: Maze and anxiety tests. Sample collection: Blood and tissue collection techniques.
3. Histology and Imaging: Preparation of tissues for histological studies. Basic imaging techniques (e.g., fluorescent microscopy).

4. Ethical Simulations: Case studies on ethical dilemmas. Mock IAEC proposal writing and review.
5. Presentation of Findings - Preparation of Scientific Posters - Oral Presentation Skills for sharing Research Outcomes
6. Project on any topic/ Project report on visit to any research institute/laboratory to for understanding some ongoing research studies using any animal model.

Essential/Recommended readings

1. Guide for the Care and Use of Laboratory Animals – National Research Council 8th Edition, 2011 9 Publisher: National Academies Press; ISBN: 978-0-309-15400-0.
2. Laboratory Animal Medicine 2nd Edition, 2002 Publisher: Academic Press; ISBN: 978-0-12-263951-7– James G. Fox, Bennett J. Cohen, Franklin M. Loew.
3. Principles of Laboratory Animal Science, Revised Edition, 2001, Publisher: Elsevier ISBN: 978-0-444-50612-2– L.F.M. van Zutphen, V. Baumans, A.C. Beynen.
4. Handbook of Laboratory Animal Management and Welfare, 4th Edition, 2013, Publisher: Wiley-Blackwell; ISBN: 978-0-470-65567-1– Sarah Wolfensohn, Maggie Lloyd.
5. Ethics of Animal Research: Exploring the Controversy, 2012, Publisher: MIT Press; ISBN: 978-0-262-01734-6– Jeremy R. Garrett.

Suggested Readings

1. Experimental Design and Data Analysis for Biologists 2002, Publisher: Cambridge University Press; ISBN: 978-0-521-00976-8– Gerry P. Quinn, Michael J. Keough.
2. Animal Models in Biomedical Research, 2010, Publisher: Humana Press; ISBN: 978-1-60761-670-2 – Timothy G. Geary, Aaron Maule (Editors).
3. Alternatives to Animal Testing: New Ways in the Biomedical Sciences, 2008, Publisher: Wiley-VCH; ISBN: 978-3-527-32090-2 – Christoph A. Reinhardt. Laboratory Manual for Animal Research, 1997, Publisher: Oxford University Press; ISBN: 978-0-19-511908-4– Tom L. Beauchamp *(A practical resource for students learning techniques in animal research and experimentation)*.
4. CPCSEA Guidelines for Laboratory Animal Facility, 2003 – Committee for the Purpose of Control and Supervision of Experiments on Animals (India).
5. Zebrafish: Methods and Protocols. 2012, Publisher: Humana Press; ISBN: 978-1-61779-597-8 – Allan V. Kalueff, Adam C. Gould.
6. Behavioral Research and Animal Welfare, 2019 Publisher: Springer; ISBN: 978-3-030-13966-1 – Edward Narayan.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -18

Advanced Biotechniques and Bioinstrumentation

Zoo-DSE-18

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Biotechniques and Bioinstrumentation **Zoo-DSE-18**	**04**	**03**	**0**	**01**	**As per the Program Eligibility**	**Basic understanding of Zoology**

Learning Objectives

The learning objectives of this course are as follows:

- To understand advanced techniques used for research, diagnostics, and industrial applications Biotechnology.
- To learn the principles, applications, and limitations of bioinstrumentation methods.
- To gain hands-on experience in the operation and maintenance of advanced instruments.
- To develop critical thinking to select and apply suitable techniques for solving specific biological problems.
- To learn to interpret experimental data and troubleshoot issues in instrumentation.

Learning Outcomes

By studying this course, students will be able to

- Have a better understanding of the diverse cellular processes and cellular interactions.
- To explain the principles and working mechanisms of advanced instruments in biotechnology.
- To demonstrate proficiency in operating instruments like spectrophotometers, chromatographs, and PCR machines.
- To design experiments using advanced techniques like chromatography, electrophoresis, and mass spectrophotometry.
- To analyze experimental data generated by advanced bioinstrumentation.
- To apply biotechnological tools to solve problems in diagnostics, genomics, proteomics, and drug discovery.

