

List of Courses for B.Sc. Zoology Program w.e.f 2015-2016

Course Name	
Zoology Courses – Code: ZP	
1	Semester I: ZP: 01: Diversity of Lower Non Chordates ZP: 02: Cell Biology
2	Semester II: ZP: 03: Diversity of Higher Non-Chordates ZP: 04: Genetics & Molecular Biology
3	Semester III: ZP: 05: Diversity of Lower Chordates ZP: 06: Animal Physiology
4	Semester IV: ZP: 07: Diversity of Higher Chordates ZP: 08: Ecology & Animal Behaviour
5	Semester V: Theory ZP:09: Comparative Anatomy of Vertebrates ZP:10: Human Physiology & Biochemistry ZP: 11: Applied Genetics & Evolution ZP: 12: Basic Animal Biotechnology
	Practical ZLC: 01 Practicals: a. Comparative Anatomy of Vertebrates b. Human Physiology & Biochemistry ZLC: 02 Practicals: a. Applied Genetics & Evolution b. Basic Animal Biotechnology
6	Semester VI: Theory ZP: 13: Developmental Biology ZP: 14: Endocrinology ZP: 15: Environmental Biology & Toxicology ZP: 16: Animal Biotechnology Applications
	Practical ZLC: 03 Practicals: a. Developmental Biology b. Endocrinology ZLC: 04 Practicals: a. Environmental Biology & Toxicology b. Animal Biotechnology Applications

Year	Semester	Chemistry Courses (CH)
First Year	I	ZP: 01: Diversity of Lower Non Chordates ZP: 02: Cell Biology
	II	ZP: 03: Diversity of Higher Non-Chordates ZP: 04: Genetics & Molecular Biology
Second Year	III	ZP: 05: Diversity of Lower Chordates ZP: 06: Animal Physiology
	IV	ZP: 07: Diversity of Higher Chordates ZP: 08: Ecology & Animal Behaviour
Third Year	V	Theory ZP:09 Comparative Anatomy of Vertebrates ZP:10 Human Physiology & Biochemistry ZP: 11 Applied Genetics & Evolution ZP: 12 Basic Animal Biotechnology
		Practical ZLC: 01 a. Comparative Anatomy of Vertebrates b. Human Physiology & Biochemistry ZLC: 02 a. Applied Genetics & Evolution b. Basic Animal Biotechnology
	VI	Theory ZP: 13 Developmental Biology ZP: 14 Endocrinology ZP: 15 Environmental Biology & Toxicology ZP: 16 Animal Biotechnology Application
		Practical ZLC: 03 a. Developmental Biology b. Endocrinology ZLC: 04 a. Environmental Biology & Toxicology b. Animal Biotechnology Applications

PROGRAMME SPECIFIC OUTCOME (PSO)

- To understand the diversity of fauna (Non- Chordate and Chordate), structure and function of the different form of life and their relationship, the relationship between life and environment.
- To understand the structure and function of cell, basics of molecular biology, basic of animal biotechnology.
- To understand the scope of entrepreneurship through Applied Zoology.

ZP: 01	Diversity of Lower Non- Chordates (SEMESTER I)	Number of Lectures: 45
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COURSE OBJECTIVES:

- Review of the general characters and classification of the phyla listed below (up to classes). Classification of animals to be followed as in “**Invertebrate Zoology**” by **E. L. Jordan & P.S. Verma**.
- The gross anatomy and life history of the types mentioned.
- Local examples with common and scientific names are to be given more emphasis for all the groups.
- Those not found in India too has to be cited as example because of taxonomic / phylogenetic or of other special significance.
- At least one example from each class of invertebrates has to be included. Only those examples need to be mentioned which explain the general characters of the phylum / class.

SYLLABUS**Theory**

<p>I . General principles of animal taxonomy. Binomial nomenclature; hierarchy Salient features of non-chordates and classification up to classes Definition of species. Phylogeny of non- Chordata</p>	7 L
<p>II. Phylum Protozoa General Topic Comparative account of locomotion with respect to-Sarcodina, Mastigophora, Ciliophora; Nutrition and Skeleton in Protozoa.</p>	8 L
<p>III. Phylum Porifera Type Sycon, General Topic Cell types, Skeleton, Canal system and Reproduction</p>	8 L
<p>IV. Phylum Cnidaria Type Obelia, General Topic ----- Gastrovascular cavity, Polymorphism, Coral reefs (Definition, types and economic importance).</p>	8 L
<p>V. Phylum Platyhelminthes Type Planaria. General Topic Parasitism & Parasitic adaptation in Platyhelminthes</p>	6 L
	3 L

<p>VI. Phylum Aschelminthes General Topic Bionomic importance of Nematodes.</p> <p>VII. Phylum Annelida Type Nereis, General Topic Metamerism in Annelids.</p>	<p>5 L</p>
<p>Practical</p>	
<ol style="list-style-type: none"> 1. Study of animals with special reference to systematic position up to order level Habit, Habitat, Characteristic Features and Economic Importance of----- Protozoa, Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida with at least One example from each class. 2. Observation of the following permanent slides: T.S. of Sponges, Obelia, Ascaris (male & female), Nereis, Planaria & Liverfluke, Tapeworm scolex, Larval forms of Liverfluke. 3. Mountings: Spicules in sponges, Parapodia of Nereis, Nematocyst of sea anemone, Setae and Nephridium from earthworm 4. Dissection: Earthworm – Digestive system and Nervous system. 5. Identification of protozoans in pond water sample. 	
<p>COURSE OUTCOMES:</p>	
<p>At the end of the course students will be able to:</p> <ul style="list-style-type: none"> • Explain the general characters of each phylum. • Classify the examples in the Phyla listed in the syllabus. • Understand the anatomy and life history of the types mentioned in the syllabus. • Cite examples with common and scientific names for all the groups. 	
<p>REFERENCES:</p>	
<ol style="list-style-type: none"> 1. Barnes, R. D. (2000). Invertebrate Zoology. Hall Saunders International Editions 2. Kotpal, R. L (2000). Invertebrates. Rastogi Publication, Meerut. 3. Ganguli, B.B.; Sinha, A.K., and Adhikari, S. (2000). Biology of Animals Vol-1. New Central Book Agency, Calcutta. 4. Ayer Ekabaranath, M. (2000). A Manual of Zoology. Vol. I Part I & II. S. Viswanath, Madras. 5. Dhami, P. S. and Dhami, J. K. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi. 6. Jordan, E. L. & Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi. 7. Parker, A.J. & Haswell, W.A.A. (2002). Textbook of Zoology. Vol. I. Macmillan. 	

ZP: 02	Cell Biology (SEMESTER I)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ol style="list-style-type: none"> 1. To make the students understand the structure and functions of cell organelles 2. To understand the importance of nucleus in the cell 3. To understand the role of various physical and chemical components of the cell 4. To have basic knowledge of cancer biology 5. To learn basic techniques in cytology 		
SYLLABUS		
Theory		
I. Overview of the General structure and organization of cells. Viruses, Prokaryotic and Eukaryotic Cells.	5 L	
II. Cell Environment. Water, Salts and Ions; Biological molecules; Freezing and Thawing of cells; Radiations in Cell environment (UV radiations, photodynamic sensitization). (Treat as in Cell Physiology by Arthur C. Giese, 1983)	5 L	
III. Cell Organelles A) Plasma Membrane: Isolation and Characterization with reference to Composition, Fluid- Mosaic Model; Passive transport, Active transport and Bulk Transport. B) Mitochondria: Isolation, Chemical Composition, Ultra structure and functions with reference to energy transactions – Kreb’s Cycle, Electron Transport system; Mitochondria as a semiautonomous organelle. C) Isolation, Chemical composition, structure and functions of: <ol style="list-style-type: none"> 1. Endoplasmic reticulum 2. Ribosomes 3. Golgi complex 4. Lysosomes and polymorphism 5. Microbodies 6. Cytoskeleton – Microtubules, Microfilaments and Centrioles. (Treat as in Cell Biology by C. B. Powar 2004)	16 L	
IV. Cell Nucleus Isolation, Nucleus envelope, Nucleoplasm; General structure of metaphasic eukaryotic Chromosome; Euchromatin, Heterochromatin, Nucleolus, Structure of Nucleosome; Polytene and Lamp Brush Chromosome.	6 L	
V. Cancer Biology General idea of cancer cells, Carcinomas, Sarcomas, Lymphomas, Leukemia; Characteristics of Cancer cells; Carcinogenesis - Mutation and Viral theories of Carcinogenesis; Environmental causes of cancer; Prevention and treatment	6 L	
VI. Techniques in Cell Biology Principles and application of:	7 L	

