



SunRise University

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B.Sc. ZOOLOGY (HONS.) SEMESTER SYLLABUS

FIRST SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHZ101	Introduction to biology	40	60	100
BSHZ102	Biodiversity-I Non-Chordata	40	60	100
BSHZ103	Biodiversity-II Non-Chordata	40	60	100
BSHZ104	Chemistry I	40	60	100
BSHZ105	Botany I Plant Diversity	40	60	100
BSHZ106	English	40	60	100
PRACTICAL				
BSHZ107	Biodiversity-I Non-Chordata	60	40	100
BSHZ108	Biodiversity-II Non-Chordata	60	40	100
BSHZ109	Chemistry I	60	40	100
BSHZ110	Botany I Plant Diversity	60	40	100
Total		500	500	1000

SECOND SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHZ201	Biodiversity-III Chordata	40	60	100
BSHZ202	Biodiversity-IV Chordata	40	60	100
BSHZ203	Animal Physiology & Histology I	40	60	100
BSHZ204	Chemistry II	40	60	100
BSHZ205	Botany II Plant Physiology and Metabolism	40	60	100
PRACTICAL				
BSHZ206	Biodiversity-III Chordata	60	40	100
BSHZ207	Biodiversity-IV Chordata	60	40	100
BSHZ208	Animal Physiology & Histology I	60	40	100
BSHZ209	Chemistry II	60	40	100

BSHZ210	Botany II Plant Physiology and Metabolism	60	40	100
Total		500	500	1000

THIRD SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHZ301	Cell Biology I	40	60	100
BSHZ302	Molecular Biology I	40	60	100
BSHZ303	Animal Physiology & Histology II	40	60	100
BSHZ304	Chemistry III	40	60	100
BSHZ305	Botany III Plant Anatomy, Reproduction & Biotechnology	40	60	100
PRACTICAL				
BSHZ306	Cell Biology I	60	40	100
BSHZ307	Molecular Biology I	60	40	100
BSHZ308	Animal Physiology & Histology II	60	40	100
BSHZ309	Chemistry III	60	40	100
BSHZ310	Botany III Plant Anatomy, Reproduction & Biotechnology	60	40	100
Total		500	500	1000

FOURTH SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHZ401	Cell Biology II	40	60	100
BSHZ402	Molecular Biology II	40	60	100
BSHZ403	Animal Ecology	40	60	100
BSHZ404	Chemistry IV	40	60	100
BSHZ405	Environmental Management	40	60	100

PRACTICAL				
BSHZ406	Cell Biology II	60	40	100
BSHZ407	Molecular Biology II	60	40	100
BSHZ408	Animal Ecology	60	40	100
BSHZ409	Chemistry IV	60	40	100
BSHZ410	Environmental Management	60	40	100
Total		500	500	1000

FIFTH SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHZ501	Genetics & Genomics I	40	60	100
BSHZ502	Evolutionary Biology	40	60	100
BSHZ503	Immunology I	40	60	100
BSHZ504	Biochemistry & Metabolism	40	60	100
BSHZ505	Computer and Biostatistics	40	60	100
PRACTICAL				
BSHZ506	Genetics & Genomics I	60	40	100
BSHZ507	Evolutionary Biology	60	40	100
BSHZ508	Immunology I	60	40	100
BSHZ509	Biochemistry & Metabolism	60	40	100
BSHZ510	Computer and Biostatistics	60	40	100
Total		500	500	1000

SIXTH SEMESTER

PAPERS CODE	PAPERS NAME	INTERNAL	EXTERNAL	TOTAL
BSHZ601	Genetics & Genomics II	40	60	100
BSHZ602	Applied Zoology	40	60	100
BSHZ603	Immunology II	40	60	100

BSHZ604	Animal Biotechnology	40	60	100
BSHZ605	Developmental Biology	40	60	100
PRACTICAL				
BSHZ606	Genetics & Genomics II	60	40	100
BSHZ607	Applied Zoology	60	40	100
BSHZ608	Immunology II	60	40	100
BSHZ609	Animal Biotechnology	60	40	100
BSHZ610	Developmental Biology	60	40	100
Total		500	500	1000

SYLLABUS
B.Sc. (Hons) Zoology
SEMESTER - I
PAPER-101
INTRODUCTION TO BIOLOGY

UNIT 1:

a. Introduction to concepts of biology

Themes in the study of biology; A closer look at ecosystem; A closer look at cell; The process of Science; Biology and everyday life

b. Evolutionary history of biological diversity

Early earth and the origin of life; Major events in the history of life; Mechanism of Macroevolution; Phylogeny and the tree of life

c. Classifying the diversity of life

Kingdoms of Life – Prokaryotes, Eukaryotes, Archaea

UNIT II

b. Darwinian view of life and origin of species

Darwin's theory of evolution; The evolution of populations; Concepts of species; Mechanism of speciation

c. Genetic approach to Biology

Patterns of inheritance and question of biology; Variation on Mendel's Law; The molecular basis of genetic information; The flow of genetic information from DNA to RNA to protein; Genetic Variation; Methodologies used to study genes and gene activities; Developmental noise; Detecting macromolecules of genetics; Model organisms for the genetic analysis; Distinction between Phenotype and Genotype

