Post Graduate & Research Department of Zoology
The American College, Madurai

Proposed Curriculum for M.Sc. Zoology Programme – 2019-2020 Onwards

SEM	S.No.	Course Code	Course Title	Hours	Credits	Marks
I	1.	PGZ 4433	Animal Diversity	5	4	80
	2.	PGZ 4435	Biological Chemistry	5	4	80
	3.	PGZ 4337	Cell Biology	5	3	60
	4.	PGZ 4339	Know Your Body (CBCS)	4	3	60
	5.	PGZ 4441	Microbiology	5	4	80
	6.	PGZ 4343	Lab. in Cell Biol., Biol. Chem. & Microbiol.	6	3	60
			Total	**30**	**21**	**420**
II	7.	PGZ 4434	Animal Physiology	6	4	80
	8.	PGZ 4336	Biostatistics and Bioinformatics	4	3	60
	9.	PGZ 4438	Genetics	5	4	80
	10.	PGZ 4440	Molecular Biology	5	4	80
	11.	PGZ 4342	Poultry Science (CBCS)	4	3	60
	12.	PGZ 4344	Lab. in Anim. Physiol. & Mol. Biol.	6	3	60
			Total	**30**	**21**	**420**
III	13.	PGZ 5545	Entomology	6	5	100
	14.	PGZ 5547	Evolution	6	5	100
	15.	PGZ 5549	Immunology	6	5	100
	16.	PGZ 5551	Methods in Biology	6	5	100
	17.	PGZ 5153	Lab. in Entomology	2	1	20
	18.	PGZ 5355	Lab. in Imm. & Meth. in Biol.	4	3	60
			Total	**30**	**24**	**480**
IV	19.	PGZ 5546	Biotechnology	6	5	100
	20.	PGZ 5548	Developmental Biology	6	5	100
	21.	PGZ 5550	Environmental Biology	6	5	100
	22.	PGZ 5252	Lab. in Biotech. & Dev. Biol.	4	2	40
	23.	PGZ 5154	Lab. in Env. Biol.	2	1	20
	24.	PGZ 5656	Res. Project	6	6	120
			Total	**30**	**24**	**480**
			Grand Total	**120**	**90**	**1800**

M.Sc. Zoology

PROGRAMME SPECIFIC OUTCOMES

Upon completion of this Programme, the postgraduates will be able to:

1. Analyze the concepts pertaining to the various disciplines of Zoology and the diversity of animals.
2. Analyze the concepts and mechanisms relevant to Zoology at cellular, biochemical and molecular levels to solve environmental and health problems.
3. Analyze the principles of Genetics and the process of Evolution along with evidences.
4. Critically evaluate the issues related to Ecology and Environment and find solutions to such issues using Biotechnology principles.
5. Compare the functions of various systems in man and animals and assess the concepts of Immunology.
6. Evaluate the role of microbes in food preservation, soil fertility, health and industries.
7. Analyze biological data using statistical techniques and the developments of Bioinformatics.
8. Design projects to conduct studies to derive data and compile information along with documentation.
9. Equip to appear in competitive examinations and to become teaching professionals.
10. Achieve proficiency in analytical methods and experimental techniques.

Mapping of Courses with Programme Specific Outcomes (PSOs)

Course Code	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
PGZ 4433	✓	✓	✓		✓				✓	
PGZ 4435	✓	✓		✓	✓				✓	✓
PGZ 4337	✓	✓		✓	✓				✓	✓
PGZ 4339	✓	✓	✓	✓	✓	✓			✓	
PGZ 4441	✓	✓	✓	✓		✓			✓	✓
PGZ 4343 (I)	✓	✓			✓	✓			✓	✓
PGZ 4343 (II)	✓	✓			✓				✓	✓
PGZ 4343 (III)	✓	✓			✓			✓	✓	✓
PGZ 4434	✓	✓		✓	✓			✓	✓	
PGZ 4336	✓		✓				✓		✓	
PGZ 4438	✓	✓	✓		✓		✓		✓	
PGZ 4440	✓	✓	✓						✓	
PGZ 4342	✓	✓	✓	✓	✓	✓		✓		
PGZ 4344 (I)	✓	✓		✓	✓			✓	✓	✓
PGZ 4344 (II)	✓	✓	✓	✓						✓
PGZ 5545	✓	✓	✓	✓		✓			✓	
PGZ 5547	✓	v	✓	✓					✓	
PGZ 5549	✓	✓			✓	✓		✓	✓	✓
PGZ 5551	✓	✓	✓		✓			✓	✓	✓
PGZ 5153	✓	✓		✓	✓			✓		✓
PGZ 5355 (I)		✓			✓	✓			✓	✓
PGZ 5355 (II)		✓			✓		✓	✓	✓	✓
PGZ 5546	✓	✓		✓	✓	✓			✓	
PGZ 5548	✓	✓			✓				✓	✓
PGZ 5550	✓			✓		✓			✓	✓
PGZ 5252 (I)		✓		✓		✓			✓	✓
PGZ 5252 (II)	✓	✓			✓				✓	✓
PGZ 5154	✓			✓		✓		✓	✓	✓
PGZ 5656		✓		✓		✓	✓	✓		✓

Mapping of Programme Specific Outcomes (PSOs) with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	✓	✓	✓	✓	✓		✓		✓	
PSO2	✓	✓	✓	✓	✓		✓		✓	
PSO3	✓	✓	✓	✓	✓	✓	✓			
PSO4	✓	✓	✓	✓	✓	✓			✓	
PSO5	✓	✓	✓	✓	✓				✓	
PSO6	✓	✓	✓	✓	✓				✓	
PSO7	✓	✓	✓	✓	✓	✓			✓	
PSO8	✓	✓	✓	✓	✓	✓			✓	
PSO9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PSO10	✓	✓	✓	✓	✓	✓	✓		✓	✓

PGZ 4433 Animal Diversity (4+1=5hr/wk) (4cr)

This course aims at refreshing the fundamental aspects of core Zoology. It provides adequate facts which will enrich the knowledge in Zoology. It deals with broad outline classification of invertebrates and chordates. It also deals with minor phyla, living fossils, connecting links, missing links, Zoogeography and general topics such as parental care and migration of birds.

Course Outcomes

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

i. Explain principles and practice of animal systematics.
ii. Outline evolution, hierarchy and classification of Invertebrate phyla and Chordates.
iii. Apply the basics of systematics by learning the specific and general characters of various groups.
iv. Identify typical examples for each class.
v. Demonstrate in-depth knowledge on the diversity and relationships in animal world.

1. **Levels of structural organization:** Concepts of species, biological, binomial and trinomial nomenclature. Kinds of classification - five kingdoms, types of taxonomy - morphology, numerical, molecular and phyletic lineages. Hierarchical organization of animal complexity - unicellular, colonial & multicellular forms, coelom, symmetry, organs and systems.

2. **Methods of Biosystematics:** Classical and modern methods - typological, phenetics, evolutionary, phylogenetic and cladistics. Molecular taxonomy - Phylocode, tree of life & bar-coding of life, Serotaxonomy, Integrated Taxonomic Information System (ITIS), biodiversity informatics and websites related to taxonomy. Importance and applications of systematics in biology.

3. **Outline classification and Minor Phyla:** Outline classification of Invertebrates (up to class level) and chordates (up to order level) - general characters, examples. Comparative account of digestive, respiratory, exoskeletal, skeletal, circulatory, nervous and urinogenital systems of chordates. Minor phyla - Ctenophora, Ectoprocta, Endoprocta and Rotifera.

4. **Living Fossils, Connecting and Missing Link:** Geological time scale - Living fossil - *Limulus*, *Latimeria*, *Callorhinchus* (Elephant shark), *Sphenodon,* and *Ctenophora*. Connecting links - *Peripatus*, *Neoplina*, *Protopterus*, *Chimera*, *Balanoglossus and Orinthorhyncus.* Missing link - *Archeopteryx*, *Ichthyostega,* and *Seymouria*.

5. **Natural history of Indian subcontinent:** Zoogeography, major habitat types of the subcontinent, seasonality and phenology. Wildlife organizations - ICZN, WWF, ZSI and BNHS. General topics - parental care in fishes & amphibia, migrations of fishes & birds.

Text book

Hickman CPJR, Roberts SL and Larson A (2001) Integrated Principles of Zoology, Eleventh edn, McGraw-Hill publishers, New York.

References

Agarwal VK (2000) Invertebrate Zoology, First edn, S. Chand & Co Ltd, New Delhi.

Ayyar E (1993) Manual of Zoology, Vol. I - Invertebrata, S. Viswanathan (Printers & Publishers) Pvt. Ltd, Chennai.

Jordan EL and Verma PS (2013) Invertebrate Zoology, S. Chand & Co Ltd, New Delhi.

Kotpal RL (2003) A Text book of Minor Phyla, Eleventh edn, Rastogi Publications, Meerut.

Kotpal RL (2014) Modern Textbook of Zoology: Vertebrates, Eleventh edn, Rastogi Publishers, Meerut.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3				4		
CO4		2				
CO5					5	

Mean = 3.0

PGZ 4435 Biological Chemistry (4+1=5hr/w) (4cr)

Course on biological chemistry includes physical and chemical concepts in biology, composition, structure and functions of carbohydrates, proteins, lipids and vitamins. Enzymes & enzyme kinetics, metabolism of carbohydrates, proteins, lipids, and vitamins will be taught. It also includes biosynthesis and degradation of purines and pyrimidines

Course Outcomes

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

i. Explain the basic concepts of biochemistry such as chemical bonds, pH, buffer and kinetic properties of biological reactions.
ii. Analyze the biomolecular structures of carbohydrates, proteins, lipids and vitamins.
iii. Evaluate the regulation and mechanism of enzyme activity and the role of thermodynamic principles in metabolic reactions.
iv. Demonstrate the metabolic pathways of carbohydrates and vitamins.
v. Explain the amino acid, nucleic acid and lipid metabolism.

