

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES
Offered by Department of Zoology
Category-IV

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GENERIC ELECTIVES (GE-1): Human Physiology

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
		Lecture	Tutorial	Practical/ Practice			
Human Physiology	4	2	-	2	12 th Pass	Nil	Zoology

Learning Objectives

This course offers an overview of the concepts of normal biological functions in the human body. The fundamentals of human physiology and histological structures will be correlated. The concept of homeostasis in response to changes in the external environment will be introduced. Further, students will be provided with knowledge that can be applied in everyday life. The students will be encouraged to pursue further studies in physiology and related fields as well as multidisciplinary subjects that require an understanding of the physiology of humans.

Learning outcomes

Upon completion of the course, students will be able to:

- Understand the principles of normal biological function in the human body.
- Outline basic human physiology and correlate it with histological structures.
- Understand the homeostasis in animals in response to changes in their external environment.

SYLLABUS OF GE-1

Unit I: Tissues (05 Hours)

Types of Tissues; Structure and Function of Epithelial, Connective, Muscular and Nervous tissues.

Unit II: Functioning of Excitable Tissue (Nerve and Muscle) (05 Hours)

Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Mechanism of muscle contraction (Sliding filament theory).

Unit III: Digestion and Absorption of Food (05 Hours)

Structure and function of digestive system; Digestion and absorption of carbohydrates, fats and proteins.

Unit IV: Respiratory Physiology (04 Hours)

Structure and function of respiratory tract and lungs; Ventilation, External and Internal respiration; Transport of oxygen and carbon dioxide in blood.

Unit V: Cardiovascular System (04 Hours)

Structure of heart, Cardiac cycle, Composition of blood

Unit VI: Renal Physiology (03 Hours)

Functional anatomy of kidney

Unit VII: Reproductive Physiology (04 Hours)

Structure of testis and ovary; Spermatogenesis and Oogenesis.

Practical component (if any) (60 Hours)

1. Preparation of temporary mount of neurons and blood cells (blood film preparation).
2. Preparation of haemin and haemochromogen crystals.
3. Haemoglobin estimation using Sahli's haemoglobinometer.
4. Determination of ABO Blood group.
5. Recording of blood pressure using a Sphygmomanometer.
6. Examination and detailed study of permanent histological sections of mammalian Stomach, Duodenum, Liver, Lung, Kidney, Pancreas, Testis and Ovary.

Essential readings

1. Tortora, G.J. and Derrickson, B.H. (2012). Principles of Anatomy and Physiology. XIIIth Edition, John Wiley and Sons, Inc.
2. Widmaier E, Raff H and Strang K. (2013). Vander's Human Physiology: The Mechanism of Body Functions. XIIIth Edition, McGraw-Hill Education.
3. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology. XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Kesar, S. and Vashisht, N. (2007) Experimental Physiology. Heritage Publishers.
5. Prakash, G. (2012) Lab Manual on Blood Analysis and Medical Diagnostics. S. Chand and Company Ltd.

GENERIC ELECTIVES (GE-2): Nature and Wildlife Studies

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
		Lecture	Tutorial	Practical/ Practice			
Nature and Wildlife Studies	4	2	-	2	12 th Pass	Nil	Zoology

Learning Objectives

The course is designed to acquaint students with varied aspects of wildlife conservation, including its importance, major threats, and management of habitats and populations. The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. Further, students will be motivated to pursue careers in the field of wildlife conservation and management..

Learning outcomes

By studying the course the students will develop:

- Understanding about wild life
- Evaluation and Management of Wildlife
- Wild life resources and protection

SYLLABUS OF GE-2

Unit I: Conservation of Nature and Wildlife (06 Hours)

Values of wildlife - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: Wildlife Conservation Society (WCS), Convention on Biological Diversity (CBD), Agenda 21 of United Nations.

Unit II: Evaluation and Management of Wildlife (06 Hours)

Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage; Census method

Unit III: Management of Natural Habitats (04 Hours)

Setting back succession: Grazing logging, Mechanical treatment, Advancing the successional process.

Unit IV: Management Planning of Wildlife in Protected Areas (04 Hours)

Human-wildlife conflict, Captive Breeding, Ecotourism.

Unit V: Wildlife Health and Management (04 Hours)

Care of injured and diseased animals, Quarantine; Zoonotic diseases: Ebola, Salmonellosis, Rabies, Foot and Mouth Disease, MonkeyPox, SARS, Bovine and Avian Flu.

Unit VI: Protected Areas (06 Hours)

National parks and sanctuaries, Biosphere reserves, Conservation and Community reserve, Important features of protected areas in India, Tiger conservation , management and challenges.

Practical component (if any) (60 Hours)

1. Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field: Identification of animals
4. through pug marks, hoof marks and scats.

5. To study the various animal tracking system: Global Positioning System, Remote Sensing and Biotelemetry.
6. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
7. A report based on a visit to National Park/ Wildlife Sanctuary/ Biodiversity Park or any other wildlife conservation site.

Essential readings

1. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313
2. A.R.E. Sinclair, J.M. Fryxell and G. Caughley (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
3. S.K. Singh (2005). Textbook of Wildlife Management. IBDC, Lucknow.
4. K. Banerjee (2002). Biodiversity conservation in managed and protected areas. Agrobios, India.
5. B.D. Sharma (1999). Indian Wildlife Resources Ecology and Development. Daya Publishing House, Delhi.
6. R.B. Primack (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
7. B. B. Hossetti (1997). Concepts in Wildlife Management. Daya Publishing House, Delhi.

- a. Bromination of phenol/aniline.
- b. 2,4-Dinitrophenylhydrazone of aldehydes and ketones
- c. Semicarbazone of aldehydes/ ketones
- d. Aldol condensation reaction using green method.
- e. Bromination of Stilbene.
- f. Acetanilide to p-Bromoacetanilide.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

References:

Theory:

1. Sykes, P.(2003), **A Guide Book to Mechanism in Organic Chemistry**, 6th Edition Pearson Education.
2. Eliel, E. L. (2001), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Pearson Education.
4. Bahl, A; Bahl, B. S. (2019), **Advanced Organic Chemistry**, 22nd Edition, S. Chand.

Practical:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), **Advanced Experimental Organic Chemistry**, Manakin Press.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Teaching Learning Process:

- Blend of conventional blackboard teaching, modern teaching learning tools and
- Computational infrastructure- based instructions and Practical training.
- Problem solving and quizzes for enhanced understanding of the concepts.
- Explaining the handling and usage of the hardware and softwares required for solution to the given set of problems.

Assessment Methods:

- Presentations by individual student/ group of students
- Class Tests at periodic intervals.
- Written assignment(s)
- End semester University theory examination presentations by individual student/ group of students

Keywords: Chirality, Electrophilic addition, Nucleophilic addition, Nucleophilic substitution, Electrophilic substitution

**COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE
DEPARTMENT OF ZOOLOGY**

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-3): Economic Zoology

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Economic Zoology	04	02	0	02	Class XII pass	NIL

Learning Objectives

The learning objectives of this course are as follows:

- It deals with the application of zoological knowledge for the benefit of mankind by understanding the economy, health and welfare of humans.
- It includes culturing organisms for mass production for human use and to control or eradicate harmful ones.
- It will bring to the fore the multidisciplinary nature of Economic Zoology as it includes sericulture, apiculture, aquaculture, pisciculture and insect pests of agriculture.

Learning Outcomes

By studying this course, students will be able to

- develop an understanding of the beneficial higher and lower organisms in terms of economic prospective.
- aquatic organisms and agriculturally important insect pests based on their morphological characteristics/structures.
- develop a critical understanding of the contribution of organisms to the welfare of society.
- examine the diversity of insect pests of different orders in the agro-ecosystem and sustainable pest management strategies.

SYLLABUS OF GE-3

UNIT – I Aquaculture

05 Hours

Definition, scope, and significance of Aquaculture, Prawn culture, Pearl culture, Edible Oyster culture.