UNIT III

a. Chemistry of life

The constituents of matter; Structure of an atom; The energy level of electron; The formation and function of molecules depend on chemical bonding between atoms; Chemical reaction make or break chemical bonds

b. Water and life

The water molecule is polar; Properties of water; Ionization of water

UNIT IV

c. Carbon and life

Organic chemistry-the study of carbon compounds; What makes carbon special? Properties of organic compounds

d. Structure and function of biomolecules

Most macromolecules are Polymers; Carbohydrates act as fuel and building materials; Lipids are group of hydrophobic molecules; Protein have diverse structures and functions; Nucleic acids store and transmit hereditary information

PRACTICALS

1. To learn a) use of microscope b) principles of fixation and staining.
2. Preparation of Normal, molar and standard solutions, phosphate buffers, serial dilutions
3. Use of micropipettes
4. Separation of A) amino acids B) chloroplast pigments by paper chromatography.
5. To perform gram staining of bacteria.
6. To study the cytochemical distribution of nucleic acids and mucopolysaccharides with in cells/tissues from permanent slides.
7. To perform quantitative estimation of protein using the Lowry's method. Determine the concentration of the unknown sample using the standard curve plotted.
8. To separate and quantify sugars by thin layer chromatography.
9. To raise the culture of *E. coli* and estimate the culture density by turbidity method. Draw a growth curve from the available data.
10. Isolation of genomic DNA from *E.coli*.

SUGGESTED BOOKS

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi
3. Griffiths, A.J.F et al (2008) Introduction to Genetic Analysis, 9th edition, W.H. Freeman & Co. NY

SYLLABUS
B.Sc. (Hons) Zoology
SEMESTER - I
PAPER-102
BIODIVERSITY-I: NON-CHORDATA

THEORY

General characters and outline classification of different phyla:

Unit I

Protozoa

General characters and outline classification

Locomotion and reproduction in Protozoa.

Type study of *Paramecium*: Structure and life history

Unit II

Metazoa

Origin of metazoa, metamerism and coelom.

Phylum Porifera

General characters and outline classification

Type study of *Sycon*: Structure and life history

Unit III

Phylum Cnidaria

General characters and outline classification

Polymorphism in Cnidarians; corals and coral reefs

Type study of *Aurelia*: Structure and life history

Unit IV

Phylum Platyhelminthes

General characters and outline classification

Type study of *Taenia*: Structure and life history; parasitic adaptations and evolution of parasitism

Phylum Aschelminthes

General characters and outline classification

Type study of *Ascaris*: Structure and life history; parasitic adaptations.

PRACTICALS

Protozoa:

1. Examination of *Amoeba*, *Euglena*, *Paramecium*, *Ceratium*, *Noctiluca*, and *Vorticella*.

Porifera:

2. Study of *Sycon* (including T.S. and L.S.). *Hyalonema*, and *Euplectella*;

3. Temporary mounts of spicules, gemmules and spongin fibres.

Cnidaria:

4. Study of *Obelia*, *Sertularia*, *Physalia*, *Millepora*, *Aurelia*, *Scyphistoma* and *Ephyra* larvae, *Tubipora*, *Metridium* (including T.S. and L.S.).

Platyhelminthes:

5. Study of *Fasciola*, *Taenia*, *Echinococcus*; life history and sections of *Fasciola* and *Taenia*

Aschelminthes:

6. Study of male and female *Ascaris* (including sections).

SUGGESTED BOOKS

1. Barnes, R.D. Invertebrate Zoology (1982) VI Edition. Holt Saunders International Edition.

2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.

3. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.

4. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.

5. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.

SEMESTER - I
PAPER-103
BIODIVERSITY-II: NON-CHORDATA

1. .

THEORY

General characters and outline classification of different phyla:

Unit I

Phylum Annelida

General characters and outline classification

Adaptive radiations in Polychaeta.

Type study of *Leech*: Structure and life history

Unit II

Phylum Arthropoda

General characters and outline classification.

Larval forms of crustacea; social life, moulting and metamorphosis in Insecta; vision in Arthropoda.

Type study of Scorpion: Structure and life history

Affinities of **Onychophora**

Unit III

Phylum Mollusca

General characters and outline classification

Torsion and detorsion; modifications of shell and foot

Type study of *Sepia* :Structure and life history

Unit IV

Phylum Echinodermata

General characters and outline classification

Water-vascular system and larval forms

Type study of *Asterias*: Structure and life history

PRACTICALS

Annelida:

1. **Demonstrations, models, CD's etc:** digestive and nervous systems of earthworm.
2. **Temporary mounts:** Ovary, pharyngeal and septal nephridia of earthworm.
3. **Slides:** T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
4. **Specimens:** *Aphrodite*, *Heteronereis*, *Chaetopterus*, *Pheretima*, *Tubifex*, *Hirudinaria*.