1. **Physical and chemical concepts in biology**: Structure of atoms, molecules and chemical bonds. Biomolecule interaction - van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction and covalent bond. Principles of biophysical chemistry- pH, buffer, reaction kinetics, colligative properties.

2. **Biomolecules:** Composition, structure, classification and function - Carbohydrates, lipids, proteins and vitamins. Conformation of proteins - Ramachandran plot, primary, secondary, tertiary & quaternary structures, domains, motif and folds.

3. **Enzymes and bioenergetics**: Enzymes and enzyme kinetics - regulation of enzymatic activity - mechanism of enzyme catalysis - Michaelis-Menten equation - isozymes. Bioenergetics - thermodynamics, free energy, coupled reactions, group transfer and biological energy transducers.

4. **Carbohydrate and vitamin metabolism**: Types of metabolism. Carbohydrate metabolism - glycolysis, TCA cycle, oxidative phosphorylation, Gluconeogenesis, glycogen metabolism - Glycogenesis and Glycogenolysis, HMP shunt, uronic acid pathway, Vitamin metabolism - vitamins A and C.

5. **Amino acid, nucleic acid and lipid metabolism**: Amino acid metabolism - Urea cycle. Nucleotides - Biosynthesis and degradation of purines and pyrimidines. Biosynthesis and β-oxidation of fatty acid, Ketone bodies, metabolism of Phospholipids, Glycolipids, Cholesterol and HDL.

Textbook

Voet JG, Pratt CW and Voet D (2016) Fundamentals of Biochemistry: Life at the molecular level, Fifth edn, John Wiley & Sons, New York

References

Berg JM, Tymoczko L and Stryer L (2012) Biochemistry, Seventh edn, W.H. Freeman, New York.

Murray RK, Granner DK and Rodwell VW (2006) Harper's Illustrated Biochemistry, Twenty Seventh edn, McGraw Hill Companies, Inc.

Nelson DL and Cox MM (2013) Lehninger Principles of Biochemistry, Sixth edn, W.H. Freeman, New York.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2		4		
CO3			3		5	
CO4				4		
CO5				4		

Mean = 3.4

PGZ 4337 Cell Biology (4+1=5h/wk) (3cr)

This course enables the students to understand the properties of living cells related to cell organization and behaviour.

Course Outcomes

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

i. Explain the structure, functions and properties of cell membrane.
ii. Discuss the mechanisms and control of inter-cellular communication.
iii. Outline the structure and functions of cell organelles in cell functioning.
iv. Evaluate the structure and organization of nucleus and chromosomes.
v. Analyze regulation of cell cycle and therapeutic intervention.

1. **Cell membrane:** Structure of membrane models - lipid bilayer and membrane proteins - Diffusion, osmosis, ion channels and active transport - membrane pumps - mechanism of sorting and regulation of intra cellular transport - electrical properties of membrane - cell wall.

2. **Cell signalling and cellular communication:** Cell surface receptors - signalling through G protein coupled receptors - signal transduction pathways - secondary messengers - regulation of signalling pathways - bacterial chemotaxis and quorum sensing. General principles of cell communication - desmosomes - cell adhesion and roles of different cell communication - adhesion molecules - gap junction - extra cellular matrix - integrins.

3. **Ultrastructure and functions of cellular organelles:** Mitochondria - Golgi bodies - Lysosomes - Endoplasmic reticulum - Ribosomes - Plastids - Chloroplast - Vacuoles – Peroxisomes - Cytoskeleton.

4. **Nucleus, chromosomes and organization of genes:** Nucleus - structure of chromatin and chromosomes - heterochromatin and euchromatin - unique and repetitive DNA - interrupted gene - gene families.

5. **Cell division, cell cycle and cancer :** Mitosis and meiosis - their regulation - steps in cell cycle - regulation and control of cell cycle - oncogenes - tumour suppressor genes - cancer and cell cycle - metastasis - interaction of cancer cell with normal cell - apoptosis - therapeutic interventions of uncontrolled cell growth.

Textbook

De Robertis EDP and De Robertis EMF (2010) Cell and Molecular Biology, Eighth edn, BI Waverly Pvt. Ltd, New Delhi.

References

Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P (2002) Molecular Biology of the Cell, Third edn, Garland Science Publisher, New York.

Karp G (2010) Cell Biology, Sixth edn, John Wiley & Sons, New York.

Kleinsmith LJ and Kish VM (1995) Principles of Cell and Molecular Biology, Second edn, Harper Collins College Publishers, New York.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3				4		
CO4			3			
CO5			3			

Mean = 3.2

PGZ 4339 **Know Your Body** **(4h/wk) (3cr)**
(CBCS)

It is a comprehensive course that aims to give a basic understanding on the anatomical and physiological features of various organ systems like digestive, respiratory, circulatory, nervous, endocrine, excretory and reproductive systems in human beings. This course also deals with some areas in health and hygiene.

Course Outcomes

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

i. Discuss nutrient requirements, structure and functions of digestive system in humans.
ii. Explain the structure and functions of skeleton, muscles and central nervous system.
iii. Demonstrate in depth knowledge on the physiology of circulatory and respiratory system.
iv. Outline the organs of excretory and reproductive systems and their disorders.
v. Utilize their knowledge to maintain health and hygiene.

1. **Nutrition, diet and digestive system:** Carbohydrates - Fats - Proteins - Caloric values of food - Obesity & BMI. Minerals - Vitamins - Deficiency disorders. Organs of digestive system - digestion and absorption.

2. **Skeletal, muscular and nervous systems:** Bones - cartilage - ligaments - tendons - muscles - disorders. Nervous system - brain, sensory organs - skin, tongue, nose, eye and ear.

3. **Respiratory and circulatory systems:** Lungs - respiration - heart - structure & functions - cardiac & respiratory disorders (myocardial infarction and tuberculosis). Blood - composition - blood groups - Rh factor - blood clotting - transfusion - blood Bank - heart.

4. **Excretory and reproductive systems:** Kidney - structure and function - disorders. Male and female reproductive organs - hormones - IVF - Sexually transmitted diseases.

5. **Health and Hygiene:** Environment and health - Sleep and sleep disorders - World awareness days on health - silent killer disorders - Nosocomial infections - Personal hygiene and occupational disorders - stress.

Text book

Mader SS and Windelspecht M (2018) Human Biology, Fifteenth edn, McGraw-Hill Education, New York.

References

Hall JE (2015) Guyton and Hall textbook of medical physiology, Thirteenth edn, Saunders (Elsevier), Canada.

Taylor DJ, Green NPO and Stout SW (2005) Biological Science, R. Soper (ed.), Third edn, Cambridge University Press, UK.

Vander AJ, Sherman JH and Luciano DS (2001) Human Physiology: The Mechanism of Body Function, Eighth edn, McGraw Hill Inc. New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3		2				6
CO4		2				
CO5			3		5	

Mean = 3.1

PGZ 4441 Microbiology (4+1=5h/wk) (4cr)

This course is designed to promote the interest of basic and applied areas of microbiology. It deals with detailed classification of bacteria, algae, fungi, protozoa and viruses. It imparts knowledge of microorganisms in industrial, food and agricultural microbiology. It emphasizes primary and secondary screening of microbes linked with fermentation industry. The course also deals with medically important microbes, diseases and control measures in terms of public health.

Course Outcomes

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

i. Analyze the evidences, historical events, diversity and scope of microbiology.
ii. Assess the classification of bacteria, fungi, algae and protozoa and characteristic features of prokaryotic and eukaryotic cells.
iii. Explain various bacterial growth media, sterilization and growth curve.
iv. Apply the knowledge of microorganisms in soil, food and industrial sectors.
v. Evaluate the role of microorganisms in epidemic and communicable diseases in global perspectives.

1. **Introduction, Microbial taxonomy and Microscopy:** Structure & function of bacterial and Archaebacterial cells - Taxonomy ranks - techniques for determining microbial taxonomy - Phylogenic trees - concept of microbial species - Bergey's classification of bacteria - classification of algae, fungi, protozoa and viruses. Components and working principles of microscope - light, phase contrast, electron and fluorescence microscope.

2. **Microbial Physiology and Biochemistry:** Nutritional types - Growth curve - Culture media - Bacterial cell cycle - Measurement of microbial growth - Pattern of microbial death - Chemotaxis and endospore formation - Microbial metabolism - Oxidation-reduction reactions - Physical and chemical methods of sterilization.

3. **Microbial Ecology:** Global climate changes - Assessing microbial diversity - Microbial community activity. Water as a microbial habitat - Marine and freshwater ecosystems - Coliform analysis. Soil as a microbial habitat - Plant-microbe associations - Nitrogen fixation - Mycorrhizae. Water purification and sanitary analysis - Sewage treatment and recycling of wastes.

4. **Food and Industrial Microbiology:** Food spoilage, food poisoning and preservation - food borne diseases - detection of food borne pathogens. Microorganisms used in industry - Downstream processing - Production strains - Primary, secondary screening of microbes and scale up fermentations - Types of fermentors - raw materials. SCP and applications of microbial products in human welfare - Production of antibiotics (Penicillin, Streptomycin), vitamins, enzymes and vinegar.