-- Electron microscopy -- Centrifugation (ultra and refrigerated) techniques, ---TLC and Gel electrophoresis	
Practical	
<ol style="list-style-type: none"> 1. Study of Prokaryotic cells using suitable staining techniques. Bacteria (Gram +ve and gram –ve) from curd and tarter 2. Study of Eukaryotic Cell using suitable staining technique (Buccal epithelial Cells) 3. Methods of Protozoan culture (any two types) 4. Study of cytoplasmic movements (Cyclosis) in Paramecium. 5. Cytoplasmic localization of Protein, Fat and Carbohydrates 6. Study of osmosis using human R.B.Cs. 7. Buccal smear preparation for localization of Mitochondria by using Janus Green stain 8. Study of Polytene chromosomes in Drosophila or Chiromonas larva. 9. Study of Cancer cells through permanent slides. 10. Study of Cell organelle (any 3) through electron micrographs 11. Separation of serum proteins by Electrophoresis (only for demonstration). 12 Separation of fats by TLC 	
COURSE OUTCOMES:	
At the end of the course students will be able to <ul style="list-style-type: none"> • Gain knowledge on the structure and functioning of cell organelles. • To understand the importance of nucleus in the cell. • Understand the role of various physical and chemical components of the cell • Understand how abnormalities within cells can lead to a cancerous state. • Explain the basic techniques in cytology 	
REFERENCES:	
<ol style="list-style-type: none"> 1. Giese, A. (1983). Cell Physiology Saunders International edition 2. Powar, C.B. (2004). Cell biology, Himalaya Publication 3. DeRobertis & Deli Robertis (2000). Cell and Molecular Biology. 6th Edition 4. Bhamrah, H.S.; Kavita Juneja. Molecular Cell Biology. Anmol Publications Pvt. Ltd, New Delhi 5. Kumar, H.D. (1996). Molecular Biology and Biotechnology, Vikas Publication, New Delhi. 6. Verma and Agarwal (2004). Cell Biology, Genetics, Molecular Biology, Evolution & Ecology. S. Chand & Co. Ltd. New Delhi. 	

ZP: 03	Diversity of Higher Non-Chordates (SEMESTER II)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ul style="list-style-type: none"> • Review of the general characters and classification of the phyla listed below (up to classes). Classification of animals to be followed as in “Invertebrate Zoology” by E. L. Jordan & P.S. Verma. • The gross anatomy and life history of the types mentioned. • Local examples with common and scientific names are to be given more emphasis for all the groups. • Those not found in India too has to be cited as example because of taxonomic / phylogenetic or of other special significance. • At least one example from each class of invertebrates has to be included. Only those examples need to be mentioned which explain the general characters of the phylum / class. 		
SYLLABUS:		
Theory		
<p>I. Phylum Onychophora General topic----- Affinities and systematic position.</p>	5 L	
<p>II. Phylum Arthropoda Type – Prawn (<i>Penaeus</i> sp), General Topics – Crustaceans Larvae,</p>	8 L	
<p>III. Phylum Arthropoda (General topics) Respiration and excretion in Arthropoda; Metamorphosis in Insects, Respiration and excretion in Arthropoda; Metamorphosis in Insects, Mouth parts of insects.</p>	8 L	
<p>IV. Phylum Mollusca. Type <i>Pila</i>, General Topics – Foot and shell in Mollusca; Torsion in Gastropoda,.</p>	13 L	
<p>V. Phylum Echinodermata Type Starfish, General Topics, Larvae of echinoderms and symmetry in Echinodermata.</p>	6 L	
<p>VI. Phylum Hemichordata General type, Affinities and systematic position.</p>	5 L	
Practical		

1. Studies of animals with special reference to systematic position up to order level-
Habit, Habitat, Characteristic features, and Economic importance of – Onychophora, Arthropoda, Mollusca, Echinodermata, Hemichordata, with at least one example from each class.
2. Observation of the following permanent slides. Larval forms of Crustacea (any 5 only), larval forms of Echinoderms (any 3 only).
3. Mountings:
 - a) Honeybee- Mouth parts, legs and sting apparatus
 - b) Housefly- Mouth parts
 - c) Cockroach – Mouth parts,
 - d) Appendages of Prawn
4. Dissection
 - a. Prawn – Nervous system.
 - b. Pila – Digestive system
5. Listing and identifying local butterflies and preparation of checklist of butterflies of college campus.

COURSE OUTCOMES:

At the end of the course students will be able to:

- Explain the general characters of each phylum.
- Classify the examples in the Phyla listed in the syllabus.
- Understand the anatomy and life history of the types mentioned in the syllabus.
- Cite examples with common and scientific names for all the groups.

REFERENCES:

1. Barnes, R. D. (2000). Invertebrate Zoology. Hall Saunders International Editions
2. Kotpal, R. L. (2000). Invertebrates. Rastogi Publication, Meerut.
3. Ganguli, B. B., Sinha, A. K. and Adhikari, S. (2000). Biology of Animals Vol 1. New Central Book Agency, Calcutta.
4. Ayer Ekabaranath, M. (2000). A Manual of Zoology. Vol. I Part I & II. S. Viswanath, Madras.
5. Dhama, P.S. and Dhama, J. K. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi.
6. Jordan, E. L. and Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.
7. Parker, A.J. and Haswell, W.A.A. (2002). Textbook of Zoology. Vol. I. Macmillan.

ZP: 04	Genetics and Molecular Biology (SEMESTER II)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ol style="list-style-type: none"> 1. To make the students understand the structure and functions of gene 2. To understand the importance of Genetics 3. To have basic knowledge breeding and mutation 4. To understand the basics of Molecular biology 5. To learn basics in genetic engineering and animal biotechnology 		
SYLLABUS:		
Theory		
I: Overview of Mendelian genetics and Modifications. Monohybrid cross, Dihybrid cross, Test cross and Interaction of gene (9:3:4,9:7, 13:3, 15:1), Epistasis and Hypostasis. Multiple alleles – Eg. Coat colour in Rabbit. Multiple genes - Eg. Skin colour in Man.		10 L
II: Sex Determination and Sex related Inheritance. Sex Determination in Drosophila, Insects, Honeybee, Bonelia, Turtle, Birds, Man; Sex related Inheritance – Sex Linked, Sex Limited and Sex influenced Inheritance.		9 L
III: Human Genetics. Pedigree analysis, Inheritance of Human traits – Brown Eyes, Polydactyl; Diabetes insipidus, Phenylketonuria, Sickle cell Anemia, Eugenics and Genetic Counseling.		7 L
VI: Gene Mutations Types of Gene Mutations (Base pair substitution and frame shift mutation), Natural and Induced Mutations; Molecular basis of Mutation – spontaneous mutation and induced mutation (chemical mutagens and radiation)		7 L
V: Inbreeding and Heterosis Definition of Inbreeding, Inbreeding depression, Practical application of Inbreeding. Heterosis – Genetic basis; Application and Evolutionary significance.		4 L
VI: Elementary Idea of Genetic engineering and Animal Biotechnology Introduction to restriction enzymes; Ligases; Cloning vectors (Plasmids, Cosmids, Phagemids) Application of Animal Biotechnology with reference to Aquaculture, Livestock (cattle), and Human health (Hormone and vaccines).		8 L
Practical		

1. Problems in Genetics through beads / seeds mixtures. Monohybrid and Dihybrid ratios.
2. Problems in Genetics on multiple alleles and Quantitative inheritance (multiple genes).
3. Preparation of Diploid complement of Rat or Mice by air drying technique.
4. Study of ABO blood group and Rh factor in Humans.
5. Drosophila culture techniques.
 - a. Study of phenotypic characters in Drosophila (Body colour, Wing pattern and Eye colour).
6. Determination of sex by Barr body method.
7. Karyotyping Analysis in Humans from Printed material.
 - Normal male or female
 - Klinefelter's Syndrome
 - Turner's Syndrome
 - Down's Syndrome
 - Philadelphia
8. Determination of allelic frequency of the following Mendelian Human traits- Tongue Rolling, Ear lobes, Widow's peak, Claspings of hand, Thumb crossing pattern, Folding of arms, Hitch-hiker's thumb.

General note on field work:

In addition to the practical component, the student should undertake at least two Field Trips of not less than eight hours duration each (The fieldwork is to be treated as two contact hours per batch per week).

COURSE OUTCOMES:

At the end of the course students will be able to:

- Understand the structure and functions of gene
- Understand the importance of Genetics
- Gain basic knowledge on breeding and mutation
- Understand the basics of Molecular biology
- Learn basics in genetic engineering and animal biotechnology

REFERENCES:

1. Powar, C.B. (2003) "Genetics" Vol.I & Vol II.
2. Verma P.S. and V. K. Agarwal (2008) Cell biology, Genetics, molecular Biology, Evolutionary Ecology, S. Chand & Co. New Delhi
3. Singh, B. D. (2002) Biotechnology, 3rd Ed., Kalyani Publ. Calcutta
4. Bhamrah, H. S. and Kavita Juneja. "Molecular cell Biology", Anmol publications Pvt. Ltd.
5. Gupta, P.K. (1996) "Genetics" Rastogi Publications.
6. Ranga, M.M. "Animal Biotechnology (Agrobios), Published by Agrobios (India).
7. Rastogi, Sharma, V.N. and Anuradha Tandon (1993). "Concepts in Molecular Biology". Wiley Eastern Ltd. N. Delhi.
8. Smustad, Simmons, Jenkins (1999). "Principles of Genetics" John Wiley and sons. Inc.
9. Daniel Fairbanks, W. Ralph Anderson. "Genetics, the Continuity of Life" (1999). Brooks/Cole Publishing Company, New York.