Syllabus of DSE-18

THEORY **45 hrs**

UNIT- 1: Spectroscopic Techniques **10 hrs**

Principles and Applications: UV-Visible spectroscopy, Fluorescence spectroscopy, Circular Dichroism (CD). Advanced Techniques: Infrared (IR) spectroscopy, Atomic Absorption Spectroscopy (AAS), and Nuclear Magnetic Resonance (NMR).

Applications: Structure determination, protein folding studies, and biomolecular interactions.

UNIT-2: Chromatography and Electrophoresis **10 hrs**

Chromatography: Principles and applications of HPLC, Gas Chromatography (GC), and Ion Exchange Chromatography.

Electrophoresis: Polyacrylamide Gel Electrophoresis (PAGE), Agarose Gel Electrophoresis, 2D Gel Electrophoresis. Applications in genomics and proteomics.

UNIT-3: Molecular Biology Techniques **9 hrs**

Polymerase Chain Reaction (PCR): qPCR, RT-PCR, and digital PCR.

DNA Sequencing: Sanger sequencing and Next-Generation Sequencing (NGS).

UNIT 4: Imaging and Analytical Tools **16 hrs**

Microscopy: Principles and applications of Confocal Microscopy, Electron Microscopy (SEM, TEM). Mass Spectrometry (MS): Principles, instrumentation, and applications in proteomics and metabolomics. Principles, components, and applications of Biosensors in diagnostics.

PRACTICALS **30 hrs**

(Laboratory periods: 15 classes of 2 hours each)

1. Chromatography Techniques: Separation of biomolecules using Chromatography.
2. Electrophoresis Techniques: SDS-PAGE for protein separation.
3. Amplification of DNA. Gel documentation and analysis of PCR products.
4. Imaging Techniques: Demonstration of SEM/TEM.
5. Biosensors: Demonstration of glucose biosensors and ELISA techniques.

Project related to topics covered in Theory/ project report based on visit to labs/institutions/industry.

Essential/Recommended readings

1. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, 7th Edition (2010), Cambridge University Press.
2. Biophysical Chemistry: Principles and Techniques by Upadhyay, Upadhyay, and Nath, Revised Edition (2020), Himalaya Publishing.
3. Introduction to Spectroscopy by Donald L. Pavia et al., 5th Edition (2015), Cengage Learning.
4. Bioinstrumentation by John G. Webster, 1st Edition (2004), Wiley-Interscience.

Suggestive readings

1. Fundamentals of Analytical Chemistry by Douglas A. Skoog et al., 9th Edition (2013), Cengage Learning.
2. Molecular Biology of the Gene by James D. Watson et al., 7th Edition (2013), Pearson.
3. Chromatography: Principles and Instrumentation by B.K. Sharma, Revised Edition (2007), Goel Publishing House.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE -19

Ichthyology

Zoo-DSE-19

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ichthyology **Zoo-DSE-19**	**4**	**3**	**0**	**1**	**As per the Program Eligibility**	**Basic understanding of Zoology**

Learning Objectives

The Learning Objectives of this course are as follows:
• To increase student familiarity with evolutionary history and taxonomic diversity of fishes.
• To improve understanding of the basic physiological and behavioural adaptations of fishes.
• To enhance students' skills in studying locally available fish species.
• To expose students to some of the issues surrounding the conservation of fish biodiversity in the environment.

The Learning Outcomes

The learning Outcomes of this course are as follows:

After studying this course, students can:

- Keep track of types of fishes and their morphology.
- Get detailed knowledge about the physiology of fishes.
- Attain knowledge of various feeding habits, adaptations, parental care, and reproduction of fishes.
- Attain advanced knowledge about the fishes which would be helpful for designing experiments for research.

Syllabus- DSE-19:

THEORY **45 hrs**

Unit 1: Introduction to Fishes **16 hrs**

Introduction and types of fishes, Classification, General Characters, Fish Origin: The diversification and relationships of jawless and jawed fishes, Fish morphology and anatomy: Scales, Teeth, Muscles, Swim-bladder, Gills, Fins, Skull, Weberian ossicles, Lateral-line system.