5. **Medical microbiology and Public health:** Human microbiome - Antimicrobial drugs and chemotherapy - Epidemiology - infectious diseases in human population – Nosocomial infections - Control of epidemics - Bioterrorism - Global health considerations – Air borne,

Zoonotic, Prion, direct, contact and opportunistic diseases and diagnosis. Causative agents, symptoms, transmission and control measures of tuberculosis, typhoid, Aspergillosis, malaria and AIDS.

Text book

Willey JM, Sherwood LM and Woolverton CJ (2016) Prescott's Microbiology, Tenth edn, McGraw Hill International publication, New York.

References

Kapil A and Bhaskaran CS (2013) Ananthanarayan and Paniker's Textbook of Microbiology, Ninth edn, University Press.

Kingsbury DT and Wagner GE (1990) Microbiology, NMS (series), Second edn, National Medical Series.

Pelczar MJJR, Chan ECS and Krieg NR (1993) Microbiology, Fifth edn, Tata McGraw-Hill, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2				4		
CO3		2				
CO4			3			
CO5					5	

Mean = 3.6

PGZ 4343 Lab. in Cell Biology, Biological Chemistry & Microbiology
(2+2+2=6h/wk) (3cr)

The Cell Biology laboratory component emphasizes on the working principle of compound microscope, observation of specialized cells, micrometry, permanent slide preparation, observation of mitosis in onion root tip and polytene chromosomes in Chironomus larva. Biological Chemistry laboratory component includes pH metry, colorimetric estimation of biomolecules, centrifugation, chromatographic separation of amino acids, electrophoresis and enzyme kinetics. Microbiology laboratory skills will train the students to maintain pure culture from various sources under aseptic condition, staining and biochemical tests. It also includes isolation of ubiquitous organisms from sewage, soil, plants and hospital environment. Use of microorganisms in wine production and quality analysis of milk will also be carried out.

I. Lab. in Cell Biology

Course Outcomes

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

i. Identify various types of cells.
ii. Utilize various microscopes and Camera Lucida.
iii. Prepare various types of microscopic slide mountings.
iv. Demonstrate various phases of cell division and types of chromosomes.
v. Explain the effects of pH, ionic concentration and solvents on cell membrane.

Laboratory Exercises:

1. Microscopic observation of specialized cells (nerve cell, muscle cell etc)
2. Outline sketch of cells using Camera Lucida
3. Micrometry
4. Permanent slide preparation I – principle, fixation, dehydration, embedding
5. Permanent slide preparation II – sectioning, staining, mounting
6. Study of mitosis using onion root tip
7. Preparation of polytene chromosomes from salivary glands of Chironomus larvae
8. Plasmolysis – with different plant cells with different NaCl and sucrose solution concentration
9. Hemolysis I – Principle, influence of NaCl solution of various concentrations
10. Hemolysis II – Influence of temperature, molecular size, organic solvents
11. Observation of cell division stages using permanent slides

II. Lab. in Biological Chemistry

Course Outcomes

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

i. Use pH meter, colorimeter, spectrophotometer and centrifuge.
ii. Demonstrate paper and thin layer chromatography.
iii. Design experiments using quantitative tests for carbohydrates, protein and nucleic acids.
iv. Analyze the enzyme activity.
v. Compare the different methods of centrifugation.

Laboratory Exercises:

1. pH metry.
2. Preparation of biological buffer.
3. Colorimetry.
4. Estimation of Glucose -Anthrone method.
5. Estimation of Protein - Lowry's method.
6. Estimation of DNA by Diphenylamine reaction.
7. Estimation of RNA by Orcinol reagent.
8. Centrifugation technique.
9. Electrophoresis
10. Chromatography: Paper and Thin Layer
11. Enzyme assay - alkaline phosphatase activity
12. Enzyme kinetics using alkaline phosphatise

III. Lab. in Microbiology

Course Outcomes

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

i. Prepare media, isolate pure cultures, biochemically test and stain microbes.
ii. Perform antimicrobial susceptibility test and methylene reduction test.
iii. Analyze microbes from sewage, soil, root nodule and human body.
iv. Identify nosocomial infection causing organisms.
v. Plan visits to hospitals and industries.

Laboratory Exercises:

1. Aseptic techniques - sterilization methods and preparation of media (selective and differential).
2. Pure culture isolation from air - water - soil.
3. Staining techniques and biochemical tests to classify microbes.
4. Cultivation and identification of unknown Fungi from various sources.
5. Antimicrobial susceptibility test using Kirby Bauer method.
6. Methylene blue reductase test of milk.
7. Wine Production
8. Primary and secondary screening of industrially relevant microbes.
9. Immobilization of microbial products.
10. Isolation and characterization of microbes from sewage sample.
11. Isolation and maintenance of pure culture for actinomycetes.
12. Isolation of antibiotic producing organism from soil.
13. Isolation of Nitrogen fixing bacteria from Root nodule.
14. Isolation of Normal microflora of Human body.
15. Identification of Nosocomial infection causing organisms.
16. Visit to Industry/Hospital/fermentation unit

References

Aneja RK (2014) Laboratory Manual of Microbiology and Biotechnology, First edn, MEDTECH Publication.

Cappucino GS and Sherman N (2013) Microbiology-A Laboratory Manual, Tenth edn, Pearson Education.
Gasque EA (1992) Manual of laboratory experiences in Cell Biology, Universal Bookstall, New Delhi.
Gunasekaran P (1995) Laboratory manual in Microbiology, New Age International Pvt. Ltd, New Delhi.
Jayaraman J (2011) Laboratory manual in Biochemistry, Second edn, New Age International Publishers, New Delhi.
Karp G (1996) Cell and Molecular Biology-concepts and experiments, John Wiley and Sons Inc. New York.
Palanivelu P (2009) Analytical Biochemistry and Separation Techniques, Fourth edn, Twenty first Century Publications, Madurai.
Plummer DT (1997) An introduction to practical Biochemistry, Tata McGraw Hill Publishing Company, New Delhi.

I. Lab. in Cell Biology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3			3			
CO4					5	
CO5				4		

Mean = 3.6

II. Lab. in Biological Chemistry

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2		2				
CO3						6
CO4				4		
CO5					5	

Mean = 4.0

II. Lab. in Microbiology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3	4		
CO3			3	4		
CO4			3			
CO5			3		5	

Mean = 3.5

PGZ 4434 Animal Physiology (5+1=6h/wk) (4cr)

This course deals with principles and basic facts of Animal Physiology. It also emphasize on mammalian physiology and other vertebrate taxa. It deals with diverse of functions of the living organisms encompassing digestive, respiratory, cardiovascular, muscular, nervous, renal and endocrine physiology.

Course Outcomes

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

i. Compare digestive and respiratory systems of animals and infer mechanism of digestion and respiration.
ii. Explain the functions of circulatory and excretory systems of animals.
iii. Assess the relationship between nervous system and muscle contraction.
iv. Evaluate the principles of endocrinology and sensory physiology.
v. Analyze the relationship between environment and physiological adaptations.

1. **Digestion and respiration**: Digestive function - assimilation & absorption, unique food and feeding mechanisms in animals. Mechanism of respiration - respiratory pigments - transport of respiratory gases in the blood - air breathing in fishes - hypoxia - oxygen therapy - control of respiration.

2. **Circulation and excretion**: General pattern and principles of vertebrate circulation - blood coagulation - ECG - cardiodynamics - haemodynamics - microcirculation - tissue fluid exchange - lymphatic circulation - control of heart beat and circulation. Kidneys of vertebrates - body fluids - nitrogen excretion - physiology of urine formation - renal clearance - control of micturition.

3. **Muscle, nerve cell and signals**: Structure of muscle cell - sliding filament theory - cross - bridge function and production of force - role of calcium - electrochemical coupling - neural control of muscle contraction. Components of nervous system - functional morphology of synapse, Impulse - types and transmission, Chemical transmitters - excitation, inhibition and computation.

4. **Endocrine and sensory physiology**: Endocrine systems in vertebrates - Endocrine function - hormones - target tissues - mechanism of hormone action - endocrine disorders - hormone therapy - hormonal control on metabolism. Sensory qualities - principles - receptors - chemical senses - mechanical senses - optic sense - animal electricity - sorting of sensory information.

5. **Environmental physiology**: Adaptation to the environment - temperature regulation - Osmo-iono regulation. Physiological time - Effect of high altitude - Problems of diving - adaptations - stress physiology.

Text book

Nielson KS (1997) Animal Physiology - Adaptation and Environment, Fifth edn, Cambridge University Press, London.

References

Eckert R (1982) Animal Physiology, Surjeet Publications, New Delhi.

Gordon MS (1968) Animal Structure and function, Amerind Publishers.

Hoar WS and Hikman CP (1967) General and comparative Physiology, Prentice Hall India, New Delhi.

Pocock G, Richards GD and Daly MDB (1999) Human Physiology, Oxford University Press, London.

Widmaier E, Raff H and Strang K (2013) Vander's Human Physiology: The Mechanisms of Body Function, Thirteenth edn, Mc Graw Hill Education, New York.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3				4		
CO4			3			
CO5					5	

Mean = 3.4

PGZ 4336 Biostatistics and Bioinformatics (3+1=4h/wk) (3cr)

This course is designed to impart a fundamental knowledge on data, sources & acquisition, organization & presentation of data. It targets at teaching certain important biostatistical analyses such as measures of central tendencies, dispersion of data and tests of significance. It also gives an introduction to the usage of SPSS package in biostatistical analysis. Second part of the course deals with the information of biological databases and file format. It emphasizes the concept of sequence analysis, sequence alignment tools & algorithm, a special attention given to phylogenetic analysis methods**.**

Course Outcomes

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

i. Identify the sources and methods of data collection, classification and presentation.
ii. Compute the central tendencies, measures of dispersion, standard deviation & error, linear regression and simple correlation.
iii. Analyze the significance, goodness of fit, variance & use SPSS package.
iv. Utilize biological databases for bioinformatics analysis.
v. Analyze biological sequence alignments and create phylogenetic tree.