Arthropoda:

5. **Demonstrations, models, CD's etc:** digestive and nervous systems of cockroach.
6. **Temporary mounts:** salivary glands and mouth parts of cockroach.
7. **Specimens/slides:** *Limulus*, spider, crustacean larvae, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, termite, louse, wasp, honeybee, silkworm and *Peripatus*.

Mollusca:

8. **Demonstrations, models, CD's etc:** digestive system of *Pila*;
Temporary mounts- radula and gill of *Pila*.
9. **Specimens:** *Chiton*, *Dentalium*, *Unio*, *Ostrea*, *Teredo*, *Loligo*, *Sepia*, *Octopus* and *Nautilus*.

Echinodermata:

10. **Slides:** T. S. arm of *Pentaceros*, Echinoderm larvae.
11. **Specimens:** *Pentaceros*, *Ophiura*, *Clypeaster*, *Echinus*, *Echinocardium*, *Cucumaria*, and *Antedon*.

SUGGESTED BOOKS

1. Barnes, R.D. Invertebrate Zoology (1982) VI Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
3. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
4. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
5. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.

SYLLABUS
B.Sc. (Hons) Zoology
SEMESTER - I
PAPER-104
Chemistry I (Subsidiary)

THEORY

Section-A

Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge, Slater's rules.

Covalent Bond

Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions (BeF_2 , BF_3 , CH_4 , PF_5 , SF_6 , IF_7 , SO_4^{2-} , ClO_4^-) Valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_3O^+ , SF_4 , ClF_3 , ICl_2^- and H_2O . MO theory of heteronuclear (CO and NO) diatomic molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

Section-B

Gaseous States

Maxwell's distribution of velocities and energies (derivation excluded) Calculation of root mean square velocity, average velocity and most probable velocity. Collision diameter, collision number, collision frequency and mean free path. Deviation of Real gases from ideal behaviour. Derivation of Vander Waal's Equation of State, its application in the calculation of Boyle's temperature (compression factor) Explanation of behaviour of real gases using Vander Waal's equation.

Critical Phenomenon: Critical temperature, Critical pressure, critical volume and their determination. PV isotherms of real gases, continuity of states, the isotherms of Vander Waal's equation, relationship between critical constants and Vander Waal's constants. Critical compressibility factor. The Law of corresponding states. Lequifaction of gases.

Liquid States

Properties of liquids – surface tension, viscosity and their determination.

Solid State

Liquid crystals: Difference between solids, liquids and liquid crystals, types of liquid crystals. Applications of liquid crystals.

Section-C

Structure and Bonding

Localized and delocalized chemical bond, resonance effect and its applications,

Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism.

Optical isomerism — elements of symmetry, molecular chirality, enantiomers, , optical activity, , chiral and achiral molecules with two stereogenic centres, diastereomers,

Relative and absolute configuration, sequence rules, R & S systems of nomenclature.

Geometric isomerism — determination of configuration of geometric isomers. E & Z system of nomenclature,

Mechanism of Organic Reactions

Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles. Types of organic reactions.

Reactive intermediates — carbocations, carbanions, free radicals,

Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes.

Isomerism in alkanes, methods of formation (with special reference to Wurtz reaction, Kolbe reaction).

Cycloalkanes — nomenclature, synthesis of cycloalkanes , dehalogenation of α,ω -dihalides.

PRACTICALS

Section-A (Inorganic)

Volumetric Analysis

1. **Redox titrations:** Determination of Fe^{2+} , $\text{C}_2\text{O}_4^{2-}$ (using KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$)
2. **Iodometric titrations:** Determination of Cu^{2+} (using standard hypo solution).

Section-B (Physical)

1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. To determine the specific refractivity of a given liquid

Organic

1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point

(i) Iodoform from ethanol (or acetone)

2. To study the process of) sublimation of camphor and phthalic acid

Distribution of marks

1.	Section I	12 marks
2.	Section II	12 marks
3.	Section III	12 marks
4.	Viva-voce	10 marks
5.	Lab Record	04 marks

SEMESTER - I
PAPER-105
BOTANY I (PLANT DIVERSITY)

THEORY

Unit I

Algae, Fungi and Lichen: Salient features, habitat, range of thallus structure, reproduction and broad classification of algae; General account, classification and reproduction in fungi; Brief account of Lichen and Mycorrhiza; Economic importance of algae, fungi and lichens.