Unit 2: Fish Physiology **15 hrs**

Gas exchange, Internal transport and Homeostasis- Aquatic and Aerial respiration, Cardiovascular physiology, Hematology, Lymphoid organs, osmoionic regulation, Acid-base balance, nitrogen excretion and metabolism, Sensory systems–photoreception, chemoreception, mechanoreception, electroreception.

Unit 3: Reproduction and Development **8 hrs**

Oviparity and ovoviviparity, Prolific breeders, Fecundity, Induced breeding, Fish larval stages, Parental care in fishes.

Unit 4: Food and Feeding habits of Fishes and their Adaptations **6 hrs**

Fish foods and feeding habits, Adaptations in hill stream and deep-sea fishes, Types of migration in fishes, Abiotic factors and their influence on fish.

PRACTICALS: **30 hrs**

(Laboratory periods: 15 classes of 2 hours each)

1. Identification of local fishes by physical key methods.
2. Study of different types of fish scales.
3. Study of chromatophores of fishes under microscope.
4. Analysis of water quality parameters viz. temperature, pH, dissolved oxygen.
5. Fish Morphometric measurements: Standard length, Total length, Fork length, Dorsal fin height, Pectoral fin length, Ventral fin length, Anal fin height.
6. Study of anatomy of digestive systems among different types of fishes.
7. Gonado-somatic index.
8. Study of Weberian ossicles and otoliths.
9. Visit to local fish market/farm and report preparation.

Essential/Recommended Readings:

1. Biology of Fishes, Bone, Q. and Moore, R., Taylor and Francis Group, CRC Press, U.K.
2. The Physiology of Fishes, Evans, D. H. and Claiborne, J. D., Taylor and Francis Group, CRC Press, UK
3. The Senses of Fish Adaptations for the Reception of Natural Stimuli, von der Emde, R., Mogdans, J. and Kapoor, B. G., Narosa Publishing House, New Delhi, INDIA
4. Ichthyology, Lagler, K.F., Bardach, J.E. and Miller, R.R. John Wiley and Sons Inc., New York, USA
5. A textbook of fish biology and fisheries, Khanna S.S. and Singh H.R. Narendra publishing house, Delhi

Suggested readings:

1. Ichthyology, Karl F. Lagler, John E. Bardach, Robert R. Miller, Dora R. May Passino, Wiley, New York, USA
2. Ichthyology Handbook, Kapoor, B. G., Khanna, B. Springer Science & Business Media, 2004

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE -17

Principles of Developmental Biology

Zoo-GE -17

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Principles of Developmental Biology **Zoo-GE-17**	**4**	**2**	**0**	**2**	**As per the program eligibility**	**Nil**	**Zoology**

Learning Objectives

The learning objectives of this course are to:

- Identify the basic principles of developmental biology
- Understand the mechanisms associated with the development of organ system of the human body
- Acquaint the students with the fascinating transformation of a single cell (fertilised egg) into a fully developed, complex organism.
- Explain the basic principles and concepts underlying morphogenesis.
- Be able to investigate the effects of environmental factors on embryonic development.

Learning Outcomes

By studying this course, students will be able to:

- Understand the process and significance of formation of haploid germ cells
- Interpret the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
- Understand the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of the body plan of multicellular organisms.
- Gain knowledge of the general mechanisms involved in morphogenesis and to explain how different cells and tissues interact in a coordinated way to form various tissues and organs.
- Become aware of the effects of pollutants/chemicals on abnormal embryonic development.

SYLLABUS

THEORY **30 Hrs**

UNIT- 1: Introduction and Historical perspectives **2 hrs**

Definition and scope of developmental biology; Importance of embryology in medicine and biology.

UNIT- 2: Gametogenesis, Fertilisation and Morphogenetic movements **18 hrs**

Spermatogenesis and oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal), Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula. Gastrulation: Process of Gastrulation in frog and chick. Fate of the three germ layers: ectoderm, mesoderm, and endoderm.

UNIT- 3: Metamorphosis **2 hrs**

Metamorphosis of Amphibian larvae to Adult.