1. **Introduction, data and collection methods:** Biostatistics - introduction, definition, basic concepts, terminologies. Data - types and sources, collection methods, sampling - random & non-random, classification of data - Sturge's rule. Presentation of data - tabulation, graphical and diagrammatic representation.

2. **Descriptive statistics:** Measures of central tendency - arithmetic mean, median and mode. Measures of dispersion - standard deviation and Standard error - linear regression and simple correlation.

3. **Tests of significance:** Students *t*-test (simple, paired), *F*-test - applications of $\chi 2$ (chi-square) test in biology & testing the goodness of fit - Analysis of Variance (ANOVA). Introduction to statistical software - SPSS - data editor - creating coding variables - output viewer - graphic & diagrammatic representations - Elements of Probit analysis.

4. **Introduction and Bioinformatics Resources:** Computational Biology and Bioinformatics - definition - Biological databases - Nucleic acid sequence databases - GenBank, EMBL and DDBJ. Protein sequence databases - SWISS-PROT, TrEMBL, PIR and PDB. Genome Databases - NCBI, EBI, TIGR and SANGER. Other Databases - Patterns/Motifs/System Biology.

5. **Sequence Similarity Searches:** Basic concepts of sequence similarity, identity and homology. Scoring matrices - PAM & BLOSUM series - local versus global alignment. Needleman-wunsch and Smith-waterman algorithms. Heuristic Methods of sequence alignment - FASTA, BLAST & PSI BLAST, Software tools for pairwise & multiple sequence alignment. Phylogenetic Analysis - Phylogenetic tree, Comparative genomics, orthologs and paralogs. Methods of phylogenetic analysis - UPGMA, WPGMA and neighbour joining method.

Text books

Attwood KT, Pettifer RS and D Thorne (2016) Bioinformatics Challenges at the Interface of Biology and Computer Science: Mind the Gap, First edn, John Wiley & Sons, New York.

Rastogi VB (2015) Biostatistics, Third edn, MEDTECH publishers, New Delhi.

References

Ignacimuthu S (2005) Basic Bioinformatics, Second edn, Narosa Publishing House, New Delhi.
Landau S and Everitt BS (2003) A Handbook of Statistical analyses using SPSS, Chapman & Hall/CRC Press, London.
Le CT and Eberly LE (2016) Introductory Biostatistics, Second edn, John Wiley and Sons, New Jersey.
Lesk AM (2002) Introduction to Bioinformatics, First edn, Oxford University Press, London.
Stanton GA (2002) Primer of Biostatistics, Fifth edn, McGraw-Hill, New York.
Zar JH (2005) Biostatistical Analysis, Fourth edn, Pearson Education Inc., New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2				4		
CO3					5	
CO4			3			
CO5						6

Mean = 4.2

PGZ 4438 Genetics (4+1=5hr/wk) (4cr)

This course focuses on the basic principles of genetics by presenting the important concepts of classical, microbial and population genetics. Study on Mendelian genetics introduces the basic concepts and history of genetics. It also gives an overview on genetic map and linkage. A section on microbial genetics helps to understand the mechanisms of genetic exchange. Human genetics deals with karyotyping and pedigree analysis.

Course Outcomes

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

i. Identify Mendelian principles and theories of heredity.
ii. Explain the mechanisms and importance of linkage and crossing over.
iii. Analyze the mechanisms of microbial genetics.
iv. Discuss the importance of Hardy-Weinberg equilibrium and factors affecting it.
v. Apply the concepts related to human genetics.

1. **Mendelian principles and chromosomal basis of inheritance:** Study of heredity, testing genetic hypotheses, multiple alleles, gene interactions, chromosome theory of heredity, extra nuclear inheritance, sex chromosome & sex determination, sex linked, sex influenced genes, rearrangement of chromosome structure and dosage compensation.

2. **Linkage, crossing over and chromosome mapping**: Linkage - types - an exception to Mendel's principle of independent assortment, crossing over as physical basis of recombination, chromosome mapping using recombination frequency, linkage maps using ordered tetrad data.

3. **Microbial genetics**: Mechanisms of genetic exchange in bacteria through transformation, conjugation and transduction - use of partial diploids to map closely linked genes. Bacteriophage T_4 and lambda, rII locus of bacteriophage T_4, evolution of the concept of gene as a unit of structure, function, and complementation test as an operational definition of the gene.

4. **Quantitative and population genetics**: Genetic analysis of quantitative traits, polygenic inheritance, Hardy-Weinberg equilibrium, estimating allele frequencies, factors affecting, inbreeding and out breeding.

5. **Human Genetics:** Human karyotype, banding techniques, genetic traits and inborn errors in man. Variations in chromosome number - Genetics of human behavioural traits. Twin studies - Pedigree analysis - symbols - sex linked and autosomal pedigree. Eugenics, Euthenics and genetic counselling.

Text book

Snustad DP and Simmons MJ (2010) Principles of Genetics, Fifth edn, John Wiley & Sons, Inc, New York.

References

Brooker RJ (2005) Genetics- Analysis and Principles, Second edn, McGraw-Hill Book Company, Boston, USA.

Hartl DL and Jones WJ (2005) Genetics - Analysis of Genes & Genomes, Sixth edn, Jones & Barlett Publishers, Massuchusetts.

Hexter W and Yost HT (1977) The Science of Genetics, Prentice Hall of India Private Ltd., New Delhi.

Levine L (1969) Biology of the Gene. The CV Mosby Company, St. Louis, USA

RothWell NV (1977) Understanding Genetics, Second edn, Oxford University Press, London.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3		2		4		
CO4				4		
CO5		2	3			

Mean = 3.0

PGZ 4440 Molecular Biology (6h/wk) (4cr)

This course emphasizes the molecular basis of life and it forms the blueprint of life. It deals mainly with nucleic acids, proteins and their interactions. It covers the detailed molecular mechanisms involved in DNA replication, recombination, transcription and translation. A special emphasize is given to post- transcriptional and -translational modifications. It also includes an in depth study on mutations, DNA damage and repair mechanisms. Current understanding on the gene regulatory mechanisms is also focused.

Course Outcomes

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

i. Explain chromatin structure, DNA topology, replication & recombination.
ii. Discuss the events involved in transcription and post transcriptional modifications.
iii. Analyze the different stages of translation and post translational modifications of proteins.
iv. Compare the different gene regulatory mechanisms in prokaryotes and eukaryotes.
v. Evaluate the types of DNA damage, repair, mutation and transposition mechanism.

1. **DNA structure, replication and recombination:** Structure and forms of DNA, Replication - Semi conservative, rolling and D-loop models, mechanisms of replication. Homologous and site specific recombination.

2. **Transcription in prokaryotes and eukaryotes:** Structure and types of RNA - RNA polymerases - stages of transcription - transcriptional factors - Post transcriptional modifications - RNA processing - capping, splicing, polyadenylation and RNA editing.

3. **Translation in prokaryotes and eukaryotes:** Genetic code - properties - deciphering and exceptions to universality - stages of translation - translation factors - aminoacylation of tRNA - aminoacyl tRNA synthetase - translational proofreading - translational inhibitors - Post translational modifications of proteins.

4. **Gene regulation in prokaryotes and eukaryotes:** Inducible and repressible systems - *Lac* operon system - *Lac* positive and negative control mechanisms - *trp* operon - DNA binding proteins - galactose metabolism in Yeast - DNA looping and homeobox - Gene Silencing.

5. **DNA damage, repair mechanisms, mutation and transposons:** Types of DNA damage and repair mechanisms - spontaneous and induced mutations - molecular and biochemical basis of mutation. Transposable elements - Tn3, Tn5, Tn10, *Mu* phage, LINES, SINES, copia and P-element - significance and mechanism of transposition.

Text book

Watson JD, Baker TA, Bell SP, Alexander G and Levine M (2013) Molecular Biology of the Gene, Seventh edn, Benjamin-Cummings Pub Co., San Francisco, USA.

References

Brown TA (2017) Genomes 4, Fourth edn, Garland Science (Taylor & Francis Group), New York.

Friefelder D (1987) Molecular Biology, Narosa Publishing House, New Delhi.

Hartl DL and Jones WJ (2005) Genetics - Analysis of genes and genomes. Sixth edn, Jones & Barlett Publishers, Massachusetts.

Krebs JE, Goldstein ES and Kilpatrick ST (2014) Lewin's Genes XI, Jones and Barlett learning, Burlington, MA.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3			3			
CO4		2		4		
CO5		2			5	

Mean = 3.1

PGZ 4342 **Poultry Farming** **(4h/wk) (3cr)**
(CBCS)

This course aims to develop human resource in the area of poultry farming. It will impart knowledge in poultry industry, farming, breeding, housing, nutrition, disease and management. This course will also help to understand the various aspects of poultry rearing.

Course Outcomes

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

i. Discuss the aspects of poultry industry, biology of fowl and nutrition.
ii. Identify the Indian exotic breeds, importance of layers and broilers and to evaluate their efficiency.
iii. Use the poultry equipment for day to day activities to be involved in the farm and explain the rearing system and use them efficiently.
iv. Compile the source of ingredients for the poultry feed stuff and formulate homemade feed for broilers and layers, feed additives and summer and winter management.
v. Analyze the nature and control of bacterial, fungal, viral and parasitic infections.