Unit II

Bryophytes and Pteridophytes: General characteristics, broad classification and reproduction in Bryophytes and Pteridophytes; Ecological and Economic importance of Bryophytes; Evolution of stelar system and seed habit in Pteridophytes

Unit III

Gymnosperms: Salient features and diagnostic characters of; Distribution in India, Pteridospermic seeds and evolution of seed habit in gymnosperms, Economic Importance with reference to Wood, Resins, Essential oils and Drugs

Unit IV

Angiosperms and Taxonomy: Botanical nomenclature and Elementary knowledge of International Code of Botanical Nomenclature, Role of Herbaria and Botanical Gardens, Broad outline of Bentham & Hooker system of classification with merits and demerits

PRACTICAL

Morphological studies through specimens, temporary mounts and permanent slides (Fresh material whichever available).

1. Fungi: *Rhizopus, Aspergillus, Yeast, Puccinia, Agaricus*
2. Algae: *Volvox, Spirogyra, Chara, Vaucheria, Polysiphonia, Ectocarpus*
3. Bryophytes: *Riccia, Marchantia, Anthoceros, Funaria, Sphagnum*
4. Pteridophytes: *Lycopodium, Selaginella, Equisetum, Marsilea, Pteris*
5. Gymnosperm: *Cycas, Pinus, Ephedra, Thuja, Cedrus*
6. Herbarium/museum specimens of the diseased plants: Black stem rust of Wheat, Late blight of Potato, Red rot of Sugarcane, Green year of Bajra
7. Familiarity with local flora and herbarium techniques.
8. **Field Excursion:** Visit to any Botanical or Medicinal Plant Garden
9. **Field Records:** Field note-book and 20 herbarium sheets of common angiospermic weeds are to be prepared and submitted at the time of Practical Examination.

SUGGESTED READINGS

1. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
2. Bilgrami, K.S. and Saha, L.C., 2001, *A Text Book of Algae*, CBS Publishers, New Delhi.
3. Kumar, H.D. 1999. Introductory Phycology. East-west Press Pvt Ltd., Delhi.
4. Alexopolous, C.J. , Mims, C.W. and Blackwell, M. (1996), *Introductory Mycology*, John Wiley and Sons, New York.
5. Bold, H.C. & Wayne, M.J. 1996 (2nd Ed.) Introduction to Algae.
6. Shaw, A.J. and Goffinet, B. (2000) Bryophyte Biology. Cambridge University Press.
7. Parihar, N.S. 1991. Bryophytes. Central Book Depot, Allahabad.
8. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
9. Bhatnager, S.P. and Moitra, A. (1996) Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi.
10. Simpson, M.C. (2006). Plant Systematics. Elsevier, Amsterdam.

11. Stussy, T.F. 1990. Plant Taxonomy, Columbia University Press, USA.39
 12. Rashid, A., 1992, *An Introduction to Pteridophytes*, Vikas Publishing House Pvt. Ltd., New Delhi
 13. Davis, P.H. and Heywood, V.H., 1965, *Principles of Angiosperm Taxonomy*, Oliver and Boyd, Edinburgh.
- Naik, V.N., 1984, *Taxonomy of Angiosperms*, Tata McGraw- Hill, New Delhi.

SunRise University

SEMESTER - II
PAPER-201
BIODIVERSITY-III: CHORDATA

THEORY

General account of Chordates:

Unit I

Chordates

Introduction, affinities and origin.

Protochordates

General features, Phylogeny & classification of Hemichordates, Urochordates & Cephalochordates.

Retrogressive metamorphosis.

Agnatha

General features of living Agnatha and classification upto classes.

Type study of *Pteromyzon*: Structure and life history

Unit II

Pisces

General features & Classification of Placodermi upto subclasses, Chondrichthyes up to suborders and

Osteichthyes upto orders. Osmoregulation, migration and Parental care.

Amphibia

General features & Classification upto orders.

Origin and evolution of terrestrial ectotherms/tetrapods, Parental care & pedomorphosis.

Unit III

Reptiles

General features & Classification upto orders. Origin of reptiles skull types, Poisonous and non- poisonous snakes in India, Biting mechanism in snakes, Status of *Sphenodon* and Crocodiles.

Aves

General features & Classification upto orders.

Origin of birds, Flight adaptations, Mechanism of flight and Migration.

Unit IV

Mammals

General features & Classification upto orders.

Origin of mammals, dentition.

Comparative Anatomy of Chordates:

Integument Structure and derivatives of integument

Digestive System Alimentary canal and associated glands

PRACTICALS

1. Protochordata:

Study of *Balanoglossus*, *Herdmania*, *Branchiostoma*, *Ciona*, *Salpa*, *Doliolum*. *Balanoglossus* sections through Proboscis, Collar, branchiogenital & hepatic region.

Amphioxus - oral hood, Whole Mount sections through pharyngeal, intestinal & caudal regions .

2. Fishes:

Study of *Petromyzon*, *Scoliodon*, *Sphyrna*, *Pristis*, *Trygon*, *Torpedo*, *Chimaera*, *Notopterus*, *Labeo*, *Catla*, *Cirrhina*, *Heteropneustes*, *Mystus*, *Exocoetus*.