UNIT – II Pisciculture

07 Hours

Basic concept on mono and composite fish culture (Carp culture); Fish diseases caused by *Ichthyophthirius multifiliis*, *Trichodinia* sp. and *Ichthyobodo* sp., symptoms and control; Maintenance of aquarium.

UNIT – III Sericulture**05 Hours**

Different species and economic importance of silkworm, Mulberry and Non-mulberry Sericulture (Eri, Muga, Tussar), Sericulture techniques.

UNIT – IV Apiculture**05 Hours**

Different species of Honeybee, types of beehives - Newton and Langstroth, Bee Keeping equipment, Methods of extraction of honey (Indigenous and Modern) and its processing, Products of apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses.

UNIT – V Agricultural Crop Pest and Management**08 Hours**

Bionomics of crop pests of rice (*Leptocorisa acuta*); sugarcane (*Pyrilla perpusilla*); vegetable (*Raphidopalpa foveicollis*); and stored grain (*Corcyra cephalonica*); Pest Management Strategies (Physical, Chemical & Biological)

Practical component – 60 Hours

1. Study of aquatic organisms - prawns, oysters and fishes (*any three*) through museum specimens in the laboratory with details on their classification, distribution and specialized features.
2. Study of different species of aquarium fishes (Goldfish, Guppy, Swordtail fish) and maintenance of aquarium in lab/indoor.
3. Study of major crop pests of rice (*Leptocorisa acuta*), sugarcane (*Pyrilla perpusilla*), vegetable (*Raphidopalpa foveicollis*) and stored grain (*Corcyra cephalonica*) belonging to different orders.
4. Study of *Bombyx mori*, its life cycle and economic importance.
5. Study of the life history of honeybee, *Apis cerana indica* and *Apis mellifera* from specimen/ photographs - egg, larva, pupa, adult (queen, drone, worker)
6. Study of artificial hive (Langstroth/Newton), its various parts and beekeeping equipment.
7. Project report on life cycle of any one crop pest or on a product obtained from apiculture industry.
8. Field study/lab visit to an apiary/honey processing unit/sericulture institute/aquarium shop/fish farm/pisciculture unit.

Essential/recommended readings

1. Atwal, A.S. (1993) Agricultural Pests of India and Southeast Asia. Kalyani Publishers, New Delhi.
2. Shukla, G.S. and Upadhyay, V.B.: Economic Zoology, 4e, 2002, Rastogi.
3. D. B. Tembhare. (2017) Modern Entomology. Published by Himalaya Publishing House (ISO 9001: 2008 Certified).
4. Dawes, J. A. (1984) The Freshwater Aquarium, Roberts Royce Ltd. London.

Suggestive readings

1. S.S. Khanna and H.R. Singh. A Textbook of Fish Biology & Fisheries Published by Narendra Publishing House. 3rd Edition. (ISBN13: 9789384337124)
2. Dokuhon, Z.S. (1998). Illustrated Textbook on Sericulture. Oxford & IBH Publishing Co., Pvt. Ltd. Calcutta.

GENERIC ELECTIVES (GE-4): Lifestyle Disorders

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
		Lecture	Tutorial	Practical/ Practice		
Lifestyle Disorders	04	02	0	02	Class XII pass	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course aims to introduce the students to the concept of health, nutrition, and the factors affecting it.
- It will apprise students of the prevalence of emerging health issues affecting the quality of life.
- The course will facilitate the understanding of different physical and psychological associated disorders and their management for a healthy lifestyle.
- It highlights the important lifestyle-related disorders and describes the risks and remedies in relation to adopting a better life.

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of lifestyle choices and the diseases associated with them.
- have an in-depth understanding of making better lifestyle decisions.
- learn about various techniques for preliminary diagnosis of lifestyle disorders

SYLLABUS OF GE-4

UNIT – I Introduction to Lifestyle

05 Hours

Traditional Indian lifestyle vs modern Indian lifestyle, lifestyle diseases – definition, risk factors-erratic sleep patterns, wrong food choices, smoking, alcohol abuse, stress, lack of optimum physical activity, illicit drug use, Obesity, respiratory diseases, diet and exercise.

UNIT – II Diabetes and Obesity

05 Hours

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes-paediatric and adolescent obesity-weight control and BMI (Body Mass Index), Prediabetes, PCOS/PCOD.

UNIT – III Cardiovascular Diseases

06 Hours

Coronary atherosclerosis-Coronary artery disease, Causes-Fat and lipid, Alcohol Abuse-Diagnosis, Electrocardiograph, Echocardiograph, Treatment, Exercise and Cardiac rehabilitation.

UNIT – IV Cancer**05 Hours**

Introduction to Cancer and general diagnostic methods to detect cancer; Lung Cancer, Mouth Cancer: associated lifestyle choices, symptoms and treatment.

UNIT – V Hypertension**04 Hours**

Risk factors, complications (brain, heart, eye and kidney) and management of hypertension.

UNIT – VI WHO Global action plan and Monitoring**05 Hours**

WHO Global action plan and Monitoring framework for prevention and control of non-communicable diseases, NPHCE (National Programme for the Health Care of Elderly), Fit India movement (Yoga and meditation).

Practical component – 60 Hours

1. Estimation of blood glucose (GOD/POD) by kit.
2. Calculation of BMI, waist to hip ratio, skin fold test.
3. Imaging techniques for cancer diagnosis. CT Scan, MRI, PET-CT scan. Confirmatory Biopsy.
4. Blood pressure measurement using a sphygmomanometer.
5. Study of cardiac rehabilitation- thrombolytic agents and balloon angioplasty.
6. Project Work based on Case studies related to risk factors of any ONE lifestyle disorder studied.

OR

7. To write a review of personal experience of using any of the available health or lifestyle-related applications over a period of time with some data to correlate.

Essential/recommended readings

1. James M.R, Lifestyle Medicine, 2nd Edition, CRC Press,2013,
2. Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy & Physiology. XI edition. John Wiley & Sons
3. Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition, ASM Press and Sinauer Associates

Suggestive readings

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd/W.B. Saunders Company.
2. Widmaier E, Raff H and Strang K. (2013) Vander's Human Physiology: The Mechanism of Body Functions. McGraw-Hill Education 13th Edition.

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

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

GENERIC ELECTIVES (GE-5): Food, Nutrition & Health Zoo-GE-5

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
		Lecture	Tutorial	Practical/ Practice		
Food Nutrition & Health Zoo-GE-5	04	02	00	02	Passed 12 th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- This course offers an overview of the concepts of normal food and nutrition required by the human body to maintain good health.
- To understand physiology, biochemistry, pathology, immunology, medicine, food science, and other fields with context to nutrition.
- Learn the concept of malnutrition, lifestyle-related disorders, addiction-related social health problems and eating disorders will be introduced.
- Appreciate knowledge that can be applied in everyday life.
- Learn the role of macronutrients and micronutrients, their nutritional requirements for different age groups during various health conditions.
- The students will be encouraged to pursue further studies in nutrition and health.

Learning Outcomes

By studying this course, students will be able to

- have an in-depth understanding of the dietary sources and role of nutrients in forming a balanced diet.
- appreciate the concept of nutritional requirements for different age groups and in pregnancy and lactation.
- know about the various food allergens and the body's hypersensitivity towards it.
- understand the concept of health and role of various nutrients in mitigating several deficiency disorders.
- identify and analyse the causes of malnutrition, lifestyle-related disorders, addiction-related social health problems and eating disorders.

- appreciate the various techniques from identification of adulterants, estimation of essential nutrients in food products, to measurement of vital anthropometric indicators of health, as widely used by practitioners.

SYLLABUS OF GE-5

UNIT-1: Basic concept of food and nutrition

2 hrs

Components of nutrients (Macronutrients and Micronutrients).

UNIT-2: Dietary sources and physiological functions

6 hrs

Carbohydrates, Proteins, Lipids Vitamins and Minerals (Iron, Iodine, Calcium, Selenium, Zinc); beneficial effects of dietary fibres; elementary idea of Probiotics, Prebiotics, Organic Food.