1. **Poultry industry & biology:** History of poultry industry in India - 5 year plans - NECC - entrepreneurship - funding agencies - role of egg and meat in human nutrition - poultry manure and byproducts. External features - digestive and reproductive systems - egg formation - feather sexing - feather tracts.

2. **Breeds of layers and broilers:** Classification - Indian and exotic breeds - production of commercial laying stock - cross breeds - sexing in one day old chicks - popular breeds of layers and broilers in India.

3. **Housing and Equipment:** Location of the farm - construction of poultry sheds - layout of broiler and layer farms - 1+3 housing system, all in and all out system - deep litter system - cage rearing - incubator - waterer - feeder - nest box - brooder - dropping pit - disposal pit.

4. **Nutrition and Management:** Energy - carbohydrates - fats - proteins - vitamins - minerals - feed stuff - feed formulation - non-nutritive feed additives - feed grinder - home made mineral mixture of feed for chick - grower - layer - broiler and finisher - Incubation - management of growers - layers - summer and winter management - forced moulting - debeaking - culling - marketing.

5. **Diseases and control measures:** Bacterial (Infectious coryza), viral (Newcastle, bird flu), fungal (Mycotoxicosis) and parasitic (Coccidosis) – transmission, symptoms & treatment. Vaccination - antibiotics - nutritional deficiencies.

Text book

Gnanamani MR (2003) Modern Aspects of Commercial Poultry Keeping, Ninth edn, Giri Publications, Madurai.

References

Chauhan HVS and Roy S (2007) Poultry Diseases, Diagnosis and Treatment, Third edn, New Age International, New Delhi.

Jaiswal V and Jaiswal KK (2014) Economic Zoology, PHI Learning Private Limited, New Delhi.

Jull MA (1976) Poultry Husbandry, Third edn, Tata McGraw Hill Publishing Company Ltd. New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1	1					
CO2				4	5	
CO3			3			
CO4			3			6
CO5				4	5	

Mean = 3.8

PGZ 4344 Lab. in Animal Physiology and Molecular Biology (2+2=4h/wk) (3cr)

Animal Physiology part of the laboratory course deals with exercises on digestion, osmo-iono regulation, thermoregulation, nitrogen excretion, respiration, circulation and chronobiology.
Molecular Biology part of the laboratory course deals with basic molecular biology laboratory exercises such as isolation of DNA and RNA from eukaryotic cells, and plasmids from bacteria. Experiments using *E. coli* such as mutagenesis, transformation, conjugation and β-galactosidase assay will also be carried out.

I. Lab. in Animal Physiology

Course Outcomes
Upon completion of this course, students will be able to:

i. Evaluate factors influencing physiological activity.
ii. Analyze the constituents of blood.
iii. Explain the process of excretion and osmoregulation in animals.
iv. Assess the physiology of heart and sense organs.
v. Demonstrate influence of stress in oxygen consumption in fish.

Laboratory Exercises:

1. Plasticity of pulse rate and heart beat
2. Analysis of human blood - total and differential count of RBC, WBC
3. Estimation of oxygen consumption under stress
4. Determination of Q_{10} in freshwater mussel and fish
5. Osmoregulation in an aquatic animal
6. Experiments on sensory organs - vision, hearing and taste
7. Effect of insulin level on vertebrate blood glucose
8. Qualitative analysis of excretory products
9. Factors affecting salivary amylase activity

II. Lab. in Molecular Biology

Course Outcomes
Upon completion of this course, students will be able to:

i. Analyze molecular mechanisms in various microbial processes.
ii. Apply molecular aspects of isolation and quantification of nucleic acids.
iii. Demonstrate skill in performing transduction and mutagenesis.
iv. Plan molecular biology experiments and solve problems.
v. Communicate in experiments involving team activities.

Laboratory Exercises:

1. Isolation of genomic DNA from bacteria
2. Isolation of plasmid DNA
3. RNA extraction from chick liver
4. Isolation of DNA from plant tissue and human blood
5. Agarose gel electrophoresis of DNA
6. Mutagenesis using chemical mutagens
7. Physical mutagenesis (UV-induced)

8. Quantification of nucleic acids
9. Bacterial transformation
10. Bacterial Conjugation
11. Transduction using bacteriophages
12. Study of *Lac* operon (β-galactosidase assay)

References

Amrit K (2006) Laboratory manual of animal physiology and Biochemistry, First edn, CBS Publishers & Distributors Pvt. Ltd, New Delhi.

Durairaj G (1987) Animal physiology - A laboratory manual, COSIP-ULP Publications, Dept. of Zoology, University of Madras, Chennai.

Rajamanickam C (2000) Laboratory Protocols in Molecular biology and Biochemistry. Osho science Publishers, Madurai.

Sambrook J and Russell DW (2001) Molecular cloning: A Laboratory Manual. Third edn, Cold Spring Harbor Press, New York.

Lab. in Animal Physiology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3			3			
CO4				4		
CO5					5	

Mean = 3.4

Lab. in Molecular Biology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3				4		
CO4				4		
CO5					5	

Mean = 3.4

PGZ 5545 Entomology (5+1=6h/wk) (5cr)

This course is designed to understand the structure and functional aspects of insects and their economic importance. This course covers the four major aspects: insect taxonomy, functional morphology, impact of insects in human welfare and pest control measures.

Course Outcomes

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

i. Compare the external morphological features of insects.
ii. Identify the different orders of insects with taxonomy.
iii. Outline the organ systems in insects.
iv. Discuss the beneficial and harmful aspects of insects.
v. Assess integrated pest management and use of insecticides.

1. **Insect body Plan:** External morphology - head, sutures, photoreceptor organs, antennae structure, diversity, mouth parts - types. Thorax - tergum - sternum - pleuron - leg & wing modifications - coupling mechanism - abdomen - modification - genital structures.

2. **Insect taxonomy:** Insects as most successful group of organisms - Apterygota - Protura - Diplura - Archaeognatha - Thysanura. Exopterygota - Paleopterous - Neopterous. Endopterygota - Coleopterous - Neopterous - Hymenopterous insects - economic importance.

3. **Organ systems:** Digestive system - glands - mechanism of digestion. Excretory system - malphigian tubules and other organs - mechanism. Circulatory system - pumping organs - mechanism - haemolymph - haemocytes - functions. Respiratory system - structure - aquatic respiration - respiration of endoparasitic insects. Endocrine glands - corpora cardiaca - corpora allata - thoracic glands - molting - functions.

4. **Insects of economic importance:** Harmful insects - feeding injury - agricultural pests - major pests of paddy, sugar cane, cotton, coconut and vegetable crops – damage, symptoms and control measures. Domestic pests - lice, bed bugs, mosquitoes, and housefly - vector status and control. Beneficial insects - honey bee - diversity, structural adaptations, colony and management. Sericulture - moriculture - silkworm - diversity - life cycle - rearing - grainage - diseases.

5. **Pest control and integrated pest management:** Pesticides - I, II, III and IV generations. Insecticides - nomenclature - classification - natural products - formulations. Biological control - parasitoids, parasites, predators and microbes. Pest management - IGR - synthetic hormones - pheromones - allelochemicals - genetic control - IPM in paddy field.

Text book:

Ambrose DP (2004) The Insect Structure, Function and Biodiversity, Kalyani publications, New Delhi.

References

Chapman RF, Simpson SJ and Douglas AE (2012) The Insects: Structure and Function, Fifth edn, Cambridge University Press, London.

David BV and Ananthakrishnan TN (2004) General and Applied Entomology, Tata McGraw-Hill publishing Company Limited, New Delhi.

David BV and T Kumarasamy (1982) Elements of Economic Entomology, Popular Book Depot, Chennai.

Fennemore PG and Alka Prakash (1992) Applied Entomology, Wiley Eastern Ltd, New Delhi.

Fox RM and FoxJW (1964) Introduction to Comparative Entomology, Chapman and Hall, London.

Richards OW and Davies RG (1977) Imm's General Textbook of Entomology, Vol-1 & 2, Tenth edn, BI Publications Pvt. Ltd, New Delhi.

Robert HR (1959) A Textbook of Entomology, Second edn, John Wiley & Sons Inc., New York.

Snodgrass RE (1935) Principles of Insect Morphology, McGraw Hill Book Company Inc., New York.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2			3			
CO3		2				
CO4	1					6
CO5					5	

Mean = 3.5

PGZ 5547 Evolution (5+1=6h/wk) (5cr)

This course provides an insight of human existence on earth. It includes origin of life, history of evolutionary thought, Darwinism & current challenges, molecular phylogeny and evolutionary clock, isolating mechanisms, speciation and transpecific. It also deals with human evolution, phylogeny and cultural way of living.

Course Outcomes

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

i. Discuss the evidences and objectives of evolutionary theories.
ii. Analyze the various theories of evolution.
iii. Assess DNA, protein and biotechnology principles in phylogenies.
iv. Discuss the isolation and speciation mechanisms in evolution.
v. Explain the concept of micro and macro evolutionary thoughts.

1. **Origin of life and history of evolutionary thoughts:** Life - origin of life - theories - abiogenesis, cosmozoic & naturalistic theories. Chemical evolution - concept of Oparin & Haldane, and experiment of Urey & Miller - evidences and objections. Lamarckism & Darwinism - modern synthesis.

2. **Darwinism:** HMS Beagle - Darwinian syllogism - natural selection in nature and laboratory, modes of selection - adaptive radiation. Modern understanding of natural selection - polymorphism - coloration - mimicry.

3. **Challenges to Darwinism:** DNA and protein phylogenies - protein evolution and neutrality theory - molecular evolutionary clock. Group selection - altruism, kin, sexual, group & directional selection - punctuated equilibria.