Demonstrations, models, CD's etc: Afferent branchial system, V, VII, IX and X Cranial nerves of *Scoliodon*.

Weberian ossicles of *Mystus*.

Temporary unstained preparation of Placoid, Cycloid and Ctenoid scales.

3. Amphibia:

Study of *Uraeotyphlus*, *Necturus*, *Salamander*, *Bufo*, *Hyla*, *Rhacophorus*.

4. Reptiles:

Study of *Chelone*, *Testuda*, *Kachuga*, *Hemidactylus*, *Varanus*, *Uromastix*, *Ophiosaurus*, *Chameoleon*, *Draco*, *Hydrophis*, *Bungarus*, *Viper*, *Krait*, Coral snakes, Crocodiles.

5. Aves: Study of dozen Birds of District/State
Temporary mount of pecten

6. Mammals:

Study of *Sorex*, *Shrew*, *Hedgehog*, Bat (Insectivorous & frugivorous).

SUGGESTED BOOKS

1. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
3. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers, Inc.

**SEMESTER - II
PAPER -202**

THEORY

Comparative Anatomy of Chordates:

Unit I

Respiratory system

Skin, Gills, Lungs, Air sacs and voice apparatus, Air bladder and accessory breathing organs in fishes.

Circulatory System

Evolution of heart and aortic arches, Venous system and lymphatic system.

Unit II

Bone

Structure and types, Ossification, bone growth.

Skeleton System

Axial and appendicular skeleton, Jaw suspensorium and Visceral arches.

Unit III

Nervous System

Central & Autonomic Nervous System, Cranial nerves.

Sense Organs

Classification of receptors, structure and working of Mammalian eye and ear.

Unit IV

Urinogenital System

Succession of kidney, Evolution of Urinogenital ducts.

PRACTICALS

Osteology:

1. Articulated skeleton of *Scoliodon* . Axial, opercular & appendicular skeleton of *Labeo*.
2. Disarticulated skeleton of *Varanus* , Carapace & plastron of tortoise.
3. Disarticulated skeleton of Fowl
4. Disarticulated skeleton of Rabbit

Demonstration of systems through chart, models, CD etc:

- a. Arterial, venous and urinogenital system of frog
- b. Brain of pigeon
3. Arterial, Venous, Urinogenital system, Neck region of Rat.

SUGGESTED BOOKS

1. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
3. Young, J.Z. (2004). The life of Vertebrates. III Edition. Oxford University Press.
4. Weichert, C.K. (1970). Anatomy of Chordate. McGraw Hill.
5. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers, Inc.

SEMESTER - II
PAPER-203
ANIMAL PHYSIOLOGY & HISTOLOGY -I
(With reference to Human)

THEORY

Unit I

Tissues and Glands

Concepts and classification- Epithelial tissue, Connective tissue.

Blood

Structure & composition of Blood

Muscle

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation, tetanus and muscle dystrophies.

Unit II

Digestive System

Histology and functions of gastrointestinal tract and its associated glands; Mechanical and chemical digestion of food; Role of gastrointestinal hormones; Control and action of GI Tract secretions; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins.

Unit

III

Respiratory System

Histology of trachea and lung; Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen in the blood (oxygen-hemoglobin and myoglobin dissociation curve and its influencing factors), Carbon monoxide poisoning; Carbon dioxide transport in the blood; Regulation of acid-base balance; Control of respiration.

Unit

IV

Circulatory System

An outline structure of heart; Coronary circulation; Origin and conduction of cardiac impulse; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart, Autonomic control and chemical regulation of heart rate. Blood pressure and its regulation; Electrocardiogram. Structure and functions of hemoglobin; Haemopoiesis; Haemostasis; Coagulation of blood

PRACTICALS

1. Recording of simple muscle twitch with electrical stimulation.
2. Preparation of temporary mounts: Squamous epithelium, Ciliated epithelium, Striated muscle fibres and nerve cells.
3. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, spleen, trachea, lung, kidney.
4. Enumeration of red blood cells using haemocytometer.
5. Estimation of haemoglobin using Sahli's haemoglobinometer.
6. Preparation of haemin and haemochromogen crystals.
7. Enumeration of total and differential count of white blood cells.
8. Recording of frog's heart beat *in situ* and with perfused heart.
9. Recording of blood pressure using a sphygmomanometer

SUGGESTED BOOKS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. / W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons, Inc.
3. Victor P. Eroschenko . (2008). diFiore's Atlas of Histology with Functional Correlations. XII Edition. Lippincott W. & Wilkins.
4. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders.