UNIT-3: Nutritional requirements

4 hrs

Study of different age groups (infants, preschool children, school children, adolescents, adults, elderly) and in pregnant women and lactating mother.

UNIT-4: Concept of a balanced diet

4 hrs

Food groups, Food Pyramid, Food and Culture; Food Hypersensitivity: Food allergy (nuts and seafood) and Food intolerance (lactose and gluten).

UNIT-5: Health

2 hrs

Definition and concept of health. Indicators of metabolic health.

UNIT-6: Nutritional deficiencies and disorders

9 hrs

Symptoms and prevention of the following: Protein Energy Malnutrition (Kwashiorkor and Marasmus), Vitamin deficiency (A, D, B1, B3 B12, C) Mineral deficiency (Iron, Iodine, Calcium, Selenium, Zinc).

Lifestyle-related diseases: Causes, Symptoms and Complications of Hypertension, Diabetes mellitus and Obesity. Role of dietary and lifestyle modifications for the prevention of these diseases.

Eating Disorders: Complications and Management of Anorexia nervosa and Bulimia nervosa.

UNIT-7: Social health problems

3 hrs

Deleterious effects of addiction-related social health problems: Smoking, alcoholism, and drug dependence.

Practical

60 hrs

(Laboratory periods: 15 classes of 4 hours each)

1. To detect adulteration in (a) Ghee (b) Sugar (c) Tea Leaves (d) Turmeric.
2. Study of nutrition labelling of any 5 popular packaged foods.
3. Study and comparison of food pyramids of any 3 popular diet trends with focus on their pros and cons.
4. Ascorbic acid estimation in food by titrimetry.
5. Estimation of calcium in food by titrimetry.
6. Measurement of anthropometric indicators of health (BMI, Waist to hip ratio, Skin fold test).
7. Plan the diet chart of any three different age groups using RDA values (infants, preschool children, school children, adolescents, adults and elderly).
8. An exercise based on 24-hour food recall of students for quantification and analysis of the macronutrients' and micronutrients' uptake based on the current RDA values (with focus on nutritional status and risk factors).
9. Project Work on the Indian government initiatives focused on nourishment of school children/ expectant mothers.

OR

A small-scale questionnaire-based survey on the knowledge and usage of available resources for quitting smoking and its success/relapse rates.

Essential/recommended readings

1. Gibney MJ et al (2009) Introduction to Human Nutrition, 2nd edition, Wiley-Blackwell, Hoboken
2. ICMR-NIN (2020) Expert Group on Nutrient Requirement for Indians, Recommended Dietary Allowances (RDA) and Estimated Average Requirement (EAR)
3. Elia M et al (2013) Clinical Nutrition, 2nd edition, Wiley-Blackwell, Hoboken

Suggested readings:

1. Mann J and Truswell AS (2017) Essentials of Human Nutrition, 5th edition, Oxford University Press. Oxford
2. Kaveri Chakrabarty and A.S. Chakrabarty (2020) Textbook of Nutrition in Health and Disease, 1st edition, Springer Nature Singapore Pte Ltd

GENERIC ELECTIVES (GE-6): Introduction to Biology Zoo-GE-6

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
		Lecture	Tutorial	Practical/ Practice		
Introduction to Biology Zoo-GE-6	04	02	00	02	Passed 12 th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course is designed to acquaint students with the basic concepts of modern biology including processes in cell biology, genetics and variation, process of evolution and also the physico-chemical aspects of life.
- It emphasizes on exploring different techniques, perspectives in the fields of biology from microscopy to computational biology.
- The course has been designed keeping in mind the fact that biology helps to understand ourselves and our place and role in the living world.
- It will motivate the students to pursue careers in the field of technology.

Learning Outcomes

By studying this course, students will be able to

- learn the importance of Biology in everyday life, understand the conditions and processes that led to biochemical origin of life on earth.
- compare and contrast evolutionary theory and their application to populations.
- appreciate the different cell types and cellular processes.
- know the basic structure and functioning of cell such as division, processes of information transfer from DNA to proteins.
- have an in-depth understanding of the role and importance various biomolecules like nucleic acids, proteins, lipids and carbohydrates.
- demonstrate practical knowledge of using basic laboratory instrumentation such as microscopes, micropipettes and their applications.
- learn the diverse techniques taught in practical like chromatography, biochemical test, spectrophotometric analysis and also computational biology will hone their analytical skills.

SYLLABUS OF GE-6

UNIT-1: Introduction to concepts of biology

2 hrs

Themes in the study of biology; a closer look at ecosystem; a closer look at cell; process of science, biology and everyday life.

UNIT-2: Evolutionary history of biological diversity

4 hrs

Early earth and the origin of life; major events in the history of life; classifying the diversity of various Kingdoms of Life.

UNIT-3: Darwinian view of life and origin of species

9 hrs

Darwin's theory of evolution; evolution of populations (Hardy-Weinberg principle); Concepts of species; mechanism of speciation.

UNIT-4: Genetic approach to Biology

7 hrs

Cell and organelles; cell cycle: Mitosis and meiosis; Mendel's laws and variations; model organisms for the genetic analysis.

UNIT-5: Chemical context of living systems

8 hrs

Structure and function of biomolecules: carbohydrate, protein, lipid, and nucleic acid.

Practical

60 hrs

(Laboratory periods: 15 classes of 4 hours each)

1. To learn use of microscope and other common instruments used in laboratory.
2. Preparation of normal, molar, and standard solutions, phosphate buffers.
3. Separation of amino acids (*any three*) by paper chromatography.
4. To perform gram staining of bacteria.
5. To prepare temporary mount of human cheek epithelial cells and to study its characteristics.
6. To perform quantitative estimation of protein using the Lowry's method.
7. To perform biochemical test and identify two functional groups of carbohydrates.
8. To retrieve sequence from database and perform Multiple Sequence Alignment.
9. Visit to a cell culture and tissue culture facility and submission of project report.

Essential/recommended readings

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P. Hetal (2006) Biology 7th edition Tata McGraw Hill Publications, New Delhi

3. Karp, G. (2010). Cell & Molecular Biology: Concepts & Experiments. VI edition, John Wiley & Sons Inc.
4. De Robertis, E.D.P. & De Robertis. E.M.F. (2009). The cell & Molecular Biology, Lippincott Williams, Wilkins, Philadelphia.
5. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition, John Wiley & Sons Inc.

Suggestive readings

1. Sheeler, P and Bianchi, D.E. (2006). Cell and Molecular Biology, 3rd edition, John Wiley & sons NY.
2. Rideley, M. (2004). Evolution. III Edition, Blackwell publishing.

GENERIC ELECTIVES (GE-7): Water-borne Diseases: Understanding and Management
Zoo-GE-7

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
		Lecture	Tutorial	Practical/ Practice		
Water-borne Diseases: Understanding and Management Zoo-GE-7	04	02	00	02	Passed 12 th Class	NIL

Learning Objectives

The learning objectives of this course are as follows:

- It deals with interactions between microbial water quality and human health.
- It includes appreciating how the quality of water can be affected by natural, seasonal, accidental, intentional, and man-made activities,
- It will help the students learn how the contaminated water increases the burden of human diseases with particular emphasis on infectious diseases,
- It will help understand the environmental pressures caused by contaminated water and how it drives the emergence and re-emergence of infectious diseases with increased/altered virulence, antibiotic resistance.
- It will motivate students to pursue a career in Health Management

Learning Outcomes

By studying this course, students will be able to

- know the sources of microbial water contamination and its impact on human health.
- understand the relationship between human behaviour and water quality.
- learn remediation strategies for several types of microbial water quality contamination.
- understand epidemiological studies related to water quality and public health.
- be able to grasp the concepts of various water sources and transmission mechanisms of infectious agents from those sources to humans.
- organize and present well-synthesized scientific discussions on topics relevant to waterborne disease and public health.
- develop a critical understanding of the contribution of organisms to the welfare of society.