UNIT- 4: Placentation and Teratology **8 hrs**

Types of placenta (shape and structure), Functions of Placenta, Amniocentesis. Teratology: Teratogenesis, Teratogenic agents and their effects on embryonic development.

PRACTICALS **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula (Neural plate, Neural fold and Neural tube stages), tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): primitive streak stage, head process stage, head fold stage, 4-somite stage, 13-somite stage, 16-somite stage, 37-somite stage
3. Types of placenta with the help of photomicrographs/ slides.

PROJECT WORK
Project report on *Drosophila* or any insect culture/Visit to Poultry Farm/IVF Centre.

Essential/recommended readings

1. **1.**Slack, J.M.W. (2013) Essential Developmental Biology. III Edition, Wiley-Blackwell.
2. 2.Gilbert, S. F. (2010). Developmental Biology. IX Edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA
3. 3.Balinsky, B. I. and Fabian B. C. (2006). An Introduction to Embryology. VIII Edition, International Thompson Computer Press.
4. Wolpert, L. (2002). Principles of Development. II Edition, Oxford University Press.

Suggested readings

1. Baweja, V. and Misra, M. (2021). *E-book on Practical Manual of Developmental Biology*.
2. Arora, R. and Grover, A. (2018). *Developmental Biology: Principles and Concepts*. 1st Edition, R. Chand & Company.
3. Carlson, B.M. (2007.) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE -18

Biology of Animal Cells

Zoo-GE -18

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Biology of Animal Cells **Zoo-GE-18**	**4**	**2**	**0**	**2**	As per the Program Eligibility	Nil	Zoology

Learning Objectives

The learning objectives of this course are to:

- Explore the diversity of the cells ranging from unicellular to multicellular organisms
- Explore the different models of the plasma membrane and various modes of transport across them
- Understand the fundamental structure of cell and its various functions.
- Examine the structural details of the cell organelles in relation to their role in the organism.
- Investigate the process of cell division and its relevance in the continuation of the species
- Analyse the various practical techniques to study the cell and its function.

Learning Outcomes

By studying this course, students will be able to:

- Explain the fundamental and functional principles of different types of cells
- Describe the structure and various models of plasma membrane and its role in transport of materials across cells
- Analyze the organizational details of key cell organelles involved in diverse cellular processes.

- Appreciate the characteristics of cellular growth, division, survival and death to regulate these important processes.
- Comprehend the process of cell division and its role in cellular cycle.
- Gain insights into the defects in functioning and regulation of cell organelles leading to diseases.
- Apply practical skills to understand the different cell division methods..

SYLLABUS

THEORY (30 Hrs)

UNIT 1: Types of Cells, Plasma Membrane and Endo-membrane System 13 hrs

Virus, Viroids, Mycoplasma, Prokaryotic and Eukaryotic cells. Different structures and models of plasma membrane, Transport across membranes: active and passive transport, facilitated transport; Cell-cell junctions: Tight junctions, adherens junctions, gap junctions. Endo-membrane system: Structure and Functions: Endoplasmic Reticulum, Vesicular transport from ER to Golgi apparatus; Protein sorting and transport from Golgi apparatus; Golgi apparatus, Vesicular transport: Coated Vesicles; Lysosomes; Peroxisomes.

UNIT 2: Mitochondria 4 hrs

Endo-symbiotic hypothesis; Respiratory chain, Chemi-osmotic hypothesis.

UNIT 3: Cytoskeleton 4 hrs

Microtubules, Microfilaments and Intermediate filaments.

UNIT 4: Nucleus and Cell division 9 hrs

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Transport of molecules across nuclear membrane, Chromatin: euchromatin, heterochromatin and packaging, nucleosome, nucleolus. Cell division: Mitosis, meiosis and regulation of cell cycle.

PRACTICALS 60 hrs

(Laboratory periods: 15 classes of 4 hours each)

1. Principles of Microscopy: Compound microscope: Phase contrast microscope; Electron microscope; Differential Interference Contrast (DIC) Microscope.
2. Principle and types of cell fixation and staining; Cell fractionation.
3. Study of prokaryotic cells by Gram staining and eukaryotic cells (cheek cells) by staining with hematoxylin/methylene blue.
4. 4.Study the effect of hypotonic, isotonic, and hypertonic solutions on cell permeability.
5. Preparation of a temporary slide of squashed and stained onion root tip to study various stages of mitosis.
6. Study of various stages of meiosis through permanent slides.