SYLLABUS
B.Sc. (Hons) Zoology
SEMESTER - II
PAPER-204
Chemistry II (Subsidiary)

THEORY

Section-A

Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity – definition, trends in periodic table (in s & p block elements).

s-Block Elements

Comparative study of the elements including, diagonal relationships and salient features of hydrides (methods of preparation excluded).

p-Block Elements

Emphasis on comparative study of properties of p-block elements (including diagonal relationship and excluding methods of preparation).

Boron family (13th gp):-

Diborane – properties and structure (as an example of electron – deficient compound and multicentre bonding), Borazene – chemical properties and structure.

Carbon Family (14th group)

Allotropy of carbon, Catenation, $p\pi-d\pi$ bonding (an idea), carbides, fluorocarbons – general methods of preparations, properties and uses.

Nitrogen Family (15th group)

Oxides – structures of oxides of N,P. oxyacids – structure and relative acid strengths of oxyacids of Nitrogen and phosphorus.

Oxygen Family (16th group)

Oxyacids of sulphur – structures and acidic strength

Halogen Family (17th group)

Basic properties of halogen, hydro and oxyacids of chlorine – structure and comparison of acid strength.

Section-B

Kinetics

Rate of reaction, rate equation, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst. Order of a reaction, integrated rate expression for zero order, first order, Half life period of a reaction. Methods of determination of order of reaction, effect of temperature on the rate of reaction – Arrhenius equation.

Electrochemistry

Electrolytic conduction, factors affecting electrolytic conduction, specific, conductance, molar conductance, equivalent conductance and relation among them, their variation with concentration. Arrhenius theory of ionization, Ostwald's Dilution Law. Debye-Huckel – Onsager's equation for strong electrolytes (elementary treatment only), Kohlrausch's Law, calculation of molar ionic conductance and effect of viscosity temperature & pressure on it. Application of Kohlrausch's Law in calculation of conductance of weak electrolytes at infinite dilution. Applications of conductivity measurements: determination of degree of dissociation, determination of K_a of acids determination of solubility product of sparingly soluble salts, conductometric titrations. Definition of pH and pK_a , Buffer solution, Buffer action, (elementary idea only).

Section-C

Alkenes

Nomenclature of alkenes, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. The Saytzeff rule, Chemical reactions of alkenes — mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule,

Arenes and Aromaticity

Nomenclature of benzene derivatives. Aromatic nucleus and side chain.

Aromaticity: the Huckel rule, aromatic ions, aromatic, anti - aromatic and non - aromatic compounds.

Dienes and Alkynes

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Chemical reactions — 1,2 and 1,4 additions (Electrophilic & free radical mechanism), Diels-Alder reaction, Nomenclature, structure and bonding in alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions,

Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides, Mechanisms and stereochemistry of nucleophilic substitution reactions of alkyl halides, S_N2 and S_N1 reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions of aryl halides.

Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides.

PRACTICALS

Inorganic

Volumetric analysis

Complexometric titrations: Determination of Mg^{2+} , Zn^{2+} by EDTA.

Paper Chromatography

Qualitative Analysis of the any one of the following Inorganic cations and anions by paper chromatography (Pb^{2+} , Cu^{2+} , Ca^{2+} , Ni^{2+} , Cl^- , Br^- , I^- and PO_4^{3-} and NO_3^-).

Physical

- a. To prepare arsenious sulphide sol and compare the precipitating power of mono-, bi – and trivalent anions.
2. To determine the surface tension of a given liquid by drop number method.
3. To determine the viscosity of a given liquid.

Organic

1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point
- (j) *m*-Dinitrobenzne from nitrobenzene (use 1:2 conc. HNO_3 - H_2SO_4 mixture if fuming HNO_3 is not available)
- ii) *p*-Bromoacetanilide from acetanilide.
- iii) Dibenzalacetone from acetone and benzaldehyde
- iv) Aspirin from salicylic acid.

Distribution of marks

1.	Section I	12 marks
2.	Section II	12 marks
3.	Section III	12 marks
4.	Viva-voce	10 marks
5.	Lab Record	04 marks

THEORY

Unit 1

Plant-water relations: Concept of osmosis, diffusion, imbibition and water potential; Soil-plant-atmosphere continuum concept, concepts of symplast and apoplast; ascent of sap; transpiration and antitranspirants; mechanism of opening and closing of stomata, Mineral nutrition, Translocation of photoassimilates.

Unit 2

Photosynthesis: Photosynthetic pigments; Photosystems; Cyclic and noncyclic electron transport; photophosphorylation. Carbon fixation in C_3 and C_4 plants, CAM plants, factors affecting photosynthesis

Respiration: Glycolysis; the TCA cycle and its regulation; electron transport in mitochondria; oxidative phosphorylation

Unit 3

Carbohydrate Metabolism: Structure, properties and importance of mono-, di- and polysaccharides; Synthesis of sucrose, starch and cellulose. **Nitrogen Metabolism :** Biological nitrogen fixation and nitrogen cycle **Lipid Metabolism:** Structure, properties, classification and functional significance of fatty acids, triglycerides and steroids; Synthesis and breakdown, formation of glycerides; oxidation of fatty acids, beta oxidation; energy balance.