- examine the multiple water-borne pathogens, their modes of transport and transmission, their public health effects, and existing methods for disease prevention and remediation.

SYLLABUS OF GE-7

UNIT-1: Introduction to Public Health

4 hrs

Definition, scope, concept, and importance of public health microbiology; Roles of microbiologists in public health; Concept of health and disease; Indicators of health; Basic concept of water pollution and public health hazard in the community.

UNIT- 2: Introduction to Water Quality

8 hrs

Common terms and definitions in water quality, aquatic resources of the world and sources of drinking water; Water, sanitation, and hygiene (WASH) – fact sheets, WHO guidelines and resolutions; common contaminants of drinking water and linkages to disease; Water pollution (water quality properties, types of water pollution, point and non-point sources of water pollution); Types of contaminants influencing water quality; Water Treatment, Control of Water Borne Diseases.

UNIT- 3: Microbiology of Water

3 hrs

Microbiological quality of drinking; water as a causing factor of infectious diseases; water-borne pathogens (types, sources, and transmission); microbial testing of Water; monitoring and surveillance of water quality.

UNIT- 4: Water-Borne Diseases

10 hrs

Source of infection, transmission, symptoms, mitigation, prevention and treatment (with reference to the role of agencies/NGO).

-Bacterial infections- Cholera, Typhoid fever, Botulism, *E. coli* infection, Campylobacteriosis, Dysentery, Typhoid fever.

-Viral infections: Rotavirus, Hepatitis A and E, Poliomyelitis, Polyomavirus infection.

-Protozoal infections: Acanthamoeba keratitis, Amoebiasis, Cryptosporidiosis, Cyclosporiasis, Giardiasis.

- Parasitic worms: Schistosomiasis, Fascioliasis, Strongyloidiasis, Hookworm infections, Giardiasis.

-Vector-borne infections: Malaria, Dengue, Chikungunya, Onchocerciasis, Leishmaniasis, Japanese encephalitis, Dracunculiasis, Lymphatic filariasis,

UNIT- 5: Waterborne Pathogens: Detection Methods

5 hrs

Polymerase chain reaction (PCR) -Multiplex PCR; Quantitative PCR (qPCR), Real-time PCR; Microarrays; Pyro-sequencing; Biosensors; Fluorescence *in situ* hybridization

(FISH); Immunology-based methods.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. To determine dissolved oxygen in water samples collected from different water bodies by Winkler's Method.
2. To determine temperature, pH, conductivity, total solids, and total dissolved solids in water samples from different locations.
3. To measure the COD of water samples from various sources.
4. Isolation and identification of microorganisms from different water samples.
5. Project report on water quality monitoring system.
6. Visit to WASH Institute (Water Sanitation and Hygiene Institute)/ Shri Ram Institute for Industrial Research.

Essential/recommended readings

1. Aquatic Pollution: An Introductory Text, 3rd Edition, Edward A. Laws, ISBN 9780471348757.
2. Waterborne Disease, 1st edition (January 15, 1997), Paul Hunter, ISBN 0125515707.

Suggestive readings

1. Microbiology of Waterborne Diseases, Steven Percival, Rachel Chalmers, Martha Embrey, Paul Hunter, Jane Sellwood and Peter Wyn-Jones, ISBN 978012551570-2.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-8): Exploring Animal World Zoo-GE-8

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Exploring the Animal world Zoo-GE-8	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to overview the concepts of invertebrate and vertebrate animals, including sponges, cnidarians, comb jellies, flatworms, nematodes, annelids, molluscs, arthropods, echinoderms, invertebrate chordates, fishes, amphibians, reptiles, birds, and mammals.
- to enable students to understand the diversity within different groups, and interrelationship among different species and genera within each group of animals.
- to learn the hierarchy, body plan and their role in ecological development of animals.

Learning Outcomes

By studying this course, students will be able to

- Learn about the importance of systematics, taxonomy, and structural organization of non-chordates and chordata.
- Appreciate the diversity of animals living in varied habits and habitats.
- Understand evolutionary history and relationships of different animals through functional and structural affinities.
- better understand coelom formation, different levels of organization, role of macronutrients and micronutrients, their nutritional requirements for different age groups during various health conditions.

SYLLABUS OF GE-8

UNIT- 1: An Introduction to the Animal Kingdom **2 hrs**

Non-chordates vs. Chordates; Outline of Coelom, Body symmetry, Levels of organization

UNIT-2: Kingdom Protista **2 hrs**

General characters of Protozoa; Locomotory organelles

UNIT- 3: Porifera **2 hrs**

General characters of Phylum Porifera, Canal system in Porifera

UNIT- 4: Radiata **2 hrs**

General characters of Phylum Cnidaria & Ctenophora; Polymorphism

UNIT- 5: Helminthes **3 hrs**

General characters of helminths (Platyhelminthes and Nematelminths); Parasitic Adaptations

UNIT- 6: Coelomates (Non-chordates) **6 hrs**

General characters of Phylum Annelida; Metamerism

General characters of Phylum Arthropoda; Vision in insects

General characters of Phylum Mollusca; Pearl Formation

General characters of Phylum Echinodermata, water vascular system in starfish

UNIT- 7: Lower chordates (Protochordata) **1 hr**

Salient features of Protochordates (Hemichordates, Urochordates and Cephalochordates)

Unit 8: Higher chordates **12 hr**

General characters of Vertebrates:

- Cyclostomes; Cartilaginous and Bony fishes; Catadromous and Anadromous migration.
- Amphibians; Adaptations for Terrestrial Life
- Reptiles; Poisonous and Non-poisonous Snakes
- Aves; Flight Adaptations in birds
- Mammals - Prototheria, Metatheria and Eutheria.

Practical **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. Study of specimens- Non-chordates:

Euglena, Noctiluca, Paramecium; Sycon; Physalia, Tubipora, Meandrina; Taenia, Ascaris; Nereis, Heteronereis, Aphrodite, Hirudinaria, Peripatus; Limulus, Cancer, Daphnia, Julus, Scolopendra, Apis, Termite; Chiton, Dentalium, Octopus; Asterias and Antedon

2. Study of specimens- Chordates:

Balanoglossus, Herdmania, Amphioxus; Petromyzon; Sphyrna, Pristis, Hippocampus, Exocoetus, Diodon/ Tetradon; Ichthyophis/ Uraeotyphlus, Bufo, Hyla, Salamandra; Rhacophorus, Draco, Uromastix, Naja, Viper;

Any three common birds (Crow, duck, Owl); Funambulus, Loris and Bat

3. Study through Permanent Slides:

- i) Cross Section of *Sycon*, and *Ascaris* (male and female).
- ii) T. S. of Earthworm passing through Pharynx, Gizzard, and Typhlosole region of intestine.
- iii) Septal and Pharyngeal Nephridia of Earthworm.
- iv) Placoid and Cycloid Scales in Fishes.

4. Study of Organ Systems (through videos/animations/photographs/dissections*:

- i) Digestive System of Cockroach;
- ii) Urinogenital System of Rat

* subject to UGC guidelines

Essential/recommended readings

1. Young, J.Z. (2004) The Life of Vertebrates. III Edition, Oxford University Press.
2. Ruppert, Fox and Barnes (2003) Invertebrate Zoology. A Functional Evolutionary Approach, VII Edition, Thomson Books/Cole.
3. Parker T.J. and Haswell W.A. (1972). Textbook of Zoology Vertebrates. VII Edition, Volume II. Blackwell, Hoboken

**Note: Refer Ruppert, Fox and Barnes (VII Ed.) for the classification of invertebrates;*

Suggestive reading

1. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd.
2. Campbell and Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Mann Raven, P.H. and Johnson, G.B. (2004). Biology, VI Edition, Tata McGraw Hill Publications. New Delhi.