7. Preparation of stained mount to show the presence of Barr body in human female WBCs /cheek cells.

Essential/recommended readings:

1. Cooper, G.M., Hausman, R.E. (2019). The Cell: A Molecular Approach. VIII Edition, ASM Press and Sinauer Associates.
2. Becker, Kleinsmith, and Hardin (2018). The World of the Cell, IX Edition, Benjamin Cummings Publishing, San Francisco.
3. Karp, G. (2015). Cell and Molecular Biology: Concepts and Experiments, VIII Edition, John Wiley & Sons Inc.

Suggested readings:

1. Renu Gupta, Seema Makhija and Ravi Toteja (2018). Cell Biology Practical Manual, Prestige Publishers, New Delhi
2. V. K Sharma (1991). Techniques in Microscopy and Cell Biology, Tata McGraw-Hill Publishing Company Limited, New Delhi.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE -19

Immunology: Understanding the body's defense Systems

Zoo-GE -19

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Immunology: Understanding the body's defense System Zoo-GE-19	**4**	**2**	**0**	**2**	**As per the Program Eligibility**	**Biology in Class 12th**	**Zoology**

Learning Objectives

The learning objectives of this course are to:

- Describe the general difference between the innate and the adaptive immune system.
- Broadly describe how the innate and the adaptive immune systems mature in the body, how they interact with each other, and how they function in protecting the host from infections.
- Impart an in-depth knowledge on how our immune system fights with infection and foreign substances that can harm our body.
- Acquire knowledge of the immunogenicity of biomolecules.

Learning Outcomes

By studying this course, students will be able to:

- Have an in-depth understanding of the innate and the adaptive immune system.
- Gain experimental skills and techniques frequently used in research in immunology.
- Develop essential skills in experimental design, techniques and execution, which are relevant to immunology.
- Comprehend and analyze the different cellular and humoral components of the immune system.

- Appreciate the contribution of various components of immune system in health and disease including basis of vaccination, autoimmunity, immunodeficiency and hypersensitivity

SYLLABUS

THEORY **30 Hrs**

UNIT- 1: Basics of Immunology **5 hrs**

History and scope of immunology; Types of immunity: innate and adaptive, Humoral and cell-mediated immunity, Active and Passive immunity; Cells and organs of the immune system, overview of Haematopoiesis.

UNIT- 2: Antigens and Antibodies **7 hrs**

Antigenicity, immunogenicity; Structure and types of antibodies; Antigen-antibody interactions (agglutination, precipitation); Monoclonal antibodies production and their therapeutic applications.

UNIT- 3: Immune Response, Mechanisms and Immunological Disorders **11 hrs**

Major Histocompatibility Complex (MHC I & II); Exogenous and endogenous antigen processing; overview of Cytokines and complement system. Immunological Disorders: Hypersensitivity reactions (Gell and Coomb's classification); Autoimmunity and autoimmune diseases (e.g., rheumatoid arthritis, thyroiditis); Immunodeficiency (e.g., SCID, AIDS).

UNIT- 4: Applied Immunology **7 hrs**

Vaccines and immunization programs; Principles of immunodiagnostics (ELISA, RIA, Western blot); Basics of Immunotherapy; Transplantation

PRACTICALS **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. Study of lymphoid cells and organs in rat/mouse*.
2. Identification of different blood cells using Leishman's/Giemsa/Crystal violet stained blood smear.
3. Blood group determination by ABO kit.
4. Cell counting and viability test (trypan blue dye exclusion test) from splenocytes from rat/mouse/any other species.
5. To understand the antigen and antibody interactions by:

6. Ouchterlony's double immune-diffusion method to study immune-precipitation and interpretation of patterns of identity, non-identity and partial identity.
7. Demonstration of ELISA.
8. FACS

PROJECT WORK

Project on any topic/ Project report on visit to any research institute/laboratory to study the immunological techniques.