4. **Isolation and speciation:** Isolating mechanism - pre and post zygotic - origin of isolation. Speciation - definition - modes - sympatric, allopatric and quantum speciation. Concept of adaptive peaks and valleys.

5. **Evolution of higher taxa and trans-specific evolution:** Uniqueness of man - fossil history & phylogeny of man - cultural evolution and evolutionary future of mankind. Macroevolution - recognition of higher taxa - origin - saltation theory - adaptive grid hypothesis - trends and rate of evolution - Zoological time scale - evolution of horse.

Text book

Dobzhansky T, Ayala FA, Stebbins GL and Valentine JW (1977) Evolution, Surjeet Publishers, New Delhi

References

Dodson EO (1960) Evolution: Process and Product, Affiliated East-West Press, New Delhi.
Stebbins GL (1966) Process of organic evolution, Prentice Hall, New Delhi.

Strickberger MW, Hall BK and Hallgrimsson B (2007) Strickberger's Evolution, Fourth edn, Jones and Bartlett, Sudbury, MA, USA.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3			3			
CO4				4		
CO5					5	

Mean = 3.2

PGZ 5549 Immunology (5+1=6h/wk) (5cr)

This theory course provides a comprehensive coverage of the essential concepts and the current understanding of cellular and molecular events underlying immunity. This course on Immunology deals with cells and organs of immune system, antigen, antibody - structure & diversity and antigen-antibody interactions. It also includes major histocompatibility complex, immunoregulation, immunotolerance and complement. Clinical aspects such as hypersensitivity reactions, autoimmunity, disorders of immune response, transfusion, transplantation and tumour Immunology are also dealt.

Course Outcomes

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

i. Explain the lymphoid organs, molecular structure of antibodies and antigen-antibody interactions.
ii. Analyze MHC molecule and differentiation of T & B cells.
iii. Evaluate complement system and immune response.
iv. Explain hypersensitivity and immunodeficiency disorders.
v. Assess the importance of ABO system, transplantation and tumor immunology.

1. **Cells, lymphoid organs, antigens and antibody:** Cells and organs of the immune system - antigens - adjuvants. B cell antigens & B cell epitopes, T cell antigens & T cell epitopes - Distribution and production of antibodies. Molecular structure of antibodies - Ig isotypes - biological properties - Ig super family - multigene organization of Ig genes, gene rearrangements - mechanism of variable region rearrangements, productive and non productive rearrangements - allelic exclusion - generation of antibody diversity - strength of antigen-antibody interactions - affinity - avidity- cross-reactivity - precipitation and agglutination reactions.

2. **MHC, maturation, activation and differentiation of T & B cells:** MHC - General organization, genes, inheritance, molecules, immune responsiveness and MHC & disease susceptibility. T & B cells - maturation, activation and differentiation - T & B cell co-operation - superantigens - T independent B cell activation - cytokines and cytokine receptors.

3. **Antibody and cell mediated effector functions, immunoregulation and complement:** Antibody mediated - neutralization, opsonization, complement fixation and antibody-dependent cell mediated cytotoxicity - cell mediated - cytotoxic T cell response and Natural Killer cell activity. Regulation of immune response - age - nutrition and other factors - immunotolerance - complement system - classical and alternative pathways - complement fixation test and complement deficiency diseases.

4. **Hypersensitivity reactions, autoimmunity, and immunodeficiency disorders:** Gell and Coombs classification - Hypersensitivity reactions – Ig E mediated (Type I), Antibody mediated (Type II), immune complex mediated (Type III), Cell mediated (Type IV). Organ specific and systemic autoimmune diseases - mechanisms - treatment of autoimmune diseases. Primary immunodeficiencies - defects in lymphoid lineage,

myeloid lineage and complement systems - treatment of immunodeficiency - AIDS and other acquired or secondary immunodeficiencies.

5. **Transfusion, transplantation and tumor immunology:** ABO system - ABO antigens - isohaemagglutinins - Rh antigens - transfusion reactions - transfusion transmitted infections - cross-matching. Immunologic basis of graft rejection - clinical manifestations of graft rejections - general and specific immunosuppressive therapy - clinical transplantation. Tumours of the immune system - tumour antigens - immune response to tumours - tumour evasion of the immune system - cancer immunotherapy.

Text book

Punt J, Stranford S, Jones P and Owen J (2018) Kuby Immunology, Eighth edn, W.H. Freeman and Co., New York

References

Coico R and Sunshine G (2009) Immunology: A short course, Sixth edn, Wiley Blackwell, New York.

Delves PJ, Martin SJ, Burton DR and Roitt IM (2006) Essential Immunology, Eleventh edn, Blackwell Publishers Ltd, UK.

Khan FH (2009) The Elements of Immunology. First edn, Pearson Education, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3					5	
CO4					5	
CO5					5	

Mean = 4.2

PGZ 5551 Methods in Biology (5+1=6h/wk) (5cr)

The aim of the course is to give a comprehensive knowledge about the methods used in biology such as histochemical, biophysical, electrophysiological, molecular, radiolabeling and immunotechniques. The course also deals with the methods in recombinant DNA technology and topics related to field biology such as estimation of population, sampling methods in behavior and habitat characterization using remote sensing.

Course Outcomes

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

i. Explain the principles and applications of various recombinant DNA methods.
ii. Analyze the immunotechniques of ELISA, RIA, immunoblotting, immunofluoresence microscopy, flow cytometry and cytofluorometry.
iii. Outline the biophysical and radiolabelling techniques.
iv. Evaluate the principle and applications of electrophysiological methods of EEG and Tomography.
v. Compare and evaluate various ecological sampling methods to study animal behaviour.

1. **Molecular biology and recombinant DNA methods:** Isolation and purification of Nucleic acids and proteins - Electrophoresis - one and two dimensional, PAGE and Isoelectric focusing - MALDI TOF - Generation of genomic and cDNA libraries in plasmid, phage, Cosmid, BAC and YAC vectors - *in vitro* mutagenesis - gene knock out - - Transcript and Translation product analysis - Detection of post-translational modifications in proteins - RAPD - RFLP - AFLP - Microarray.

2. **Histochemical techniques and Immunotechniques:** Detection of molecules in living cells - *in situ* localization - FISH and GISH. Antibody generation - detection of molecules using ELISA, RIA, Immuno blot, immunofluorescence microscopy, flow cytometry & cytofluorometry.

3. **Biophysical and radiolabeling techniques:** Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy. Molecular structure determination using X-ray diffraction and NMR - different types of mass spectrometry and surface plasma resonance methods. Detection and measurement of different types of radioisotopes - GM counter, scintillation counter, autoradiography - incorporation of radioisotopes in biological tissues and cells - molecular imaging of radioactive material - safety guidelines.

4. **Electrophysiological and microscopic techniques:** Single neuron recording - patch-clamp recording - EEG - Brain activity recording - lesion and stimulation of brain - Pharmacological testing - tomography (PET, MRI, fMRI, CAT). Visualization of cells and subcellular components by light microscopy - scanning and transmission microscopes - different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods - image processing methods in microscopy.

5. **Methods in field biology:** Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations - sampling methods in the study of behavior - habitat characterization: ground and remote sensing methods.

Textbook

Ghatak, KL (2011) Techniques and methods in biology, Prentice Hall India Learning Private Limited, New Delhi.

References

Brown, TA (2017) Gene cloning and DNA analysis: an introduction, Seventh edn, John Wiley & Sons, USA.

Kandel ER, Schwartz JH and Jessell TM (2000) Principles of Neural Science, Fourth Edn, McGraw-Hill, New York.

Kumar, P (2016) Fundamentals and techniques of biophysics and molecular biology. Pathfinder Publications, New Delhi.

Primrose SB and Twyman R (2006) Principles of Gene Manipulations and Genomics, Seventh edn, Blackwell Publishing, Massachusetts, USA.

Rees PA (2015) Studying Captive Animals: A Workbook of Methods in Behaviour, Welfare and Ecology, First edn, John Wiley & Sons, UK.

Swargiary, A (2017) Biological tools and techniques. Kalyani Publications, New Delhi.

Wilson, K and Walker, J (2010) Principles and techniques of biochemistry and molecular biology, Seventh edn, Cambridge University Press, London.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3		2				
CO4					5	
CO5		2				

Mean = 3.0

PGZ 5153 Lab. in Entomology (2h/wk) (1cr)

This course highlights the collection, identification and preservation of insects. It also includes the study of various systems and physiology of insects.

Course Outcomes

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

i. Plan collection, preservation and identification of insect fauna and preparation of insect box.
ii. Apply dichotomous key on insect identification.
iii. Identify digestive and reproductive system of *Mylabris* and *Chrysocoris.*
iv. Assess the insect fauna of agro-ecosystem.
v. Analyze insect damage on selected crops and stored grains and compare the efficacy of a chitin inhibitor, predators and parasitoids.

Laboratory exercises:

1. Collection, preservation and identification of insects.
2. Preparation of dichotomous key.
3. *Mylabris* – digestive and reproductive system.
4. *Chrysocoris* – mouth parts and reproductive system.
5. Survey of insect fauna in The American College/Alagar hills/Kodaikanal hills.
6. Collection and identification of soil micro-arthropods (Berleese funnel method).
7. Survey of insect fauna of an Agro-ecosystem.
8. Culture and damage assessment of a polyphagous pest (*Spodoptera litura*).
9. Evaluation of efficacy of a stomach poison on a polyphagous pest.
10. Evaluation of efficacy of a chitin inhibitor.
11. Study of predatory potential.
12. Maintenance of a parasitoid on an alternate host.
13. Rearing of silkworm.
14. Insect box/arrangement/submission.
15. Maintenance of butterfly garden.