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

GENERIC ELECTIVES (GE-9): Microbiota: Importance in Health and Disease
Zoo-GE-9

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
		Lecture	Tutorial	Practical			
Microbiota: Importance in Health and Disease Zoo-GE-9	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to acquaint students with the basic concepts of microbiota that coexist with the human being both in health and in different pathologies.
- To enable students to understand how microbiota undergoes changes as a consequence of the influence of multiple factors, diet, lifestyle, pharmacological treatments generating alterations in this bacterial ecosystem.
- To compare the role of our microbiota in behavior, mood, and development.
- to make the students aware of the microbial communities that reside within or upon us, and how they impact our health.
- To acquire knowledge about the interactions between the different types of microbiota and their host in different pathophysiological situations.

Learning Outcomes

By studying this course, students will be able to

- Identify the components of the human microbiota and their major characteristics.
- Learn the key approaches and techniques used to identify and quantify the bacterial, fungal, archaeal, protozoan, and viral components of the microbiota.
- Identify the common members of the microbiota and their influence on various body systems including the skin, upper and lower respiratory system, oral and the lower digestive system, urinary and reproductive systems, the immune system, and the nervous system in healthy and diseased states.
- Compare the role of our microbiota in behavior, mood, and development.
- Appreciate the emerging treatment approaches for microbiota-associated illnesses.

SYLLABUS OF GE-9

UNIT- 1: Microbes

4 hrs

Introduction to microbes, general approaches and techniques used for studying microbiota, the nature of microbiological problems, Prokaryotic and eukaryotic organisms.

UNIT- 2: Introduction to the Human Microbiome

16 hrs

Importance of human body environment for growth of a variety of microorganisms, concept of contamination, infection and disease, septicaemia, Acute and subacute bacterial endocarditis.

a) Microbial Diseases of the Respiratory System: Tuberculosis; Common cold,

b) Microbial Diseases of the Eyes: Conjunctivitis, Trachoma; Viral Diseases of the Eye.

c) Microbial Diseases of skin: Bacterial diseases of the skin: Acne, folliculitis, boils, cellulitis, Infections of burns and surgical wounds, gangrene, Leprosy. Viral Diseases of the Skin: Chicken pox;

Fungal Diseases of the Skin: Candidiasis.

d) Microbial Diseases of the Nervous System: Bacterial diseases: Tetanus, Viral diseases: Polio/Rabies; Protozoan diseases: Trypanosomiasis

e) Microbial Diseases of the Oral Cavity and Digestive System: Bacterial diseases: Dental caries; Cholera, Gastroenteritis; Fungal diseases: Aflatoxin poisoning, Ergot poisoning; Viral diseases: Mumps; Protozoan diseases: Amoebic dysentery, Giardiasis

f) Microbial Diseases of the Urinary/Reproductive Systems: Bacterial diseases: Syphilis; Viral diseases: genital warts; Protozoan diseases: Trichomoniasis; Fungal diseases: Vaginitis

UNIT- 3: Microbiota and the Immune System Development

5 hrs

Normal flora, transient flora opportunistic microbes, Pathogenicity, virulence, and factors that increase virulence (enzymes, toxins), Factors that affect the spread of disease, Nonspecific immune responses, Specific immune responses: humoral and cell mediated immunity

UNIT- 4: Human Microbiota in Health and Disease

5 hrs

Basic concept of Gut microbiota in the mother-child environment, Gut microbiota and cancer; Microbiota and viral diseases- An opportunity for COVID-19. Relationship between diet and the intestinal microbiota, Probiotics, prebiotics and other "biotics".

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Bacterial shapes and arrangements Cell wall, Cell membrane, Glycocalyx, Endospores, Flagella, Cytoplasmic inclusions, Cytoplasmic structures/organelles, Bacterial growth curve, Physical factors affecting microbial growth.
2. To understand Good Lab practise: The effectiveness of hand washing and sterilization.
3. To understand microbial morphology by Gram Staining.
4. To appreciate bacterial anatomy by Acid-fast Staining.
5. Environmental Factors affecting growth of microorganisms: Temperature, pH and Osmotic Pressure.
6. Bacterial growth curve and evaluation of factors affecting microbial growth.
7. Isolation of normal microbiota from the human Body (Nose, Throat, or Skin).
8. Effects of chemical agents on bacteria growth (Kirby-Bauer method).

Essential/recommended readings

1. Leboffe, M. J and Pierce; B. E. (2014) A Photographic Atlas for the Microbiology Laboratory, 5th Edition, Morton Publishing Company.
2. Michael Wilson (2005) "Microbial Inhabitants of Humans-Their Ecology and Role in Health and Disease"; Oxford University Press, UK.

Suggestive readings

1. Nina Parker, Mark Schneegurt, Anh-Hue-Thi Tu and Brian M. Forster; (2016) "Microbiology"; 1st Edition, OpenStax Resource.

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

GENERIC ELECTIVES (GE-10): Insect Vector and Disease
Zoo-GE-10

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
		Lecture	Tutorial	Practical/ Practice			
Insect Vector and Disease Zoo-GE-10	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to familiarize the students with a variety of diseases caused by insects.
- to learn the complex interactions between the transmission by Insect-borne pathogens affecting human health.
- to acquire knowledge of how the insects can only be controlled and prevented by studying their biology, modalities of pathogen transmission
- to enable students to evaluate the associated risk factors and devising new efficient techniques to control these insects.
- to help understand the environmental pressures caused by stagnant water.
- to motivate students to pursue a career in Health Management.

Learning Outcomes

By studying this course, students will be able to

- identify different insects and classify them based on their morphology and behaviour.
- describe the host-pathogen relationships and the role of the host reservoir on transmission of parasite.
- explain various modes of transmission of parasite by insect vectors.
- recognize various possible modern tools and methodologies for laboratory diagnosis, surveillance and treatment of diseases.
- develop a critical understanding of insect transmitted diseases such as Zoonotic, Vertical and Horizontal transmission, host specificity etc.
- spread awareness on public health programs about insect borne diseases and their control.

- To use advanced management strategies in disease control with respect to parasite evolution

SYLLABUS OF GE-10

UNIT- 1: Introduction to Insects

8 hrs

General Features of Insects, Classification of insects up to Orders- General features of orders, Morphological features: Head, legs and types of antennae. Types of Insects mouth parts w.r.t. feeding habits: siphoning type (butterfly), sponging type (housefly), biting and chewing type (cockroach), piercing and sucking type (mosquito), chewing and lapping type (honey bee).

UNIT- 2: Concept of Vectors

5 hrs

Brief introduction to carriers and vectors (mechanical and biological vector); Insect reservoirs; Host-vector relationship; Vectorial capacity; Host Specificity; Modes of disease transmission - vertical and horizontal transmission. Insects as vectors: General adaptations in insects to act as vectors.

UNIT- 3: Dipterans as disease Vectors-I

7 hrs

Dipterans as important insect vectors–Mosquitoes. Study of mosquito borne diseases– Malaria, Dengue, Chikungunya, Filariasis, Viral encephalitis. Control and prevention/cure of diseases caused by mosquitoes. Study of sand fly-borne diseases- Visceral Leishmaniasis, Cutaneous Leishmaniasis; Control of Sand fly; Study of house fly as important mechanical vector, Control of house fly.

UNIT- 4: Siphonapterans as disease vectors

5 hrs

Fleas as insect vectors; Study of flea borne diseases – Plague, typhus fever; Control and prevention/cure of diseases caused by fleas.

UNIT- 5: Siphunculata as disease vectors

5 hrs

Human louse (head, body and pubic louse) as disease vectors; study of louse borne diseases – Typhus fever, relapsing fever, vagabond's disease, phthiriasis; Control of human louse and prevention/cure of diseases caused by them.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Study of different kinds of mouth parts and legs of insects through slides/specimens
2. Study of insect vectors through permanent slides or photographs: Mosquitoes (*Aedes*, *Culex*, *Anopheles*), lice [head, body (*Pediculus*), pubic (*Pthirus*)], Flea (*Xenopsylla cheopis*), sand fly (*Phlebotomus*), house fly (*Musca domestica*)

3. Study of different diseases transmitted by above insect vectors using photographs.
4. Project report on any one disease transmitted by insect vector.
5. Optional field trip/Lab. visit to institutes such as NIMR, NCDC.