ZP: 05	Diversity of Lower Chordates (SEMESTER III)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ul style="list-style-type: none"> • To gain knowledge on Indian Biodiversity. • To review the general characters and classification of the phyla listed below • To cite local examples with common and scientific names. • To discuss the economic importance of fishes 		
SYLLABUS:		
Theory		
<p>I: Biodiversity Definition, levels of biodiversity – genetic, species and ecosystem level diversity. Conservation strategies; Biodiversity hotspots of India with examples and salient features.</p> <p>II : Chordata General characters, outline classification up to class, origin of chordates.</p> <p>III Protochordates <u>Urochordata</u>: General characters, Classification up to order, Phylogenetic relationships <u>Cephalochordata</u>: External features of Branchiostoma; Affinities and Systematic position.</p> <p>IV: Vertebrata General characters, <u>Agnatha</u>: Ostracodermi: Important features, Cyclostomata : General characters, Affinities and phylogenetic status <u>Gnathostomata</u> : Important features.</p> <p>V: Superclass pisces Classification up to order level. <u>Chondrichthyes</u>: General characters and distribution with examples. <u>Osteichthyes</u>: General characters and distribution with examples. <u>Dipnoi</u> – General characters, affinities and systematic position.</p> <p>VI. Pisces (General features) Air bladder in fishes, Accessory respiratory organs, Scales in fish, Migration in fishes, Parental care in fishes, Origin and types of fins, Adaptive radiation in teleostei, Economic importance of fishes</p>	<p>4 L</p> <p>4 L</p> <p>10 L</p> <p>7 L</p> <p>10 L</p> <p>10 L</p>	
Practical		

1. Museum specimens and slides:
2. Commonly available museum specimens with reference to protochordates, cyclostomata and pisces.
3. Observations: Accessory respiratory organs of two types.
4. Mountings:
The study of types of scales and weberian ossicles. Study of Ampulla of Lorenzini and internal ear of a bony fish.
5. Dissections
6. Brain of bony fish, Digestive system in bonyfish, heart and aortic arches in bonyfish.
7. Study of local edible fishes.
8. Study of type of fins in fishes.
9. Study of economically important fishes.

COURSE OUTCOMES:

At the end of the course students will be able to:

- Understand the levels of diversity and Biodiversity hotspots of India.
- Gain knowledge on the different lower chordate taxa and their characteristics.
- Cite local examples with common and scientific names.
- Discuss the economic importance of fishes

REFERENCES:

1. Ayer, Ekambaranath H and Anantha Krishnan, T. N. Manual of Zoology Vol. II (Chordata) S. Viswanathan (Printers and publishers) Pvt. Ltd., Madras.
2. Sinha, A.K., Adhikari, S., Ganguly, B.B., Biology of Animals. Vol. II New Central Book Agency, Calcutta.
3. Jordan, E. L., & Verma, P.S., Chordate Zoology (New Edn.) S. Chand & Co.
4. Dhama & Dhama – Chordate Zoology.
5. Kotpal, R.L., Modern Text book of Zoology Vertebrates Rastogi Publications, Shivaji Road, Meerut.
6. Dr. Nigam, H.C., Biology of Chordates, Vishal Publications, Adda Hoshiarpur, Jalandhar city.
7. Prasad, S. N., Chordates, Vikas Publishing House, Pvt. Ltd.
8. Parker, A.J. & Haswell, W.A., A Textbook of Zoology, Vol. II (New Ed.) Low price – publications, Delhi – 110052.
9. Agarwal & Dalela – A textbook of vertebrate Zoology.

ZP: 06	Animal Physiology (SEMESTER III)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ul style="list-style-type: none"> • To gain knowledge on the different physiological processes. • To learn the structure and function of the different organs in the human body. • To learn illustrations of the various systems. • To understand the importance of the different physiological processes 		
SYLLABUS:		
Theory		
<p>I Digestion Outline of digestive system and associated glands in mammals, including peristalsis. Salivary digestion, Gastro –Intestinal digestion; Role gastro-intestinal hormone, Role of Pancreas, Liver; Symbiotic digestion (pre and post gastric); Absorption, assimilation, defecation; Concept of balanced diet in humans.</p> <p>II: Respiration Ventilation, Mechanism of breathing; Cellular respiration: Glycolysis, citric acid cycle, Electron transport chain (Glycolysis to be dealt in details); Gaseous exchange: oxygen Absorption, transport and delivery to the tissues; Carbon dioxide transport- chloride shift and Bohr effect. Respiratory pigments: haemoglobin, hemocyanin, chlorocruonin. Regulation of Respiration: nervous and chemical.</p> <p>III: Circulation Types of hearts (Neurogenic and myogenic) Conduction and regulation of heart beat in myogenic heart. Cardiac cycle and ECG (human). Haemodynamics- Regulation of blood pressure, blood viscosity, friction, capillary pressure. Tachycardia, bradycardia.</p> <p>IV: Contraction and Movement Types of muscles: structural and functional; Structure and properties of smooth and cardiac muscles. Skeletal Muscle: Ultrastructure, chemical composition and functional properties (muscle twitch, summation, tetany, fatigue). Sliding filament theory of muscle contraction and its physiological basis; Role of neurotransmitters (acetylcholine and adrenaline) in muscle contraction.</p> <p>V: Excretion and Osmoregulation Types of Nitrogenous waste: ammonia, urea and uric acid; Urea Cycle. Mammalian kidney: Functions of Kidney; Structure of mammalian nephron and process of urine formation. Role of kidney in osmoregulation and acid base balance; Hormonal control of kidney.</p> <p>VI: Reproduction Structural and functional aspects of testis, Onset of puberty (development of secondary sexual character). Menstrual cycle in relation to ovarian cycle and menopause. Eestrous cycle; Methods of fertility control: physical chemical and surgical.</p>	<p style="text-align: right;">7 L</p> <p style="text-align: right;">8 L</p> <p style="text-align: right;">7 L</p> <p style="text-align: right;">9 L</p> <p style="text-align: right;">7 L</p> <p style="text-align: right;">7 L</p>	

Practical

1. Preparation of haemin crystals and haemoglobin estimation of man (Sahlis method).
2. Detect the presence of Albumin, sugar, uric acid, ketone/ acetone bodies, chlorides, phosphates, calcium, bilirubin from urine sample.
3. Survey of digestive enzymes in the gut of cockroach.
4. Study of oxygen consumption in cockroach with reference to body weight.
5. Transport of glucose (qualitative) across the intestine of rat/ chick.
6. Determination of pulse rate at rest/ after exercise and measurement of blood pressure using sphygmomanometer and stethoscope in man.
7. A visit to the hospitals / primary health center to know about human fertility control methods and devices. Submission of report.
8. Composition and preparation of physiological solutions, buffers, vital stains, fixatives, stains.

COURSE OUTCOMES:

At the end of the course students will be able to:

- Explain the different physiological processes.
- Describe the structure and state the function of the different organs in the human body.
- Illustrate the various systems.
- Discuss the importance of the different physiological processes

REFERENCES:

- 1 Mohan P. Arora 'Animal physiology' Himalaya publishing house.
- 2 Eckert R. "Animal physiology" CBS publishers.
- 3 R. Nagabhushanam, M. S. Kadarkar, R. Sarojini 'Text book of animal physiology', second edition, oxford and IBH publishing Co. Pvt. Ltd. New Delhi, Kolkata.
- 4 Vander, Sherman Luciano "Human physiology" MacGraw Hill publication.
- 5 Hoar "General and Comparative physiology" prentice hall.
- 6 Sujit Choudhuri "concise medical physiology" new central book agency.
- 7 Verma, Tyagi and Agarwal 'Animal physiology' S. Chand and Company.

ZP: 07	Diversity of Higher Chordates (SEMESTER IV)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ul style="list-style-type: none"> • To gain knowledge on Biodiversity. • To review the general characters and classification of the phyla listed in the syllabus. • To cite local examples with common and scientific names. • To discuss the features of class Mammalia as mentioned in the syllabus. 		
SYLLABUS:		
Theory		
<p>I. Depletion of biodiversity due to anthropogenic activities Benefits from Biodiversity, Introduction to Biodiversity Act, 2002, major threat to chordate biodiversity.</p> <p>II. Amphibia General characters and classification of amphibian diversity up to orders. Distinguishing features of anurans, apoda and urodela with suitable examples. Origin of Amphibia, Parental care in Amphibia, Neotony and Paedogenesis.</p> <p>III. Reptilia General characters and classification of reptiles up to orders (living orders only) with suitable examples. Reptilian diversity with reference to diverse habitats. Indian snakes (venomous and nonvenomous), Temporal fossae and arcades in reptiles, Poison apparatus and its working mechanisms, Extinct reptiles, Sense organs in reptiles.</p> <p>IV. Aves General characters and classification up to order level giving suitable examples. Birds as glorified reptiles, Flight adaptations in birds, Flightless birds or Ratitae, Diversity and adaptations of woodland, grassland, wetland and shore birds, Migration of birds.</p> <p>V. Mammalia General characters and classification up to orders Distinctive features of prototheria, metatheria and eutheria with important examples, Affinities of prototheria.</p> <p>VI. Mammalia (General features) Flying mammals, Dentition in mammals, Aquatic mammals. Detailed study general viscera and digestive systems of rat.</p>	<p>3 L</p> <p>8 L</p> <p>10 L</p> <p>10 L</p> <p>6 L</p> <p>8 L</p>	
Practical		
<p>A. Museum specimens and slides: Commonly available specimens to be shown with at least one example for each living orders in class amphibia, reptilia, aves and mammalia, the study may be made complete through field study as well.</p> <p>B. Observation:</p>		

Of four different types of beaks and feet in the birds surrounding your area / campus,
Identification of venomous and non venomous snakes.