Textbook

Fennemore PG and Alka Prakash (1992) Applied Entomology, Wiley Eastern Ltd, New Delhi.

References

Richards OW and Davies RG (1977) Imm's General Textbook of Entomology, Vol-1 & 2, Tenth edn, BI Publications Pvt. Ltd, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3			
CO3			3			
CO4					5	
CO5				4		

Mean = 3.6

PGZ 5355 Lab. in Immunology and Methods in Biology (2+2=4h/wk) (3cr)

Immunology laboratory part includes antigen administration, bleeding techniques and agglutination assays. It also includes lymphoid organs in vertebrates, complement mediated lysis, hypersensitivity reactions and cellular immune response in fish. Laboratory methods in biology includes exercises on microscopy, protein purification, DNA fingerprinting, gel electrophoresis techniques and field experiments involving population size estimation & sampling methods to study behaviour of animals.

I. Lab. in Immunology

Course Outcomes

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

i. Prepare soluble, particulate and cellular antigens.
ii. Demonstrate the bleeding techniques and antigen-antibody interactions.
iii. Compare the structure of lymphoid organs in vertebrates.
iv. Explain complement mediated lysis and peritoneal lavage.
v. Demonstrate foot pad thickening in mice and scale transplantation in fish.

Laboratory Exercises:

1. Preparation of soluble – particulate and cellular antigens
2. Repetitive bleeding techniques and routes of antigen administration
3. Direct haemagglutination assay
4. Passive haemagglutination assay
5. Lymphoid organs in fish and calotes and preparation of single cell suspension
6. Lymphoid organs in chick and mouse
7. Complement mediated lysis
8. Peritoneal lavage – isolation of macrophage from fish/mice
9. Hypersensitivity – foot pad thickening
10. Cellular immune response – scale transplantation in fish.
11. Immunodiffusion techniques.
12. Immunoelectrophoresis.
13. Laboratory visit

II. Lab. in Methods in Biology

Course Outcomes

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

i. Demonstrate phagocytosis by macrophages.
ii. Use different methods of purification of proteins.
iii. Design experiments involving electrophoretic techniques.
iv. Critique the principles and methods involved in ELISA, RAPD and RFLP.
v. Plan experiments with animal models to study their behaviour.

Laboratory Exercises:

1. Microscopy-I: Staining and observation of macrophages from mouse blood
2. Microscopy-II: observation of phagocytosis by macrophages

3. Purification of proteins-I: Ammonium sulphate precipitation of IgG antibodies
4. Purification of proteins-II: Sucrose gradient centrifugation (e.g. for milk proteins)
5. Isoelectric focusing gel electrophoresis for separation of serum proteins
6. 2D gel immunoelectrophoresis
7. Polyacrylamide gel electrophoresis
8. Immunoblotting
9. ELISA
10. Quantification of nucleic acids by UV spectrophotometer
11. RAPD analysis to study genetic variation between species (e.g. Grasshopper)
12. DNA fingerprinting by RFLP analysis
13. Estimation of population density of grassland insects by sweep net method
14. Study of sex ratio in insects, fishes etc.
15. Study of learning in rat through T-maze technique
16. Study of behavioural catalogue and ethogram

References

Becker JM, Caldwell GA and Zachgo EA (1996) Biotechnology - A Laboratory Course. Second edn, Academic Press, San Diego, USA.

Garvey JS, Cremer NE and Sussdorf DH (1977) Methods in Immunology, Third edn, Benjamin Cummings Publishing Co, Massachusetts, USA.

Harisha S (2007) Biotechnology Procedures and Experiments Handbook. Infinity Science Press LLC, New Delhi.

Hudson L and Hay FC (1989) Practical Immunology, Third edn, Blackwell Science Publishing, London.

Myers RL (1989) Immunology - A laboratory Manual, Wm C Brown Publishers, Dubuque, Iowa, USA.

Palanivelu P (2009) Analytical Biochemistry and Separation Techniques, Fourth edn, Twenty first Century Publications, Madurai.

Sadasivam S and Manickam A (2008) Biochemical methods, Third edn, New Age International Publishers, New Delhi.

Sinha J, Chatterjee AK and Chattopadhyay P (2010) Advanced Practical Zoology, First edn, Books and (P) Ltd, Kolkata.

Lab. in Immunology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3					5	
CO4					5	
CO5		2				

Mean = 3.4

Lab. in Methods in Biology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3					5	
CO4					5	
CO5		2				

Mean = 3.2

PGZ 5546 Biotechnology (5+1=6h/wk) (5cr)

This course emphasizes recombinant DNA technology, the importance of animal and plant tissue culture, production and applications of transgenic animals and plants. Disease diagnosis and therapeutics using biotechnology tools and industrial applications of genetically modified organisms will also be dealt. It also deals with the environmental pollution remedies using recombinant strains and bioethics of biotechnological products.

Course Outcomes

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

i. Discuss the importance of enzymes, gene transfer methods and techniques in biotechnology.
ii. Explain the procedures in animal cell culture and applications.
iii. Identify the overall process in plant tissue culture and applications.
iv. Analyze the principles in formulating pharmaceutical industrial products.
v. Evaluate the role of microbes in environmental biotechnology.

1. **Introduction and Recombinant DNA Technology:** History and Scope of Biotechnology - Restriction endonucleases - linkers & adaptors - vectors (*E. coli*, phage yeast, plant & animal viral vectors) - gene transfer methods - gene cloning strategies. Techniques in genetic engineering - blotting techniques - PCR and its types - DNA sequencing - Human Genome Project.

2. **Animal Biotechnology:** Animal cell culture media - Biology and characterization of cultured cells - Primary & secondary cell culture - Tissue and stem cell engineering - Transgenic animals - fish, cattle and gene knockout mice - applications. Cloning - mechanism - Dolly - Ploidy induction method in fish. Hybridoma technology - Monoclonal antibody production.

3. **Plant Biotechnology:** Basic concepts in plant tissue culture - micropropagation - protoplast culture and somatic hybridization - haploid plant production - gene transfer in plants - vector mediated (Ti plasmid) and virus mediated. Transgenic plants - resistance to biotic stress (insect and microbes) and abiotic stress (phosphinothricin and glyphosate) - improvement of crop yield, quality and nutrition.

4. **Pharmaceutical and Industrial Biotechnology:** Gene therapy - *ex vivo* & *in vivo*. DNA assay for disease diagnosis and DNA profiling in forensics. Pharmaceutical products - insulin, tissue plasminogen activator, recombinant vaccines. Bioprocess and enzyme technology - production and immobilization of enzymes - biosensors. Biomass production - citric acid, alcohol, bio-fuel (hydrogen and methane).

5. **Environmental Biotechnology and Society:** Environmental pollution - biotechnological methods for monitoring and management. Biodegradation & Bioremediation - Xenobiotics - Genetically engineered microorganism in bioremediation. Biotechnology - risks, ethics and patenting biotechnology inventions.

Text book

Satyanarayana U (2012) Biotechnology, First edn, Books and Allied (P) Ltd, Kolkata.

References

Dubey RC (2006) A Textbook of Biotechnology, First multicolour illustrative edn, S. Chand & Company Ltd, New Delhi.

Glick RB and Pasterneck JJ (2002) Molecular Biotechnology - Principles and Application of Recombinant DNA, Panima publishing corporation, New Delhi.

Brown, TA (2017) Gene cloning and DNA analysis: an introduction, Seventh edn, John Wiley & Sons, USA.

Brown TA (2017) Genomes 4, Fourth edn, Garland Science (Taylor & Francis Group), New York.

Primrose SB and Twyman R (2006) Principles of Gene Manipulations and Genomics, Seventh edn, Blackwell Publishing, Massachusetts, USA.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3			3			
CO4			3			
CO5				4		

Mean = 3.0

PGZ 5548 Developmental Biology (5+1=6h/wk) (5cr)

The course aims at imparting knowledge on various aspects and concepts in ontogenetic development of animals that include gametogenesis, fertilization, cleavage, gastrulation and organogenesis. It exclusively discusses the process of human development.

Course Outcomes

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

i. Explain specialized cells of gonads and the process of gametogenesis.
ii. Compare fertilization process, events during and after fertilization and cleavage patterns in selected animals.
iii. Discuss the role of genes and cytoplasm in ontogeny.
iv. Analyze the process of induction, differentiation in embryonic development and the role of stem cells and applications.
v. Outline the process of embryonic development and assisted reproductive technology in human.

1. **Spermatogenesis and oogenesis:** Structural and functional relation among cells of testis and ovary - spermatogenesis and oogenesis - process and biochemical changes - hormonal regulation - gene expression and control.

2. **Fertilization and cleavage:** Process and mechanism - activation of egg and sperm - essence of activation program - ionic fluxes and inhibition of polyspermy - changes in egg organization after fertilization - parthenogenesis and development - types, patterns and molecular changes during cleavage - maternal gene action and morphogenetic movements - cells-adhesion molecules & pattern formation.

3. **Gastrulation and nucleocytoplasmic interaction in development:** Role of paternal genes during gastrulation - organogenesis - nuclear control of development - nuclear transplantation and enucleation experiments - regional differences in egg cytoplasm - cytoplasmic determinants - cytoplasmic control over nucleus.

4. **Induction, differentiation, metamorphosis and regeneration:** Types of embryonic induction - chemical properties and role of inductors - Spemann's organizer - embryonic cell differentiation - metamorphosis in frog - regeneration in hydra and earthworm - stem cells and their applications - homeotic gene in *Drosophila* and axis formation.