Essential/recommended readings

1. Owen, Punt, Stranford, Patricia Jones, Judy Owen (2018). Kuby Immunology (8th ed.). New York, WH: Freeman, ISBN: 978-1319114670
2. Kenneth Murphy, Casey Weaver (2016), Janeway'sImmunobiology (9th ed.). Garland Science, ISBN: 978-0815345053
3. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006) Immunology, VI; Edition, W.H. Freeman and Company.
4. Abul Abbas, Andrew Lichtman, Shiv Pillai (2017). Cellular and Molecular Immunology; Elsevier
5. David, M., Jonathan, B., David, R. B. and Ivan, R. (2006) Immunology, VII Edition, Mosby, Elsevier Publication.

Suggested Readings

1. Peter Parham (2020) The immune System. (5th ed.). Garland Science, ISBN: 978-1285776902
2. Ivan Roitt, Ivan Roitt, and R. M. Hay (2016) Immunology (9th Edition) Blackwell Science.
3. Singh, I. K. and Sharma, P. [Eds.] (2022) An Interplay of Cellular and Molecular Components of Immunology. Taylor & Francis group, CRC Press.
4. Singh, I. K. and Sharma, P. [Eds.] (2022) Essentials of Immunology, Laboratory Manual; Prestige Publishers.
5. Kaur, H., Toteja, R., and Makhija, S. (2021) Textbook of Immunology, I.K International Publishing House and Wiley India Ltd.

NOTE: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE COURSE -20

Concepts of Human Metabolism

Zoo-GE -20

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lectures	Tutorial	Practical/ Practice			
Concepts of Human Metabolism Zoo-GE-20	4	2	0	2	As per the Program Eligibility	Biology in Class 12th	Zoology

Learning Objectives

The learning objectives of this course are to:

- Understand the concepts of various metabolic pathways.
- Obtain knowledge of the tissue metabolism and its regulation.
- Become conversant with the idea of enzyme specificity in metabolic pathways.
- Learn how the body adjusts to variations in the demand for energy.

Learning Outcomes

By studying this course, students will be able to:

- Comprehend the fundamental concepts of metabolism.
- Better appreciate the importance and functions of carbohydrates, lipids, proteins in human metabolism.
- Comprehend the concept and mechanism of enzyme action and its regulation.
- Appreciate the importance of high energy compounds, electron transport chain, synthesis of ATP under aerobic and anaerobic conditions.

SYLLABUS

THEORY **30 Hrs**

UNIT 1: Overview of Metabolism **4 hrs**

Concept of metabolism: anabolism and catabolism, general introduction of metabolic pathways; Regulation of metabolism (enzymatic and hormonal), compartmentalization of metabolism, Overview of digestion and absorption of carbohydrates, lipids and proteins.

UNIT 2: Metabolism of Carbohydrates **12 hrs**

Glycolysis, Citric acid cycle, Gluconeogenesis, Hexose Monophosphate pathway, Glycogen metabolism.

UNIT 3: Metabolism of Lipids and Proteins **9 hrs**

Lipids: Beta oxidation of fatty acids, Metabolism of Ketone bodies, Metabolism during starvation. Proteins: Concept of Ureotelism, Uricotelism and Ammonotelism, Transamination, Deamination, Nitrogen metabolism, Ketogenic and glucogenic amino acids.

UNIT 4: Electron transport System and ATP synthesis **5 hrs**

Biological Redox systems; Overview of mitochondrial respiratory chain: electron carriers, sites of ATP production, ATP synthesis vis Oxidative phosphorylation; Chemiosmotic THEORY, shuttle systems.

PRACTICALS **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. To qualitatively identify the functional groups of carbohydrates.
2. Estimation of total protein in given solutions by Lowry's method.
3. Separation of amino acids and lipids by chromatography.
4. Study the action of salivary amylase under optimum conditions.
5. To study biological oxidation using goat liver.

Essential/recommended readings

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.). New York, WH: Freeman.
2. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.), New York, WH: Freeman Company.

Suggested Readings

1. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.), New Jersey, John Wiley & Sons Asia Pvt. Ltd.
2. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry. XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

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