C. Mountings

1. Mounting of pecten in any suitable specimen,
2. Types of feathers in birds.

D. Dissections

Brain of rat, general viscera in rat,

E. Field Oriented study

Bird watching and preparation of checklist of birds of college campus.

COURSE OUTCOMES:

At the end of the course students will be able to:

- Summarize the threats to Biodiversity.
- Review the general characters and classification of the phyla listed in the syllabus.
- Cite local examples with common and scientific names.
- Discuss the features of class Mammalia as mentioned in the syllabus.

REFERENCES:

1. Ayer, Ekambaranath H and Anantha Krishnan, T. N. Manual of Zoology Vol. II (Chordata) S. Viswanathan (Printers and publishers) Pvt. Ltd., Madras.
2. Sinha, A.K., Adhikari, S., Ganguly, B.B., Biology of Animals. Vol. II New Central Book Agency, Calcutta.
3. Jordan, E. L., & Verma, P.S., Chordate Zoology (New Edn.) S. Chand & Co.
4. Dhami & Dhami – Chordate Zoology.
5. Kotpal, R.L., Modern Text book of Zoology Vertebrates Rastogi Publications, Shivaji Road, Meerut.
6. Nigam, H.C., Biology of Chordates, Vishal Publications, Adda Hoshiarpur, Jolandhar city.
7. Prasad, S. N., Chordates, Vikas Publishing House, Pvt. Ltd.
8. Parker, A.J. & Haswell, W.A., A Textbook of Zoology, Vol. II (New Ed.) Low price – publications, Delhi – 110052.
9. Agarwal & Dalela – A textbook of vertebrate Zoology.
10. Salim Ali & Dillon Ripley, S., - A pictorial guide to the Birds of the Indian Subcontinent, Bombay Natural History Society, Oxford University Press, 1995.

ZP: 08	Ecology & Animal Behaviour (SEMESTER IV)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ul style="list-style-type: none"> • To Gain knowledge on the different Environmental factors affecting the survival of an organism. • To understand the existence of community and its components. • To understand the ecological adaptations acquired by different groups. • To gain knowledge on the various approaches to study animal behavior. 		
SYLLABUS:		
Theory		
<p>I: Environmental factors and animal interactions Introduction, Shelford's law of tolerance; liebig's law of minimum; Physical factors: soil-classification of soil, soil profile and soil biota; Temperature- Effect of temperature on animals, Thermal stratification in lakes and sea; Light- Effect of light on animals, light stratification in lakes and sea; Water-water as a medium for life, Chemical factors: Atmospheric gases, dissolved gases, pH, nutrients, and food. Inter specific interactions-mutualism, commensalisms, amensalism (antibiosis), parasitism, and predation.</p>	8	
<p>II: Community Introduction, characters of a community, classification of a community, community periodism, community stratification, community succession, development of animal community in hydrosere and xerosere; climax community, ecotone and edge effect.</p>	7	
<p>III: Ecological adaptations of animals Kinds of adaptations (inherited and acquired adaptations)</p> <ol style="list-style-type: none"> 1. Structural adaptations (Aquatic, pelagic, deep sea, desert, volant, cursorial, fossorial and subterranean adaptations, parasitic adaptations) 2. Physiological adaptations 3. Protective adaptations 4. Mimicry (Protective and aggressive mimicry) 	8	
<p>IV: Types of animal behaviour</p> <ol style="list-style-type: none"> 1. Innate behaviour-Taxes, reflexes, instincts, motivation. 2. Learned behaviour- Habituation, Imprinting, conditioned reflexes, insight learning. 3. Social behaviour - Types of animal society, colony in honey bees, communication in honey bees, monkey troops. 4. Biological clock - Circadian rhythm. 	8	
<p>V: Behavioural Ecology</p> <ol style="list-style-type: none"> i. Approaches to the study of behaviour: psychological, physiological, and ethological, fixed action patterns (more complex behavioural patterns) and signalling devices, innate releasing mechanisms. ii. Application of ethological techniques (ethogram) to human behaviour. 	8	
<p>VI. Reproductive behaviour</p>		

Methods in the study of hormones and behaviour (Correlation method, castration, and replacement), territoriality and aggression	6
Practical	
<ol style="list-style-type: none"> 1. A. Determination of particle size of sediment sample. B. Determination of water holding capacity of different types of soil. 2. A. Estimation of Dissolved oxygen of given water samples (Winkler's Iodometric method). B. Estimation of Dissolved carbon dioxide of given water samples. 3. Estimation of organic matter of soil (Walkley & Black method). 4. Identification of Zooplankton in given water sample. 5. Study of ecological adaptations:- Aquatic (Ranatra, <i>Physalia</i>, Duck, fish). Volant (Dragon fly, Parakeet, Bat). Desert (<i>Phrynosoma</i>, Camel, Hedgehog). 6. Study of ecological adaptations (Cont..) -Cursorial (Ostrich, Tiger, Horse). -Fossorial (Mabuya, Rabbit, Cobra). -Parasitic (Leech, Tapeworm, <i>Pediculus</i>) 7. Study of chemotaxis in <i>Paramoecium</i>. 8. Study of phototaxis in Earthworm. 9. Study of type of insect nests (Bees, Wasps, ants, termites) 10. Study of type of bird nests. 11. Study of Eye withdrawal reflex in Crab to study habituation. 12. Film show on animal behavior and adaptations. 	
General note on field work:	
<p>In addition to the regular lectures and practicals, students should undertake 2 local field trips (each of not less than eight hours duration) and a long trip of not less than 72 hrs. duration. The field work is to be treated as 2 lecture hours per batch per week.</p>	
COURSE OUTCOMES:	
<p>At the end of the course students will be able to</p> <ul style="list-style-type: none"> • Describe the Environmental factors affecting the survival of an organism. • Understand the existence of community and its components. • Understand the ecological adaptations acquired by different groups. • Discuss the various approaches to study animal behavior. 	
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<ol style="list-style-type: none"> 1. Verma P.S and Agarwal B.K. (2002). Environmental Biology (Principles of Ecology). S.S. Chand and Co Publishers. 2. Sharma P.D. Ecology and Environmental Biology, 3. Arora M.P. Animal behaviour, Himalaya Publishing House, New Delhi 4. Arora M.P. (2004). Ecology, Himalaya Publishing House, New Delhi. Price and Stoker. Animal behaviour in Laboratory and field. Freeman Publishers. 5. Drickamen and Vessey. Animal behaviour-Concepts, processes and methods, Wadsworth publishers. 6. P.J.B. Slater (1999). Essentials of Animal behaviour, Cambridge University Press. 7. Pandey J. & M.S. Sharma (1999). Environmental Science, Practical and field manual. Yash Publications. 8. Trivedy R.K., Goel P.K, Trisal C.L (1987). Practical methods in Ecology and environmental Science, Environmental Publications, Karad. 	

ZP: 09	Comparative anatomy of Vertebrates (SEMESTER V)	Number of Lectures: 45
COURSE OBJECTIVES:		
Theory:		
<ol style="list-style-type: none"> 1. To examine and identify the systems of various vertebrate groups. 2. To understand the evolution of various structures across different vertebrate groups. 3. To understand the function of specialized organs in different vertebrate groups. 4. To compare the systems of various vertebrate groups. 		
SYLLABUS:		
Theory		
<p>Unit I: Skeletal System Concept of Chondrocranium, Dermatocranium and Splanchnocranium The tetrapod hyoid – Hyoid apparatus (Amphibians, reptiles, birds & mammals), Jaw suspension</p> <p>Unit 2: Integumentary system <u>Integument Proper:</u> Comparative anatomy of the integument Epidermal derivatives and their modifications: Glands – classification based on structure and modes of secretion. Comparative anatomy of integumentary glands. Scales, feather, hair, beaks & bills, claws, nails and floofs, horns and antlers.</p> <p>Dermal Derivatives – Scales and scutes. Integumentary pigments – Poikilotherms and Homeotherms. Functions of skin</p> <p>Unit 3: Respiratory system Gills – types, gross idea of gills in fishes and amphibians. Origin of lungs and swim bladder (functions not to be included) Lungs and air ducts – Larynx, trachea and Bronchi (Gross idea in different vertebrates. Mechanism of respiration not to be included).</p> <p>Unit 4: Circulatory System Heart, comparative anatomy (Cartilaginous fish, bony fish, lung fish – protopterus, frog, reptiles (calotes and crocodiles), pigeon and rabbit. Evolution of aortic arches – shark, bonyfish, protopterus, frog, calotes, pigeon, rabbit. Portal circulation – Hepatic & Renal portal circulation. (mention only).</p> <p>Unit 5: Excretory System Types of Kidneys – Archinephros, The Anamniote kidney – pronephros, opisthonephros – comparative anatomy of opisthonephros</p>	<p>10 L</p> <p>10 L</p> <p>8 L</p> <p>11 L</p> <p>10 L</p>	