Unit 4

Flowering; physiological definition; role of light; photoperiodism, inductive and non-inductive cycles; role of dark period; role of quality and intensity of light; nature of the flowering stimulus; florigen concept, vernalization: mechanism.

Structure, biosynthesis, analysis, transport, physiological effects and mechanism of action of growth regulators.

CORE PRACTICALS

1. Preparation of solutions of various concentrations of a few selected solutes.
2. Determination of osmotic potential of plant cell sap by plasmolytic method.
3. Determine water potential of given tissue by weight method and falling drop method.
4. Study of the effect of various environmental factors on transpiration in an excised twig/leaf.
5. Calculation of the stomatal index, stomatal frequency and percentage of leaf area open through stomata in a mesophyte and a xerophyte.
6. Study of the mechanism of stomatal opening and closing
7. Bolting experiment / *Avena* coleoptiles bioassay.
8. Study the effect of different factors on O_2 evolution during photosynthesis and demonstrate the Law of limiting factors.
9. Chemical separation of chloroplast pigments and determination of their absorption spectra.
10. To extract anthocyanin pigments and study the effect of pH on their absorption spectra.
11. Study of the rate of aerobic respiration and respiratory quotient in different plant parts/materials.
12. Identification tests for carbohydrates (Fehling's test, Benedicts test) and proteins (Ninhydrin test, Xanthoproteic test).
13. Preparation of standard curve for estimation of proteins and determination of total proteins in plant tissue extracts for example of control and GA3 treated embryo-less wheat grains.

Projects: Students are required to perform at least one long-duration experiment as project (a suggestive list of experiments will be provided).

SUGGESTED READINGS

1. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
2. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA.
3. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
4. Taiz, L. and Zeiger, E. (2006) Plant Physiology, 4th Edition, Sinauer Associates Inc .MA, USA 41
5. Dennis, D.T., Layzell, D.B., Lefebvre, D.D. and Turpin, D.H. (1997) Plant Metabolism. Addison Wesley Longman.

SEMESTER - III
PAPER-301

THEORY

Unit I

An Overview of Cells

Overview of prokaryotic and eukaryotic cells, cell size and shape, Phages, Virioids, Mycoplasma and *Escherichia coli*.

Tools and techniques of Cell Biology

Microscopic -Principles of Light microscopy; Phase contrast microscopy; Confocal microscopy; Electron microscopy (EM)- scanning EM and scanning transmission EM (STEM); Fluorescence microscopy.

Unit II

Tools and techniques of Cell Biology

Analytical -Flow cytometry- fluorochromes, fluorescent probe and working principle; Spectrophotometry; Mass spectrometry; X-ray diffraction analysis.

Separation -Sub-cellular fractionation- differential and density gradient centrifugation; Chromatography- paper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC).

Unit III

Composition of Cells

Molecules of cell, cell membranes and cell Proteins.

The Nucleus

Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus and rRNA Processing.

Protein Sorting and Transport

The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes.

Unit IV

Mitochondria, Chloroplasts and Peroxisomes

Structural organization, Function, Marker enzymes, Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisomes' assembly

Cytoskeleton and Cell Movement

Structure and organization of actin filaments; actin, myosin and cell movement; intermediate filaments; microtubules.

PRACTICALS

1. Separation of nucleic acid bases by paper chromatography.
2. Microscopy- Theoretical knowledge of Light and Electron microscope.
3. Study of the following techniques through electron/photo micrographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting.
4. Study of structure of cell organelles through electron micrographs.

Permanent slide preparation:

5. Cytochemical staining of DNA-Feulgen.
6. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).
7. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).
8. Cytochemical staining of Total proteins- Bromophenol blue.
9. Cytochemical staining of Histones -Fast Green.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

SEMESTER - III
PAPER-302
MOLECULAR BIOLOGY-I

THEORY

Unit I

Nucleic Acids convey Genetic Information

DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

Unit II

The Structures of DNA and RNA / Genetic Material

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves.

DNA topology - linking number, topoisomerases; Organization of DNA- Prokaryotes, Viruses, Eukaryotes.

RNA Structure

Organelle DNA - mitochondria and chloroplast DNA.

Unit III

Genome Structure, Chromatin and the Nucleosome

Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation.

The Nucleosome

Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Regulation of Chromatin Structure and Nucleosome Assembly.

Organization of Chromosomes

Unit IV

The Replication of DNA (Prokaryotes and Eukaryotes)

Chemistry of DNA synthesis, general principles - bidirectional replication, Semi-conservative, Semi discontinuous, RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), (theta) mode of replication, replication of linear ds-DNA, replicating the 5' end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins

The Mutability and Repair of DNA

Replication Errors, DNA Damage and their repair.