5. **Human development:** Puberty - hormonal regulation of menstrual cycle - ovulation - organization of sperm and egg - fertilization - blastocyst formation - implantation - pregnancy changes and foetal growth - placenta - multiple and abnormal pregnancies - parturition - birth defects - teratology- *in vitro* fertilization techniques.

Text book

Balinsky BI (2012) An introduction to Embryology, Fifth edn, Cengage Learning India.

References

Browder LW, Drickson CA and Jeffery WR (1991) Developmental Biology, Third edn, Saunders College Publishing, USA.

Gilbert SF (1997) Developmental Biology, Fifth edn, Sinauer Associates Inc Publishers, Sunderland, Massachusetts, USA.

Wolpert (1998) Principles of Development, Oxford University Press, London.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2		2				
CO3		2				
CO4				4		
CO5				4		

Mean = 3.2

PGZ 5550 Environmental Biology (5+1=6hr/wk) (5cr)

This course deals with the principles and scope of environmental biology. Special emphasis is given to environmental chemistry, geosciences, energy resources & conservation.

Course Outcomes

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

i. Discuss the nature of population, community and species interactions.
ii. Compare different types of habitats, ecosystems and assess their primary productivity.
iii. Outline biomes and biogeographical zones and evaluate conservation management strategies.
iv. Discuss the issues associated with natural resources.
v. Evaluate the impact of urbanization on environment.

1. **Principles and scope of environmental studies:** Earth and man - physico-chemical and biological factors in environment - geographical classifications and zones - natural resources, conservation & sustainable development.

2. **Environmental chemistry:** Stoichiochemistry of air and water pollutants - Gibbs energy - acid base reactions - water chemistry - natural and anthropogenic sources of pollution - soil chemistry - toxic chemicals - principles of analytical methods.

3. **Ecosystem:** Structure and function - ecological succession - flora & fauna in India - endangered & threatened species - environmental issues in India - Bhopal tragedy, Ennore oil spill, water depletion, climate change - Indian case studies on conservation & management strategies - models of population growth and interaction.

4. **Environmental geosciences:** Energy budget of earth - ecosystem flow of energy & matter - climates of India & Indian monsoon - El nino, La nino and droughts - global warming - land use planning – geochemical cycles - water, carbon, oxygen, nitrogen, sulphur, phosphorus - trace elements and human health - principles of remote sensing and its applications.

5. **Energy resources and conservation:** Renewable & non-renewable energy resources - environmental implication of energy use - environmental auditing - disaster management - restoration and rehabilitation technologies - environmental policy regulation-strategies and legislation.

Text book

Verma PS and Agarwal VK (2000) Environmental Biology- Principles of Ecology, S. Chand & Co Ltd, New Delhi.

References

Cox GW (1997) Conservation Ecology - Concepts and application, Appleton Century Crofts, USA.

Curtis LF and Barrett EC (1992) Introduction to Environmental Remote Sensing, Springer, Netherlands.

Dwivedi OP (2016) India's Environmental Polices, Programmes and Stewardship, Macmillan Press Ltd, Chennai.

Keller EA (2012) Environmental Geology, Eighth edn, Pearson Prentice Hall, USA.

Odum EP and Barret GW (2004) Fundamentals of Ecology, Fifth edn, Brooks/Cole, USA.

Sodhi GS (2000) Fundamental Concepts of Environmental Chemistry, Third edn, Alpha Science International Ltd, UK.

Stiling P (2009) Ecology: Theories and Applications, Fourth edn, PHI Learning Pvt. Ltd, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3					5	
CO4					5	
CO5		2				

Mean = 3.2

PGZ 5252 Lab. in Biotechnology and Developmental Biology (2+2=4h/wk) (3cr)

Biotechnology Laboratory course includes the basic animal and plant biotechnology experiments. It deals with extraction & manipulation of DNA, PCR analysis, microbial degradation of pollutants, animal & plant tissue culture. Laboratory course in Development Biology will impart knowledge and hands on training in the study of various aspects of development.

I. Lab. in Biotechnology

Course Outcomes

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

i. Demonstrate knowledge and understanding of applications of biotechnology techniques.
ii. Critique the strategies employed in various fields of biotechnology.
iii. Apply the methods of isolation and amplification of DNA from various sources.
iv. Plan and conduct animal and plant tissue culture experiments.
v. Identify and analyze the use of microbes in biotechnology procedures.

Laboratory Exercises:

1. Isolation of plasmids from bacteria
2. Agarose gel electrophoresis of DNA and RNA
3. DNA amplification by PCR method.
4. Restriction enzyme digestion of DNA.
5. DNA Ligation
6. Polyacrylamide gel electrophoresis
7. Western blotting
8. Preparation of primary suspension culture of liver tissue
9. Chick embryo fibroblast- monolayer and suspension culture (Trypsinization)
10. Induction of callus from leaf discs
11. Formation of shoot and root of *Oryza sativum*
12. Pesticide degradation using microbes
13. Degradation of cellulose using microbes.
14. Biogas production.
15. Visit to industries.

II. Lab. in Developmental Biology

Course Outcomes

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

i. Identify gametes of various species and their developmental stages.
ii. Assess the role of pituitary gland in development.
iii. Compare various stages of chick development.
iv. Explain the roles of various hormones in development.
v. Analyze the pattern of regeneration in various organisms.

Laboratory Exercises:

1. Microscopic observation of spermatozoa and ova.

2. Microscopic observation of development of gametes.
3. Effect of ablation of pituitary gland.
4. Role of retinoic acid in development of ornamental fish embryo.
5. Early stages of development in chick – cleavage, blastula and gastrula
6. Late stages of development in chick – organogenesis.
7. Regeneration in earthworm and tadpole.
8. Role of thyroxine on the metamorphosis of tadpole.
9. Role of juvenile hormones and ecdysone in insect larval development.
10. Hospital visit to learn IVF techniques.

References

Becker JM, Caldwell GA and Zachgo EA (1996) Biotechnology - A Laboratory Course, Second edn, Academic Press, San Diego, USA.

Harisha S (2007) Biotechnology Procedures and Experiments Handbook. Infinity Science Press LLC, New Delhi, India.

Laura RK, Evans JH and Keller TCS (1999) Experimental Developmental Laboratory: A Laboratory Manual, Academic Press, UK.

Rajamanickam C (2001) Experimental Protocols in Basic Molecular Biology. Osho Scientific Publishers, Madurai.

Sambrook J and Russell DW (2001) Molecular cloning: A Laboratory Manual, Third edn, Cold Spring Harbor Press, New York.

Tyler MS (2010) Developmental Biology, A Guide for Experimental Study, Third edn, Sinauer Associates. Sunderland, Massachusetts, USA.

Lab. in Biotechnology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3			3			
CO4				4		
CO5				4		

Mean = 3.0

Lab. in Developmental Biology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3		2				
CO4				4		
CO5				4		

Mean = 3.2

PGZ 5154 Lab. in Environmental Biology (2h/wk) (1cr)

Laboratory course in Environmental Biology involves exercises to understand the principles and concepts of ecosystem, habitat, and their interaction with abiotic components, population and community.

Course Outcomes

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

i. Identify and count plankton.
ii. Evaluate primary productivity and physico-chemical parameters of water samples.
iii. Analyze the levels of pollutants in air and water samples.
iv. Apply environmental data using GIS and remote sensing.
v. Plan visits to environmentally sensitive areas and prepare report.

Laboratory exercises:

1. Identification of fauna and flora of terrestrial and freshwater ecosystem in the American College campus
2. Qualitative estimation of phytoplankton by Luky's drop method and zooplankton by Sedgwick-Rafter cell method.
3. Estimation of primary productivity: light and dark bottle method – effect of depth and light
4. Toxicity test – estimation of LC_{50} values
5. Analysis of BOD and COD in water samples
6. Determination of portability of water by using coagulant demand, chlorine demand and residual chloride methods.
7. Analysis of heavy metals and pesticides in water by using spectrophotometry.
8. Analysis of particulate (dust fall methods) and gaseous components oxides of carbon/nitrogen/sulphur in traffic congested areas.
9. Organize and analyse environmental data from remote sensing and GIS.
10. Visiting environmentally relevant areas such as industries and prepare a report

References

Agarwal SK (2002) Industrial environment: assessment and strategy, APH Publishers, New Delhi.

Allen JRL (1977) Physical Process of Sedimentation, Allen & Unwin, London.

Eaton, AD and Franson MAH (2005) Standard methods for the examination of water and waste water. American Public Health Association, American Water Works Association, the Water Environment Federation, Washington DC.

Lynn LM (2010) Environmental Biology and Ecology Laboratory manual, Fifth edn, Kendall Hunt Publishing, USA

Odum EP and Barrett GW (2005) Fundamentals of Ecology, Fifth edn, East West Press Pvt. Ltd, New Delhi.

Subramanyam NS and Sambamurty AVSS (2000) Ecology, Narosa Publishing House, Chennai.

PGZ 5154 Lab. in Environmental Biology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2					5	
CO3				4		
CO4			3			
CO5					5	

Mean = 3.8

PGZ 5656 **Research Project** **(6h/wk) (6cr)**

The Research Project aims at sharpening the student's spirit of scientific inquiry and to train the students in analyzing, interpreting the data and drawing valid conclusions. The students are allowed to choose the problems in subject areas of their own interest. The student's initiative and inventiveness in designing experiments are encouraged. The research project will be carried out in the fourth semester and evaluated at the end of the fourth semester.

Course Outcomes

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

i. Identify a research problem and collect relevant literature
ii. Plan out research activities and collect data
iii. Analyze data using statistical tools and synthesize research findings
iv. Demonstrate capacity to carry out independent research work
v. Create new applications and prepare project proposals

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3				4		
CO4					5	
CO5						6

Mean = 4.0