<p>(cyclostomes, fishes and amphibians. The Amniote kidney-mesonephros, metanephros, Comparative Anatomy of metanephros (Reptiles, birds and mammals.) Urinary Bladder Structure of glomerulus, uriniferous tubules and maintenance of water balance kidney – structure and function.</p> <p>Unit 6 : Nervous system Primary Divisions, Central Nervous System. The brain – primary divisions, flexures, gray and white matter of brain. Myelencephalon, metencephalon, mesencephalon, Diencephalon, Telencephalon – a comparative study in different vertebrates. Peripheral Nervous System. Cranial nerves and Spinal nerves in general. Autonomic nervous system in general.</p>	<p>11 L</p>
<p>COURSE OUTCOMES:</p>	
<p>Theory</p>	
<p>At the end of the course students will be able to</p> <ul style="list-style-type: none"> • Examine and correctly identify the systems of various vertebrate groups. • Understand the evolution of various structures across different vertebrate groups. • Understand the function of specialized organs in different vertebrate groups. • Compare the systems of various vertebrate groups. 	
<p>REFERENCES:</p>	
<ol style="list-style-type: none"> 1. Romer, A. S. & Parsons, T. S. The Vertebrate Body, (New Edn.) Holt Saunder International Eds. 2. Weichert, C. K. Anatomy of the chordates. Mc Graw Hill & Co. 3. Kent, G. C. Comparative Anatomy of Vertebrates, C.V. Mosley & Co. 4. Webster, D. & Webster, M. Comparative Vertebrate Morphology published by Aeademic press. 5. Jordan, E. L., & Verma, P.S., Chordate Zoology (New Edn.) S. Chand & Co. 6. Dhami & Dhami – Chordate Zoology. 7. Sinha, A. K., Adhikari, S., Ganguly, B.B., Biology of Animals Vol. II New Central Book Agency, 8/1 Chintamoni Das Lane, Calcutta. 8. Dr. Nigam, H.C., Biology of chordates, Vishal publications, adda hoshiarpur, Jalandhar city. 9. Prasad, S. N., Chordates, Vikas Publishing House, Pvt. Ltd. 10. Parker, A. J. & Haswell, W.A., A textbook of Zoology, Vol. II (New Edn.) Low price publications, 425, Nimri, Ashok Vihar, Phase IV, Delhi – 110052. 	

ZP: 10	Human Physiology & Biochemistry (SEMESTER V)	Number of Lectures: 45
COURSE OBJECTIVES:		
Theory:		
<ul style="list-style-type: none"> • To understand the physiological processes • To understand the working mechanisms and biomolecules associated within the body. • To gain knowledge on the mechanics and kinetics of enzymes. • To apply the knowledge and infer the data, medical reports in pathology laboratories and diagnostic laboratories. 		
SYLLABUS:		
Theory		
<p>Unit I Haematology : Introduction, properties, Composition of blood - Inorganic and Organic. PLASMA PROTEINS: Inorganic and organic constituents, functions ERYTHROCYTES: Morphology, variation in numbers, functions, erythropoiesis including factors, haemoglobin , anaemia, ESR, packed cell volume. LEUCOCYTES: morphology, types, normal count, functions, leucopoiesis, differential count THROMBOCYTES: Structure, composition, normal count, functions, blood clotting process bleeding disorders. (Clinical significance to be stressed wherever applicable).</p> <p>Unit II Neurophysiology: A brief introduction to human nervous system. Basic structure of neuron, synapse and its function, origin of nerve impulse, nerve action potential, synaptic transmission, Neurotransmitter (Acetylcholine in detail)- transport and release. Electro Encephalogram (EEG). Reflex Activity: Definition, significance, reflex arc properties, Neurophysiological bases of memory, sleep, emotion and pain.</p> <p>Unit III Reproductive physiology: Brief overview of reproduction in humans. Fertilization, implantation, Pregnancy- placenta and its role. Maternal changes. Parturation- stages, Role of hormones in growth of mammary gland and lactation</p>	<p>10</p> <p>10</p> <p>8</p>	

<p>Unit IV Biomolecules</p> <p>A) Carbohydrates: Monosaccharides- Nomenclature, definition, occurrence, classification, optical isomerism, mutarotation, linear and ring structure of monosaccharides e.g. glucose, fructose, ribose, and deoxiribose.</p> <p>Oligosaccharides- composition and biological roles of sucrose lactose, maltose. Polysaccharides: occurrence, classification, composition and biological roles of Homopolysaccharides- starch glycogen, cellulose, chitin,</p> <p>Heteropolysaccharides- hyaluronic acid, chondroitin sulphate, heparin.</p>	5
<p>B) Proteins:</p> <p>Amino acids: Structure, classification (based on R. side groups), peptides.</p> <p>Chemical bonds involved in protein structure.</p> <p>Protein configuration- primary, secondary, tertiary and quaternary.</p>	6
<p>C) Lipids</p> <p>Lipids: definition, occurrence, broad classification, biological importance of fatty acids, simple lipids (fats, oils, waxes), Compound lipids (phospholipids, glycolipids), Derived lipids – steroids, cholesterol and its biological importance.</p>	6
<p>Unit V Enzymes:</p> <p>A REVIEW OF ENZYME AS CATALYST, CHEMICAL NATURE</p> <p>Michaelis-Menton equation, derivation , significance, of Km and Vmax, double reciprocal plots. Enzyme activators, inhibitors (reversible and irreversible), coenzymes and isoenzymes.</p>	6
<p>Unit VI Biosynthesis of Nucleic Acids & Proteins</p> <p>Biosynthesis of nucleic acids (DNA, RNA) (Eukaryotes).</p> <p>Protein synthesis-Transcription and translation (eukaryotes).</p>	9
<p>COURSE OUTCOMES:</p>	
<p>Theory</p>	

At the end of the course students will be able to

- Explain the physiological processes.
- Understand the working mechanisms and biomolecules associated within the body.
- Gain knowledge on the mechanics and kinetics of enzymes.
- Apply this knowledge and infer the data, medical reports in pathology laboratories and diagnostic laboratories.

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1. K. Jambulingam and P sambulingam “essential of medical physiology”. Jaypee brothers.
2. Subramanyan Madhavan Kutty and Singh “Human physiology”
3. Mohan Arora “Animal physiology” Himalaya publishing House.
4. Albert Lehninger “Principles of Biochemistry, CBS publishers and distributors.
5. Conn, Stumpf, Bruening “Outlines of Biochemistry”, John wiley
6. J.L. jain “Fundamentals of Biochemistry” S.Chand and Company
7. V. Satyanarayana ‘biochemistry books and allied (p) ltd.
8. C.C Chatterjee. Human Physiology. Allied medical publishers, Calcutta.

ZP: 11	Applied Genetics & Evolution (SEMESTER V)	Number of Lectures: 45
COURSE OBJECTIVES:		
Theory:		
<ul style="list-style-type: none"> • To gain knowledge on various processes that involve nucleic acid and proteins in living organisms. • To analyze and diagnose various genetic diseases and defects. • To interpret and analyze data from research papers and to be able to apply and implement these concepts to research based work carried out in the field or laboratory. • To gain knowledge on various theories of evolution and the evidences and proofs that supports these theories. 		
SYLLABUS:		
Theory		
GENETICS		6
1. Gene regulation in Prokaryotes and Eukaryotes		
In prokaryotes – the ‘lac’ operon; structure, function, regulation (positive and negative) and mutations. The ‘trp’ operon – structure, function and regulation (repression & attenuation). Regulation of lysis and lysogeny.		8
2. Genetic recombinations – transformation, conjugation and transduction.		
Transformation – Griffiths, Avery, Macleod, and McCarty's experiments. Natural and artificial transformation in bacteria. Transformation in eukaryotic cells, transposition (transposons)		
3. Gene mapping and genome analysis – concept of linkage and crossing over linkage and physical mapping. Linkage mapping – construction by using 2-3 points tests. Physical mapping - Chromosome mapping, insitu hybridization (FISH). Restriction mapping – restriction fragment, length polymorphism (RFLP) Pulse field gel electrophoresis (PFGE) DNA sequencing, ultimate physical mapping (Maxam Gilbert's chemical and Sanger and Coulson's enzymatic method).		8
4. Developmental genetics – Drosophila		
Drosophila – Genes that establish the body plan – maternal effect, segmentation, homeotic genes.		4
5. Genetics of Cancer – Familial and sporadic cancer, classes of cancer genes.		5

Knudson's two-hit model for retinoblastoma, cancer development is multistep process. Protooncogenes, oncogenes, antioncogenes (Tumor suppression genes).	
6. Biostatistics	5
Mean, mode, median, standard deviation, standard error, correlation, regression, chi-square, tests- students 't' test, (test of significance for correlation, regression; 'F' test, Non-parametric tests, to be dealt in practicals).	
EVOLUTION	
1.Introduction to modern synthetic theory of evolution (Neo-Darwinism) and mechanism of Evolution. Variation: Definition, kinds, sources and role of variations in evolution; Natural selection: Definition, types, nature and working of natural selection, natural selection in action and role of natural selection in evolution. Isolation: Definition, isolating mechanism (all types) and role of isolations in evolution.	8
2. Concept of micro evolution, macro evolution, mega evolution	3
3. Genetic basis of evolution – Population genetics: Gene pool, gene frequencies and Hardy- Weinberg equilibrium	3
5. Speciation: Definition of species and sub species category, Allopatric and sympatric speciation, Inter specific and intra specific speciation	3
6. Adaptations (all types), Divergent evolution, convergent evolution	4
7. Study of Fossils: Definition, formation, types and determination of age of fossils (radio- active clock method), significance of study of fossils.	3
COURSE OUTCOMES:	
Theory	

At the end of the course students will be able to:

- Gain knowledge on various processes that involve DNA, RNA and proteins in living organisms.
- Analyze and diagnose various genetic diseases and defects.
- Interpret and analyze data from research papers and to be able to apply and implement these concepts to research based work carried out in the field or laboratory.
- Explain various theories of evolution with respect to the evidences and proofs that supports these theories.