Essential/recommended readings

1. Mullen and Darden (2009) Medical and Veterinary Entomology, 3rd Edition, Academic Press.
2. Service, M.W. (1980) A Guide to Medical Entomology, Macmillan Press.

Suggestive readings

1. Burgess, N.R.H and Cowan, G.O. (1993) A colour atlas of medical entomology. Springer Science and Business Media, B. V. House.

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

SEMESTER - V

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-11): Animal Cell Biotechnology Zoo-GE-11

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Animal Cell Biotechnology Zoo-GE-11	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to give the students a fundamental understanding of the field of biotechnology.
- to provide a tool kit in the form of a number of techniques and processes developed over time to solve problems involving primarily human welfare with focus on health and medicine.
- to make the students aware of the scope of biotechnology which encompasses almost every field of science like engineering, research, commercialization and academics.
- to empower the students to face research and industrial outlets by nurturing independent thinking, initiating scientific enquiry and developing their entrepreneurship skills.
- to equip the students with basic understanding of the tools and techniques of biotechnology which are a must for anyone interested in pursuing a career in biotechnology.

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of the basic principles and applications of biotechnology.
- appreciate the basic techniques used in genetic manipulation helping them continue with higher studies in this field.
- acquire knowledge of the basic principles, preparations and handling required for animal cell culture.
- have an in-depth understanding of the principles underlying the design of fermenter and fermentation process and its immense use in the industry.

- enable students to design small experiments for successful implementation of the ideas and develop solutions to solve problems related to biotechnology keeping in mind safety factor for environment and society.
- apply knowledge and skills gained in the course to develop new diagnostic kits and to innovate new technologies further in their career.
- enhance their understanding of the various aspects and applications of biotechnology as well as the importance of bio-safety and ethical issues related to it.

SYLLABUS OF GE-11

UNIT- 1: Introduction **2 hrs**
 Concept and Scope of Biotechnology.

UNIT- 2: Techniques in Gene Manipulation **9 hrs**
 Outline process of genetic engineering and recombinant DNA technology, Restriction endonucleases, DNA modifying enzymes, Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids (λ & M13). Shuttle and Expression Vectors. Genomic and cDNA libraries. Transformation techniques: Electroporation and Calcium Chloride method.

UNIT- 3: Fermentation **9 hrs**
 Different types of Fermentation: Submerged & Solid state; batch, Fed batch and Continuous; Stirred tank, Air Lift, Downstream Processing: Filtration, centrifugation, extraction, chromatography (Only Principles: Adsorption, Ion exchange, gel filtration, hydrophobic, affinity and size exclusion and lyophilization).

UNIT- 4: Transgenic Animal Technology **5 hrs**
 Production of transgenic animals: Retroviral method, DNA microinjection method, Nuclear Transplantation: Dolly and Polly.

UNIT- 5: rDNA Application in Health **5 hrs**
 Recombinant vaccines, gene therapy (*in-vivo and ex-vivo*). Production of recombinant Proteins: Monoclonal Antibodies, Insulin and growth hormones, Bio safety: Physical and Biological containment.

Practical **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. Packing and sterilization of glass and plastic wares for microbial culture.
2. Preparation and sterilization of culture media.
3. Preparation of genomic DNA from *E. coli*.
4. Calculation of transformation efficiency from the data provided.
5. Restriction digestion of lambda (λ) DNA using EcoR1 and Hind III.

6. Techniques:
- a. Western Blot
 - b. Southern Hybridization
 - c. DNA Finger printing
 - d. Polymerase chain reaction,
 - e. DNA Microarrays
 - f. Polyacrylamide gel Electrophoresis
 - g. DNA sequencing: Sanger method

Essential/recommended readings

1. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology- Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
2. Brown, T.A. (1998). Gene Cloning and DNA Analysis: An Introduction. II Edition, Academic Press, California, USA.
3. R. Ian Freshney (2021) Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications; Wiley-Blackwell.

Suggestive readings

1. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. IX Edition. Freeman and Co., N.Y., USA.
2. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes-A Short Course. III Edition, Freeman and Co., N.Y., USA.
3. Mathur, J.P. and Barnes, D. (1998) Methods in Cell Biology: Animal Cell Culture Methods. Academic Press.

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

GENERIC ELECTIVES (GE-12): Introduction to Public Health and Epidemiology

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
		Lecture	Tutorial	Practical			
Introduction to Public Health and Epidemiology Zoo-GE-12	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to acquaint students with the basic concepts and importance of epidemiology and its contribution in the public health research.
- to acquire knowledge about the descriptive, analytic, and experimental aspects that can be applied for assessing the epidemiological studies of health status in the Indian population-based registers.
- to understand the relevance of statistics for the analysis of health-related data and its implications in the health sector
- To enable students to interpret results of data analysis for public health research, policy or practice.

Learning Outcomes

By studying this course, students will be able to

- better understand the fundamental components of epidemiology and data analysis.
- gain an understanding of the unique resources that Indian health registers represent for epidemiological research.
- comprehend various types of epidemiological studies, and understand their 'hierarchy' with respect to research.
- evaluate and interpret basic measures of occurrence and association and interpret the results
- appreciate and analytically assess the collection, analysis of data, and evaluate the relevant hypotheses.
- evaluate the strengths and limitations of epidemiologic reports
- apply epidemiological thinking to critically read and appraise articles in medical literature.

SYLLABUS OF GE-12

UNIT- 1: Epidemiology of Infectious Diseases **12 hrs**

Modes of infections with suitable examples. Overview of cause, extent, prevention, treatment and control of the diseases: Respiratory infections, Intestinal infections, Arthropod-borne infections, Zoonosis and Surface infections.

UNIT- 2: Understanding Epidemiological Data **8 hrs**

Understanding incidence, mortality (rates, ratios and proportions); Components of epidemiology: disease frequency, distribution and determinants of diseases. Epidemiological approach and measurements- vital statistics, health indicator parameters (morbidity, mortality and fertility rates); Analysis of data from National Cancer Registry Program (NCRP) and Covid-19 data.

UNIT- 3: Epidemiologic Methods and Survey **6 hrs**

Outlining the parameters for ethical issues in a study. Determining the target and control populations; Designing of questionnaires; Data collection: Strength of observation (descriptive and analytical) and experimental studies. Epidemiology study designs- case control and cohort studies (prospective and retrospective), procedures of sampling and matching, sources of bias.

UNIT- 4: Collection, Tabulation and Representation of Data **4 hrs**

Analysis of data from NCRP data and survey conducted by the students. Basic principles of “R” software for tabulation and graphical representations (bar diagrams, histograms, pie charts, box plot, etc.), measures of central tendency (mean, mode, median and partition values), dispersion (range, standard deviation, coefficient of variance and covariance) and skewness.

Practical **60 hrs**

(Laboratory periods: 15 classes of 4 hours each)

1. Designing a questionnaire for survey of prevalence diabetes/ hypertension/ allergy/ respiratory disorders/covid 19.
2. To conduct a population survey for the year for the any one of the disease- diabetes/ hypertension/ allergy/ respiratory disorders/covid 19.
3. Design an epidemiology study: case control and cohort study (prospective and retrospective), including techniques of sampling and matching, sources of bias.
4. Perform correlation and regression studies on the data collected.
5. Analyze the probabilistic distribution studies.
6. Comparison of groups and ascertaining statistical significance of differences.
8. Research and presentation on current trends in infectious diseases.

Essential/recommended readings

1. Glantz, S. (2011) Primer of Biostatistics, 7th edition, McGraw-Hill Medical. ISBN-13: 978-0071781503.
2. Park, K.(2011) Park's Textbook of Preventive and Social Medicine, 21st edition, M/s Banarsi Das Bhanot Publishers.
3. Bonita, R., Beaglehole, R., TordKjellstrøm, (2006) Basic epidemiology, 2nd edition (2006), Contributor; World Health Organization, illustrated, Publisher: World Health Organization.
4. Pagano, M. and Gauvreau, K. (2000) Principles of Biostatistics, 2nd edition, Thompson learning.