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5. Strick Berger 1985. Genetics. Mc Millan
6. Sharma, A.K. and Sharma A. 1980 (3 E). Chromosome techniques: Theory and practice. Butter works & Co. ltd. London.
7. Benjamin Lewis. Gene I to VII
8. Andrew, A.T. 1986. Electrophoresis 2nd Edition. Oxford University
9. Singer, M and Berg P. 1991. Genes and Genomics. University of Science books Mill way.
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11. Miglani G.S. 2006. Developmental Genetics. I. K. International Publ. House, N. Delhi.
12. Singh Shailendra. Genes and Evolution. Campus book.
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14. Volpe. E.P. Understanding Evolution. Universal Book stall

ZP: 12	Fundamentals of Animal Biotechnology (SEMESTER V)	Number of Lectures: 45
COURSE OBJECTIVES:		
Theory:		
<ul style="list-style-type: none"> • To identify colony forming microbes • To learn the technique of culturing the microbes • To culture a cell line and perform various experiments with them. • Perform different techniques in a pathological laboratory, pharmaceutical laboratory or research laboratory. 		
SYLLABUS:		
Theory		
1. Biotechnology: An Overview – Scope and Importance	2 L	
2. Introduction to microbes – Bacterial identification, Nutritional types; Reproduction, Nutritional requirement – media, maintenance of media	11 L	
3. Enzymes in Genetic engineering (Nucleic acid Enzymology) Restriction enzymes - types and target sites; Ligases, Alkaline phosphatase, polynucleotide kinase, Transferase, Polymerases, Nuclease, Reverse transcriptase.	10 L	
4. Recombinant DNA technology - Isolation of DNA, labeling, Probing and cloning Genomic library - Colony hybridization, plaque hybridization, chromosome walking, chromosome jumping.	8 L	
5. Genetic Engineering Techniques – Blotting Techniques – DNA by southern blotting, RNA by Northern and Protein by Western blotting; RFLP mapping, DNA sequencing.	8 L	
6. Gene cloning vectors - plasmids - Bacterial plasmids pBR 322 and its derivatives, pUC vectors; Bacteriophage vectors, Cosmids, Phagemids, virus vectors for animal cells, shuttle and expression vectors.	9 L	
7. Genetic Engineering: Gene Cloning, Gene transfer and expressions of induced genes, - Gene – cloning in bacteria and eukaryotes, Polymerase Chain Reaction (PCR), Gene transfer technology, human gene therapy	12 L	
COURSE OUTCOMES:		
Theory		

At the end of the course students will be able to

- Identify colony forming microbes
- Perform the culturing techniques of microbes
- Culture a cell line and perform various experiments with them.
- Perform or carry out different techniques in a pathological laboratory, pharmaceutical laboratory or research laboratory.

REFERENCES:

1. Old, R.W. and Primrose, S.B. Principles of Gene Manipulation: An introduction to Genetic Engineering.
2. Meyers, R.A. (Edt) Molecular Biology and Biotechnology. VCH Pub.
3. Brown T.A. 1990 Gene cloning an introduction. VNR international Pub.
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5. Wulf C and Anneliese cruega. Text book of Industrial microbiology
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7. Tata McGraw Hill, 1993 Microbiology. Pelczar, Chan, Kreig
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9. Vinita Kale, K. Bhusari, Practical Microbiology: Principles and Techniques Himalaya Pub. 2005
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ZLC: 01	Practicals: a. Comparative anatomy of Vertebrates b. Human Physiology & Biochemistry (SEMESTER V)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ul style="list-style-type: none"> • To observe, identify and compare the skeleton specimens of different organisms. • To study the different types of internal gills in vertebrates. • To identify and compare the heart of cartilaginous fish, bony fish, pigeon and rabbit. • To mount the structures mentioned in the syllabus. • To understand the principal and procedure of various biochemical tests • To identify the various types of blood cells and enumerate them. 		
SYLLABUS:		
Practicals		
<p>a. Comparative anatomy of Vertebrates</p> <p>A. Observation of following skeleton specimens: Dogfish – visceral skeleton. Cartilaginous trunk and caudal vertebrate. Bonyfish trunk and caudal vertebrate Varanus – Atlas, Axis and Caudal vertebrate. Snake – trunk vertebrae Pigeon – cervical vertebrae, synsacrum Rabbit – Vertebral column.</p> <p>B. Study of girdles: 1. Pectoral girdles of shark, bonyfish, frog, varanus, pigeon, rabbit. 2. Pelvic girdles of Shark, bonyfish, frog, varanus, pigeon, rabbit.</p> <p>C. Observation of – a) Hyoid apparatus of pigeon and rat. b) Columella of pigeon.</p> <p>D. Observation of four different types of internal gills in vertebrates Salamander, Tadpole larva, Bony fish, Cartilaginous fish</p> <p>E. Identification of heart of cartilaginous fish, bony fish, pigeon and rabbit.</p> <p>F. Mounting Chromatophores in fishes, Brain of chick, Brain of rat</p> <p>G. Dissections Heart and aortic arches of chick and rat. Urinogenital system of chick and rat.</p> <p>b. Human Physiology & Biochemistry:</p> <ol style="list-style-type: none"> 1. Enumeration of Erythrocytes 2. Enumeration of leucocytes 3. Differential count of leucocytes 4. Estimation of erythrocyte sedimentation rate. 5. Estimation of blood cholesterol. 6. Separation of lipids by thin layer chromatography 7. Estimation of fatty acids by titration method 8. Colorometric estimation of liver glycogen. 9. Colorometric estimation of plasma glucose. 10. Effect of substrate concentration on amylase activity and determination of Km. 		

COURSE OUTCOMES:

At the end of the course students will be able to

- Identify and compare the skeleton specimens of different organisms.
- Study the different types of internal gills in vertebrates.
- Identify and compare the heart of cartilaginous fish, bony fish, pigeon and rabbit.
- Mount the structures mentioned in the syllabus.
- Understand the principle and procedure of various biochemical tests
- Identify the various types of blood cells and enumerate them

REFERENCES:

1. J. Jayaraman 'lab manual in biochemistry' new age international.
2. David Plumer 'An introduction to practical biochemistry' Tata McGraw Hills.
3. T. Poddar, Mukhopadhaya, Das 'Advanced laboratory manual of zoology. Maemillan publication.
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5. Agarwal and jindal 'advanced practical zoology' - pragati parkas

ZLC: 02	Practicals: a. Applied Genetics & Evolution b. Fundamentals of Animal Biotechnology (SEMESTER V)	Number of Lectures: 45
COURSE OBJECTIVES:		
<p>To make the students understand the structure and functions of gene</p> <p>To understand the importance of Genetics</p> <p>To have basic knowledge breeding and mutation</p> <p>To understand the basics of Molecular biology</p> <p>To learn basics in genetic engineering and animal biotechnology</p>		
SYLLABUS:		
Practicals		

Applied Genetics & Evolution:

1. Extraction and Estimation of DNA
2. Extraction and Estimation of RNA
3. Extraction and Estimation of Protein
4. Electrophoretic separation of DNA / RNA
5. Electrophoretic separation of Protein
6. Problems on Gene frequency (Allele frequencies) (ABO blood groups)
7. Problems on standard deviation, correlation, regression, chi-square, F-test, test of significance for regression co-relation. Non parametric tests.
8. Problems on DNA fingerprinting (fraternity test, forensic science) by using printed material / RFLP
9. Identification based on evolution topics – Fossils, Analogous, Homologous organs
10. To demonstrate the role of natural selection in evolving adaptations.
11. To demonstrate the role of natural selection in fixing favoured adaptations and eliminating mal-adaptation
12. An exercise to illustrate the concepts of Genetic drift.

Fundamentals of Animal Biotechnology

1. Introduction to microbiology laboratory - concepts of sterilization
2. Preparation of media, autoclaving, isolation of bacteria by streak method
3. Enumeration techniques: Viable count by spread plate method and Neubauer chamber
4. Observation of microorganisms - Negative staining, gram staining
5. Motility study by stab culture method.
6. IMViC test for pathogenic bacterial identification.
7. Extraction and estimation of m-RNA
8. Determination of the concentration and purity of DNA by UV-spectroscopy.
9. Isolation of plasmid DNA by alkaline lysis method.
10. Introduction of DNA into cells. (Demonstration)
 - a. Preparation of Frozen competent cells and their transformation.
 - b. Selection of transformed cells.
11. Molecular weight determination of plasmid using restriction enzymes. (Demonstration)
12. Restriction endonuclease digestion of plasmid DNA and agarose gel electrophoresis. (Demonstration)
13. Ligation of digested DNA. (Demonstration)

COURSE OUTCOMES

The students will be able to

- Understand the structure and functions of gene
- Understand the importance of Genetics
- Gain basic knowledge breeding and mutation
- Understand the basics of Molecular biology
- Learn basics in genetic engineering and animal biotechnology

ZP: 13	Developmental Biology (SEMESTER VI)	Number of Lectures: 45
COURSE OBJECTIVES:		
Theory:		
<ul style="list-style-type: none"> • To know the importance of developmental biology and processes such as embryogenesis and blastogenesis. • To gain knowledge on the various processes that occurs during fertilization and embryonic development in various animal groups. • To acquire knowledge on the concept of regeneration as well as mechanism of ageing. 		
SYLLABUS:		
Theory		
<p>Unit 1: Introduction Theories of development and differentiation. Branches of embryology. Scope of embryology. Gametogenesis -Spermatogenesis, Oogenesis, Vitellogenesis, Egg membranes. Fertilization and parthenogenesis Sperm – Egg interactions, Biochemical events, Post fertilization events. Types of Eggs, Patterns of cleavages, Germ layers, Gastrulation, Fate maps and Cell lineage.</p>	12	
<p>Unit 2: Transplantation, embryonic inductions, concept of organizer and competence Definition of transplantation, Nuclear transplantations, Embryonic induction, Types of embryonic inductions, Experimental evidence to embryonic induction, Brachets Experiment and Experiment of Spemanns and Mangold – Concept of organizer primary organizer, Characteristics of an organizer, Regional specificity of organizer, Neural induction, Mechanism of neural induction – surface interaction and chemical interaction, Gradient theory of neural induction, Secondary, Tertiary and Quarternary organizers, Eye as an example of sequential induction, Competence</p>	10	
<p>Unit 3: Early Development of Chick Structure of hen's egg, cleavage, blastula, Gastrulation, Origin and formation of primitive streak. Development of chick embryo up to 3 days of incubation.</p>	22	
<p>Unit 4: Extra embryonic membranes of chick Development, structure and functions of yolk sac, Amnion, chorion and allantois.</p>	4	
<p>Unit 5: Placenta and placentation Definition, Classification of the different types of placenta Functions of placenta</p>	3	
<p>Unit 6: Regeneration and ageing Types, Regenerative ability in different animal groups, Mechanism of regeneration, Stimulus and suppression of regeneration, Polarity in regeneration.</p>	9	

<p>Ageing – Concepts and models.</p> <p><u>Stem Cells</u></p> <p>Definition, Kinds of stem cells and their unique properties.</p> <p>Protocol for the preparation of Embryonic stem cells in the laboratory.</p> <p>Adult stem cells – their availability and function.</p> <p>Similarities and differences between Embryonic and Adult stem cells. Application of Human stem cells.</p>	
<p>COURSE OUTCOMES:</p>	
<p>Theory</p>	
<p>At the end of the course students will be able to</p> <ul style="list-style-type: none"> • Explain the importance of developmental biology and processes such as embryogenesis and blastogenesis. • Illustrate the various processes that occurs during fertilization and embryonic development in various animal groups. • Understand the concept of regeneration as well as mechanism of ageing. 	
<p>REFERENCES:</p>	
<ol style="list-style-type: none"> 1) Balinsky, B. I., An introduction of embryology, saundus college pub., Philadelphia. 2) Berril N. J., Developmental Biology, Mc Graw Hill, New Delhi. 3) Bruce M. Carlson, Patten's Foundations of Embryology 6th Edn. Mc Graw Hill, Inc. 4) Gilbert, S. F., Developmental Biology, Sinauer Associates, Sunderland. 5) Jain, P.C., Elements of Developmental Biology, Vishal Publications, Jalandhar–8 6) Mc. Ewen, R. S., Vertebrate Embryology, Oxford and IBH publishing company, New Delhi. 7) Nair, P.K.G., Achar, K.P., Principles of Animal Embryology - Himalaya Publishing House. 8) Suresh C. Goel, Principles of Animal Developmental Biology, Himalaya Publishing House. 9) Verma, P. S., Agarwal, V.K., Chordate Embryology (Developmental Biology) S. Chand and Company Ltd., Ram Nagar, N. Delhi. 10) Waddington, C.H., Principles of Development and Differentiation, the Macmillan Company, New York. 	

ZP: 14	Endocrinology (SEMESTER VI)	Number of Lectures: 45
COURSE OBJECTIVES:		
Theory:		
To define endocrinology <ul style="list-style-type: none"> • To understand hormones and their mode of action and regulation. • To gain knowledge on the various organs and their secretions. • To understand the diseases associated with hyper and hypo secretion of hormones. 		
SYLLABUS:		
Theory		
<p>Unit I Introduction: Endocrinology, endocrine glands, concept of endocrine regulation of physiological process. Hormones: classification – proteins, steroid and derived hormones. Regulation of hormonal secretion- feedback control, secretory mechanism, Role of hypothalamus. Mechanism of hormone action-protein and steroid.</p> <p>Unit II Hypophysis Gross anatomy in mammals. Histology of Adenohypophysis and neurohypophysis. Hypothalamo hypophyseal portal system, hormones of pituitary, their functions and effect on target organs. Disorders of pituitary.</p> <p>Unit III Thyroid and Parathyroid Histology, thyroid hormones. Role of T3, T4. Thyroid disorders. Thyroid function test Parathyroid: histology, hormones, Regulation of blood calcium levels.</p> <p>Unit IV Endocrine pancreas Microscopic anatomy, hormones (insulin and glucagon), Regulation of blood glucose levels, diabetes mellitus.</p> <p>Unit V Adrenal Adrenal cortex and medulla: functional anatomy, their hormones, regulation of secretion and biological functions of their hormones.</p> <p>Unit VI Gonads Endocrine Testis: histology, endocrine component. Regulation of testicular function. Ovary: histology, endocrine structure ovary and hormones associated with ovarian cycle.</p>	<p>10</p> <p>5</p> <p>4</p> <p>3</p> <p>4</p> <p>4</p>	
COURSE OUTCOMES:		

Theory

At the end of the course students will be able to

- Define endocrinology
- Understand hormones and their mode of action and regulation.
- Describe various organs and their secretions.
- Understand the diseases associated with hyper and hypo secretion of hormones.

REFERENCES:

1. Hadley: endocrinology.
2. C.D Turner and J.T Bagnara. General Endocrinology W.B. saunders publications.
3. Eckert and Randall 'animal physiology' CBS publishers
4. B.N. Yadav 'mammalian endocrinology' vishal publications.
5. Ross Histology
6. Fawcet Histology
7. Bailey's text book of microscopic anatomy.

ZP: 15	Environmental Biology & Toxicology (SEMESTER VI)	Number of Lectures: 45
COURSE OBJECTIVES:		
Theory:		
<ul style="list-style-type: none"> • To know the resources, present in India. • To gain knowledge on various concepts in population dynamics. • To gain insight on the wildlife of India and their conservation status. • To understand toxicology and mechanisms associated with toxicity. 		
SYLLABUS:		
Theory		
<p>Unit 1: Natural resources:</p> <p>Introduction, resource cycle, mineral resources (distribution of minerals, classification of minerals, mineral wealth of India, mineral resources of Antarctica, mineral production), marine living resources, energy resources (renewable and nonrenewable resources of energy), nuclear energy (Uranium and Thorium), forest resources, water-a vital resource.</p> <p>Unit 2: Population dynamics:</p> <p>Population density, natality of population, fecundity, mortality of population, life tables, age distribution of population, age pyramids, sex ratio, biotic potential and environmental resistance, growth form of population, growth rate of population, population dispersion: emigration, immigration, migration, regulation of population size.</p> <p>Unit 3: Wildlife in India</p> <p>Introduction, reasons for depletion of wildlife, aim and necessity for wildlife conservation, endangered, vulnerable and rare species, methods of studying wildlife, wildlife protected areas, Role of Government and NGO's in wildlife conservation, Wildlife protection acts and legislation. Application of Remote sensing and GIS in wildlife studies.</p> <p>Unit 4: Introduction to toxicology</p> <p>Definition, history, and importance of toxicology, toxicants, and toxicity, disciplines of toxicology.</p> <p>Unit 5: Environmental toxicology</p> <p>Classification of environmental toxicants: toxicants contaminating food, toxicants present in atmosphere and hydrosphere, sources, environmental levels and toxicity of</p>	<p>8</p> <p>10</p> <p>12</p> <p>6</p> <p>12</p>	