Suggestive readings

1. Wayne W Daniel and Chad L. Cross (2013), Biostatistics: A Foundation for Analysis in the Health Sciences, 10th edition, Wiley. ISBN-13: 978-1118302798.
2. Jerrold H. Zar (2009) Biostatistical Analysis, 5th edition, Pearson. ISBN-13: 978-0131008465.

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

GENERIC ELECTIVES (GE-13): Concept of Animal Behaviour
Zoo-GE-13

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
		Lecture	Tutorial	Practical			
Concept of Animal Behaviour Zoo-GE-13	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL	Zoology

Learning Objectives

The learning objectives of this course are as follows:

- to familiarize the students with the scientific study of the behaviour of animals.
- to enable students to link behaviour patterns to the brain, genes, and hormones, as well as to the surrounding ecological and social environments.
- to acquire knowledge of aggression, the chase of the hunter and the flight of the hunted, the spinning of webs, the digging of burrows, and the building of nests or remaining motionless and concealed.
- to provide a good understanding of various concepts in animal behaviour.
- to motivate students to pursue a career in animal behaviour.

Learning Outcomes

By studying this course, students will be able to

- better understand the various types of animal behaviour and their importance.
- enhance their observation skills, analytical skills, scientific interpretation and documentation skills.
- enable students to evaluate the characteristic features of animal life including static postures, active movements, noises, smells, changes in colour and shape.
- realise, appreciate and develop passion to biodiversity and respect the nature and its surroundings.

SYLLABUS OF GE-13

UNIT- 1: Introduction to Animal Behaviour

4 hrs

Origin and history of ethology, Pioneers of modern ethology: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Four Questions for Ethology.

UNIT- 2: Patterns of Behaviour **7 hrs**

Innate behaviour, Instinct, Sign stimuli, Code breakers, Learning: associative learning and non-associative learning, Classical and operant conditioning, Habituation, Imprinting.

UNIT- 3: Communication **3 hrs**

Importance of communication; Role of Chemical, Tactile, Auditory, Visual stimuli in communication.

UNIT- 4: Social Behaviour **7 hrs**

Concept of Society, Social insects (Honeybee as example), Bee communication, Altruism & Reciprocal altruism, Inclusive fitness, Hamilton's rule.

UNIT- 5: Sexual Behaviour **9 hrs**

Sexual dimorphism, mate choice; Intra-sexual selection (male rivalry); Inter-sexual selection (female choice); Courtship behaviour, Parental care, sexual conflict in parental care, Infanticide.

Practical **(60 hrs)**

(Laboratory periods: 15 classes of 4 hours each)

1. To study nests and nesting behaviour of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Study of different tools, techniques and methods used in preparing ethogram.
6. To study courtship behaviour in insects and birds from short videos/movies.

Essential/recommended readings

1. Alcock, J. (2013) Animal Behaviour, Xth Edition, Sinauer Associates Inc., USA.
2. Manning, A. and Dawkins, M. S, (2012) An Introduction to Animal Behaviour, VIth Edition, Cambridge University Press, UK
3. McFarland, D. (1985) Animal Behaviour, Pitman Publishing Limited, London, UK

Suggestive readings

1. Rubenstein, D. (2022) Animal Behavior, XIIth Edition, Sinauer Associates, Oxford University Press, UK.
2. Gadagkar, R. (2021) Experiments in Animal Behaviour: Cutting-Edge Research at Trifling Cost, Indian Academy of Sciences.

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

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-14): Model Organisms in Research Zoo-GE-14

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Model Organisms in Research Zoo-GE-14	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to make the students aware about the requirement of model organisms in biological research.
- to understand the simulation of human traits in model organisms.
- to familiarize the students about the suitability and availability of different model organisms.
- to aware students about the ethical issues involved in using animals for research in laboratories.
- to give insight about the database systems available of different model organism.

Learning Outcomes

By studying this course, students will be able to

- better understand the concept of model organisms and their advantages.
- appreciate various types of model organisms used in biological research.
- gain better knowledge of how the model organisms can be used for modelling of human diseases.
- have an insight on the ethical issues related to handling and maintaining laboratory animals and plants.
- design simple experiments with model organism.
- determine the type of model organisms that are suitable to answer the specific research questions.

SYLLABUS OF GE-14

UNIT- 1: Introduction 2 hrs

Model organisms: Definition, requirement, characteristics and selection.

UNIT- 2: Commonly used Model Organisms 20 hrs

Characteristics, establishment and maintenance, specific application of following model organisms in research:

Viruses (Bacteriophage λ -phage, T4); Bacteria (*Escherichia coli*); Fungi (*Saccharomyces cerevisiae*); Ciliates (*Tetrahymena*); Annelids (*Caenorhabditis elegans*, *Lumbricusterrestris*); Arthropods (*Drosophila melanogaster*); Pisces (*Danio rerio*); Amphibians (*Xenopus laevis*); Mammals [Rodents (*Mus musculus*), *Rattus rattus* (Rat) and Primates]; Plants (*Arabidopsis thaliana*).

UNIT- 3: Model organism specific databases 6 hrs

Saccharomyces genome Database, EcoCyc, Flybase, Xenbase, Wormbase, Zfin, Mouse genome informatics, *Tetrahymena* genome Database, The Arabidopsis Information Resource etc.

UNIT- 4: Ethical consideration 2 hrs

Brief introduction about CPCSEA, IAEC and related regulatory bodies.

Practical (60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Preparation of culture medium for *E. coli* and study the growth kinetics of *E. coli*.
2. Preparation of culture medium for *Drosophila* and study different stages of life cycle of *Drosophila*.
3. Preparation of culture medium for ciliates and their growth kinetics.
4. Study different phases of cell cycle in ciliates.
5. Culturing of *C. elegans*/ earthworm and Zebra fish and perform eco-toxicological studies.
6. Demonstration of culturing of mammalian cell lines/ visit to eukaryotic cell culture facility.
7. Visit to animal house and/ or plant culture facility and prepare the report on maintenance of laboratories animal/plant.

Essential/recommended readings

1. Jarret, R. L. and McCluskey, K. (2021) The Biological Resources of Model Organisms, 1st Ed, CRC Press.

2. Ankeny, R. A. and Leonelli, S. (2020) Concept of Model Organisms; Cambridge University Press.
3. Emerging model organisms: A laboratory manual, Volume 2, lab manual edition (2010), New York, USA: Cold Spring Harbor Laboratory Press.

Suggestive readings

1. Wang, W., Rohner, N., Wang, Y. (2023) Emerging Model Organisms; SpringerLink.
2. Jarret, R. L. and McCluskey, K. (2021) The Biological Resources of Model organisms, Taylor and Francis group.
3. Carroll, P. M. and Fitzgerald, K. (2003) Model Organisms in Drug Discovery, Wiley.

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

GENERIC ELECTIVES (GE-15): Nanobiology
Zoo-GE-15

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
		Lecture	Tutorial	Practical/ Practice		
Nanobiology Zoo-GE-15	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to acquaint students with the basic concepts of Nanobiology.
- to equip the students with the concepts, properties and behaviour of nano-biomaterials.
- to provide a critical and systematic understanding of cutting-edge technology.
- to give an overall concept regarding the prominence of nanomaterials and their classification, synthesis process

Learning Outcomes

By studying this course, students will be able to

- better understand the interaction of biomolecules with surfaces of different chemical and physical species.
- appreciate the different applications of various types of nanostructured materials.
- gain knowledge of the types of nanoparticles based on size, shape, surface properties and composition.
- interpret/ analyse and get insight into the applications in the field of medicine.
- use basic principles of microfluidics to solve biotechnical and bioanalytical problems.
- appreciate the multidisciplinary nature of Nanobiology.
- develop skills in high-tech instrumental techniques suited for characterization of the micro/nano- structural properties.

SYLLABUS OF GE-15

UNIT- 1: Nanobiology

2 hrs

Definition and concepts, Development of nanobiotechnology/nanobiology, timelines and progress.

UNIT- 2: Biomaterials

8 hrs

Bulk materials vs nanomaterials. Different types of materials used to synthesize nanoparticles, Top-down approach, and bottom-up approach. Classification

nanoparticles based on size, shape, surface properties and composition; bio-inspired nanomaterials. Nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus, diatoms, bacteria).

UNIT- 3: Nanomedicine

10 hrs

Drug encapsulation, drug delivery and gene delivery, Active and passive targeting by ligands and receptor-mediated delivery, Interactions of nanoparticles with biological membranes and ion channels. Applications of nanomedicines in diagnostics: biosensor-based techniques like optical, colorimetric, and electrochemical, point-of-care diagnostics tools like lab-on-chip device, lateral flow immunoassay.

UNIT- 4: Environmental applications

6 hrs

Nanoadsorbents, release of nutrients and pesticides, Nanoremediation, Nanopollution: air - water - soil contaminants, Treatment of industrial wastewaters using nanoparticles.

UNIT- 5: Nanotoxicity

4 hrs

Effect of nanomaterials on human health, nanomaterial-cell interaction, Concept of cytotoxicity and genotoxicity, Future perspectives of Nanobiology.

Practical

(60 hrs)

(Laboratory periods: 15 classes of 4 hours each)

1. Synthesis of silver/gold nanoparticles from plants extracts and follow up with visible spectroscopy.
2. Synthesis of Iron oxide nanoparticles by using chemical methods (Tyndall effect).
3. Characterization of nanoparticles: Electron microscopy (scanning and transmission), atomic force microscopy; nanoparticle analyzer, zeta potential measurement, electrochemical analyzer, flow cytometry, spectroscopic techniques including spectrophotometer, spectro-fluorimeter.
4. Cell counting and cell viability study of a non-adherent cell (Hepatocyte) culture.
5. Study of cell and nanoparticle interaction (video demonstration).
6. Antibacterial studies of nanoparticles by MIC method.
7. Assessing cytotoxicity of nanoparticles by MTT.
8. Isolation of DNA and demonstration of apoptosis by DNA fragmentation.
9. Nano microbial degradation of various xenobiotics (e.g. pesticides, organochlorines, pyrethroids, PAH).

Essential/recommended readings

1. Kesharwani, P., Singh, K. K. (Eds) (2021) Nanoparticle Therapeutics: Production Technologies, Types of Nanoparticles, and Regulatory Aspects; Academic Press Inc.
2. Kenneth E. Gonsalves, Craig R. Halberstadt, Cato T. Laurencin, Lakshmi S. Nair, (Eds) (2008) "Biomedical Nanostructures" Wiley-Interscience, John Wiley & Sons, Inc.
3. Niemeyer, C.M. (2006) Nanobiotechnology: Concepts, Applications and

Perspectives; Wiley VCH.

4. Ralph S. Greco, Fritz B. Prinz, R. Lane Smith Eds. (2005) Nanoscale Technology in Biological Systems, CRC PRESS, Taylor & Francis.

Suggestive readings

1. Stroeve, P and Mahmoudi (2018) Drug Delivery Systems, World Scientific Series: From Biomaterials towards Medical Devices, Vol I.
2. Hillery, and Anya M et al. (2010 "Drug Delivery and Targeting", CRC Press.
3. Hong-fan, M, Huang, C.P., Bland, A. E., Honglin, W. Z., Sliman,R., Wright, I (2010) Enviro-nanotechnology; Elsevier.

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

GENERIC ELECTIVES (GE-16): Forensic Biology
Zoo-GE-15

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
		Lecture	Tutorial	Practical/ Practice		
Forensic Biology Zoo-GE-16	04	02	Nil	02	Passed Class XII with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- to introduce the concept of forensic biology and DNA analysis.
- to identify and analyse the crime scene for biological evidence.
- to familiarize the students about the scientific methods in forensic biology.
- to emphasis on the practical techniques of biological principles that includessample recovery, sample handling, different analytical techniques and DNA profile comparison.
- to highlight the importance and application of forensic science.

Learning Outcomes

By studying this course, students will be able to

- Comprehend the fundamentals of forensic biology and DNA analysis.
- better understand the concepts of proper collection and preservation of biological.
- exhibits and crime scene investigation of biological evidence.
- rationalize the significance of criminal profiling.
- Develop skills based on the practical techniques of biological principles that includes sample recovery, sample handling, different analytical techniques and DNA profile comparison.

SYLLABUS OF GE-16

UNIT- 1: Principles of DNA Forensics and DNA Typing

8 hrs

Definition and fundamental concepts of forensic biology, DNA as biological blueprint of life, Structure of DNA, collection of DNA sample, extraction, profiling, restriction fragment length polymorphism (RFLP), polymerase chain reaction (PCR), short tandem repeat markers, single nucleotide polymorphism markers (SNP), determination of ethnicity, determination of physical appearance, determination of personality traits, mitochondrial DNA, RNA and DNA database. Result interpretation.

UNIT- 2: Parentage Testing**4 hrs**

Principles of heredity, genetics of paternity, DNA testing in disputed paternity, Mendelian laws of parentage testing.

UNIT- 3: Biological Evidence**12 hrs**

Nature and importance of study of biological evidences in crime cases:

- a) Forensic examination of hair: Transfer, persistence and recovery of hair evidence, Structure of human hair, Comparison of hair samples, Morphology and biochemistry of human hair.
- b) Comparison of human and animal hair.
- c) Identification of wild life materials such as skin, fur, bones, nails, horn, teeth, plants, plant parts and products by conventional and modern methods, Identification of Pug marks of various animals
- d) Types and identification of microbial organisms of forensic significance
- e) Forensic odontology: structural variation in teeth (human and non-human), types of teeth and their functions, determination of age from teeth: eruption sequence, Gustafson's method, dental anomalies, their significance in personal identification.
Bites marks: Forensic significance, collection and preservation of bite marks, photography and evaluation of bite marks, Lip prints in forensic investigations.

UNIT- 4: Forensic Importance of Body fluids**6 hrs**

Blood: Composition and functions, Collection and preservation of blood evidence, Distinction between human and non-human blood, Determination of blood groups; Forensic characterization of bloodstains, typing of dried stains;

Semen: Forensic significance of semen, Composition, functions and morphology of spermatozoa, Collection, evaluation and tests for identification of semen, Individualization on the basis of semen examination.

Other Fluids: Composition, functions, identification tests and forensic significance of saliva, sweat, milk and urine.

Practical**(60 hrs)****(Laboratory periods: 15 classes of 4 hours each)**

1. Prepare slides of scale pattern of human hair and examine morphology of hair to determine the species to which the hair belongs.
2. Chemical identification of human blood.
3. Determination of blood group from fresh and dried blood samples.
4. Crime scene Blood Stain Pattern Analysis, using photographs and videos.
5. Identification of saliva and urine.
6. Separation of amino acids by thin layer chromatography (TLC).
7. Case study of evidences based on: DNA finger printing (disputed paternity)/ Bite marks/ Hair.
8. Visit to any Forensic Lab/Institute.

Essential/recommended readings

1. Tilstone, W.J., Hastrup, M.L. and Hald, C. (2013) Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton.
2. Saferstein, R. (2010) Criminalistics: An Introduction to Forensic Science (10th Edition), Pearson.
3. Butler, J.M. (2005) Forensic DNA Typing, Elsevier.
4. L. Stryer, (1988) Biochemistry, 3rd Edition, W.H. Freeman and Company, New York.
5. Chowdhuri, S. (1971) Forensic Biology, BPRD, New Delhi.

Suggestive readings

1. Duncan, G.T. and Tracey, M.I. (1997) Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton.
2. Inman K. and Rudin, N. (1997) An Introduction to Forensic DNA Analysis, CRC Press, Boca Raton.

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