<p>heavy metals e.g. mercury, lead, arsenic, cadmium, definition, and classification of pesticides. Safety evaluation of chemicals (process of risk assessment and safety evaluation programme).</p> <p>Unit 6: Radioactive substances</p> <p>Introduction and definition of radionuclide and radioactive substances, ionizing radiation- definition and classification of ionizing radiation, electromagnetic radiation and corpuscular radiation, Alpha and beta particles, neutrons, gamma and cosmic rays, sources of radiation: natural sources, man-made sources, x-rays, radioactive fallouts, nuclear power, ore processing operations, fate of discharged radionuclide in the environment.</p>	<p>12</p>
<p>COURSE OUTCOMES:</p>	
<p>Theory</p>	
<p>At the end of the course students will be able to</p> <ul style="list-style-type: none"> • Gain knowledge about the resources present in India • Explain various concepts in population dynamics. • Gain insight on the wildlife of India and their conservation status. • Understand toxicology and mechanisms associated with toxicity. 	
<p>REFERENCES:</p>	
<ol style="list-style-type: none"> 1. Pandey R, Shukla J.P, Trivedi S.P (2006). Fundamentals of Toxicology, New Central Book Agency. 2. Omkar. Concepts of Toxicology, Shoban lal nagin chand and Co, Jalandhar, India. 3. Rajesh Gopal (2000). Fundamentals of wildlife management, Justice Home. 4. Verma P.S and Agarwal B.K. (2002). Environmental Biology (Principles of Ecology). S.S. Chand and Co Publishers. 5. Arora M.P. (2004). Ecology, Himalaya Publishing House, New Delhi. 6. Dash M.C. (1993). Fundamentals of Ecology. Tata McGraw Hill Publishers, New Delhi. 7. Michael P. (1984). Ecological methods for field and laboratory investigations. Tata McGraw Hill Publishers, New Delhi. 8. T. Poddar, S. Mukhopadhyay, S.K. Das (2003). An advanced laboratory manual of Zoology, MacMilan India Ltd, Mumbai. 9. Gurkamal Basra: Wildlife of India, Vishvabharati publication. 	

ZP: 16	Animal Biotechnology Applications (SEMESTER VI)	Number of Lectures: 45
COURSE OBJECTIVES:		
Theory:		
<ul style="list-style-type: none"> • To gain knowledge on animal cell culture, understand the intricacies involved in culturing cells. • To apply the knowledge of animal biotechnology for large scale production of products. • To understand gene transfer for the production of transgenic animals. • To apply the knowledge of animal biotechnology in fisheries, farming and sericulture. 		
SYLLABUS:		
Theory		
<p>1. Animal Cell Culture</p> <p>History; Requirements of Cell-culture; Protocols for Primary Cell Culture; Subculture; Established Cell lines (common examples such as MRC, HeLa, CHO, BHK, Vero); Organ culture.</p> <p>2. Large scale production of mammalian cells.</p> <p>3. Important products from cell culture: Tissue Plasminogen Activator (tPA), Factor VIII, Erythropoietin(EPO), Growth Hormone (GH), Interferons (IFN)</p> <p>4. Hybridoma Technology</p> <p>Cell fusion, Production of Monoclonal antibodies (mAb), Applications of mAb</p> <p>5. Vaccines – different types</p> <p>6. Manipulation of reproduction in dairy animals and humans:</p> <p>Artificial Insemination, <i>In vitro</i> Fertilisation , Embryo Transfer, Embryo cloning</p> <p>7. Transgenic Animals</p> <p>Strategies of Gene transfer; Transgenic mice, - sheep, - fish; Molecular farming</p> <p>8. Applications of Biotechnology in fisheries - use of PCR in fisheries, monoculture in fishes, polyploid in fishes</p> <p>9. Application in sericulture- introduction of colour genes, sex markers.</p>	<p>12</p> <p>8</p> <p>6</p> <p>4</p> <p>4</p> <p>10</p> <p>8</p> <p>4</p> <p>4</p>	
COURSE OUTCOMES:		
Theory		

At the end of the course students will be able to

- Gain knowledge on animal cell culture, understand the intricacies involved in culturing cells.
- Apply this knowledge for large scale production of products.
- Understand gene transfer for the production of transgenic animals.
- Apply this knowledge in fisheries, farming and sericulture.

REFERENCES:

1. A Text Book of Biotechnology By R.C. Dubey (S. Chand)
2. Animal Biotechnology M.M. Ranga (Agrobios)
3. Biotechnology By B.D. Singh

ZLC: 03	Practicals: a. Developmental Biology b. Endocrinology (SEMESTER VI)	Number of Lectures: 45
COURSE OBJECTIVES:		
Practicals:		
<ul style="list-style-type: none"> • To observe the developmental stages of amphibian, hen and insect egg. • To learn the technique of preparing the permanent slides of chick embryo. • To acquire knowledge of the histological slides of the various endocrine glands of mammals. • To get a hands-on training of the use of microtome to prepare Histological slides. 		
SYLLABUS:		
Practical		
<p>a. Developmental Biology</p> <ol style="list-style-type: none"> 1) Observation of live gametes under microscope. 2) Observation of different types of eggs – amphibian egg, hen's egg, insect egg. 3) Observation of developmental stages of frog's egg – cleavage, blastula, gastrula. 4) Study of morphogenetic movement in vivo in hen's egg using vital staining technique by preparing a window opening. 5) In vitro observation of the different extra embryonic membranes in a 6 days old chick embryo. 6) Mounting of eye vesicle and limb buds of a 6 day old chick embryo. 7) Preparation of permanent slides of chick embryo. <ol style="list-style-type: none"> i. 24 hrs., ii. 36 hrs., iii. 48 hrs. , iv. 72 hrs. 8) To study the regenerative ability in different animals in both invertebrates and vertebrates. 9) Primary culture of Chick Embryo – Fibroblast – Warm Trypsinization, Cold Trypsinization. <p>b. Endocrinology</p> <ol style="list-style-type: none"> 1. Study of the histological slides of the following endocrine glands of mammals: thyroid, suprarenal pituitary, parathyroid, islets of langerhans, testis and ovary. 2. Demonstration of endocrine glands in cockroach / crustaceans. 3. Demonstration of surgical technique- Adrenalectomy in rats. 4. A general survey of endocrine glands in rats. 5. Study of estruous cycle by vaginal smear preparation. 6. Histological technique: preparation of tissue, fixing embedding, sectioning, staining and mounting of testis of rats. 7. Effect of oestrogen on the ovary and uterus of rat. 8. A visit to a fish breeding farm/Prawn culture or breeding farm and submission of a report 		
COURSE OUTCOMES:		
Theory		
<p>At the end of the course students will be able to</p> <ul style="list-style-type: none"> • Describe the developmental stages of amphibian, hen and insect egg. • Prepare permanent slides of chick embryo. • Describe the histological slides of the various endocrine glands of mammals. • Prepare Histological slides using the microtome.. 		
REFERENCES:		

- K. C. Ghose and B. Manna: practical zoology new central book agency.
- S. S. Lal 'a text book of practical zoology (vertebrates) Rastogi publications.

ZLC: 04	Practicals: a. Environmental Biology & Toxicology b. Animal Biotechnology Applications (SEMESTER VI)	Number of Lectures: 45
COURSE OBJECTIVES:		
<ul style="list-style-type: none"> • To understand the methods of estimation of calcium, magnesium, total alkalinity, salinity, phosphorus and nitrates. • To learn the methods to qualitatively and quantitatively estimate of soil fauna. • To learn basics in genetic engineering and animal biotechnology. • To learn various techniques involved in animal biotechnology. 		
SYLLABUS:		
Practical		
<p>a. Environmental Biology & Toxicology</p> <ol style="list-style-type: none"> 1. Determination of light penetration by Secchi Disc method. 2. Determination of calcium and magnesium in water. 3. Determination of total alkalinity in water. 4. Determination of salinity of water sample. 5. Field estimation of animal population by quadrat method. 6. Qualitative and quantitative estimation of soil fauna. 7. Estimation of total dissolved solids in given water sample. 8. Estimation of phosphorus and nitrates in the given water sample by spectrophotometer method. <p>9. To determine LC 50 of mosquito larvae using suitable pollutant/toxicant.</p> <p>10. Effect of pesticide on oxygen consumption in fish/bivalve.</p> <p>b. Animal Biotechnology Applications</p> <ol style="list-style-type: none"> 1. Raising of Antibodies. 2. Separation and collection of Serum. 3. Simple Immunodiffusion. 4. Counter Current Immunodiffusion 5. Radial Immunodiffusion. (Ouchterlony) 6. Setting up of suspension culture of spleen cells 7. Setting up a monolayer culture of Macrophages. 8. Viable count of the Given cell sample. 9. Setting up a primary culture of Chick embryo fibroblasts <ol style="list-style-type: none"> i -Warm Trypsinization ii -Cold Trypsinization <p>General Note on Field Work: In addition to the regular lectures and practicals, the students should undertake 3 local field trips (each of not less than 8-hour duration) and a long study tour of not less than 10 days' duration. The total field work is to be treated as 4 contact hours per batch per week.</p>		
COURSE OUTCOMES:		

At the end of the course students will be able to

- Understand the methods of estimation of calcium, magnesium, total alkalinity, salinity, phosphorus and nitrates.
- Qualitatively and quantitatively estimate soil fauna.
- Understand the basics in genetic engineering and animal biotechnology.
- Various techniques involved in animal biotechnology.

REFERENCES:

- K. C. Ghose and B. Manna: practical zoology new central book agency.
S. S. Lal 'a text book of practical zoology (vertebrates) Rastogi publications.