PRACTICALS

1. Preparation of Polytene chromosome from *Chironomus* larva/ *Drosophila* larva
2. Demonstration of mammalian sex chromatin.
3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).
4. Perform Southern Blot Hybridization (Restrict DNA for Southern Blot electrophoresis, perform electrophoresis of restricted DNA, perform southern transfer, hybridization and detection of gene of interest)
5. Demonstration of Northern Blotting.
6. Demonstration of Western Blotting.
7. Perform DNA amplification by PCR.
8. Study of semiconservative replication of DNA through micrographs/schematic representations.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

SEMESTER - III
PAPER-303
ANIMAL PHYSIOLOGY & HISTOLOGY -II
(With reference to human)

THEORY

Unit I

Excretory System

Histology of kidney, ureter and bladder; Renal blood supply; Mechanism and regulation of urine formation; Regulation of acid-base balance..

Unit II

Nervous System

General organization: Neuron resting membrane potential and its basis; Origin of action potential and its propagation in myelinated and unmyelinated nerve fibers; Synaptic transmission and types of synapsis, Neuro-muscular junction; Reflex activity-reflex arc; Types of reflexes, Physiology of hearing and vision.

Unit III

Reproductive System

Histology of male and female reproductive systems, Puberty, physiology of male and female reproduction; Methods of contraception (depicted through flow chart).

Unit IV

Endocrine System

Structure, histology and functions of endocrine glands; Hypothalamus- principal nuclei involved in control of endocrine system, control of anterior pituitary hormones by hypothalamic releasing hormones (neuroendocrine mechanisms); Effects of abnormal secretions of hormones; Placental hormones.

PRACTICALS

1. Preparation of temporary mounts: Squamous epithelium, Ciliated epithelium, Striated muscle fibres and nerve cells.
2. Demonstration of the knee jerk reflex.
3. Examination of sections of Mammalian Pancreas, Testis, Ovary, Pituitary, Adrenal, Thyroid, Parathyroid.
4. Preparation of permanent slide of any five mammalian tissues- Microtomy.
5. To identify & Study the different of Endocrine glands

SUGGESTED BOOKS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. / W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John wiley & sons, Inc.
3. Victor P. Eroschenko . (2008). diFiore's Atlas of Histology with Functional Correlations. XII Edition. Lippincott W. & Wilkins.
4. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders.

SYLLABUS
B.Sc. (Hons) Zoology
SEMESTER - III
PAPER-304
Chemistry III (Subsidiary)

THEORY

Section-A

Chemistry of d-Block Elements

Definition of transition elements, position in the periodic table, General characteristics & properties of d-block elements, Comparison of properties of 3d elements with 4d & 5d elements with reference only to ionic radii, oxidation state, magnetic and spectral properties.

Coordination Compounds

Werner's coordination theory, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

Metal-ligand Bonding in Transition Metal Complexes

Limitations of valence bond theory, an elementary idea of crystal-field theory, crystal field splitting in octahedral and tetrahedral complexes, factors affecting the crystal-field parameters.

Section-B

Thermodynamics

Definition of thermodynamic terms: system, surrounding etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

Zeroth Law of thermodynamics, First law of thermodynamics: statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Calculation of w.q. dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process, Kirchhoff's equation.

Second law of thermodynamics, need for the law, different statements of the law, Carnot's cycles and its efficiency, Carnot's theorem, Thermodynamics scale of temperature. Concept of entropy – entropy as a state function, entropy as a function of P, V & T.

Section-C

Alcohols

Monohydric alcohols — nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature.

Dihydric alcohols — nomenclature, methods of formation, chemical reactions of vicinal glycols,.

Phenols

Nomenclature, structure and bonding. Preparation of phenols, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Mechanisms of Fries rearrangement, Claisen rearrangement, and Schotten and Baumann reactions.

Epoxides

Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides,

Ultraviolet (UV) absorption spectroscopy

Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts.

Carboxylic Acids & Acid Derivatives

Nomenclature of Carboxylic acids, structure and bonding, , acidity of carboxylic acids, effects of substituents on acid strength. Hell-Volhard-Zelinsky reaction. Mechanism of decarboxylation.

. Relative stability of acyl derivatives. interconversion of acid derivatives by nucleophilic acyl substitution.

Mechanisms of esterification and hydrolysis (acidic and basic).

PRACTICAL

SECTION – I (Inorganic)

Preparations: Preparation of Cuprous chloride, prussian blue from iron fillings, tetraammine cupric sulphate, chrome alum, potassium trioxalatochromate (III).

Section-B (Physical)

1. To determine the solubility of benzoic acid at various temperatures and to determine the ΔH of the dissolution process

2. To determine the enthalpy of neutralization of a weak acid/weak base vs. strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
3. To determine the enthalpy of solution of solid calcium chloride
4. To study the distribution of iodine between water and CCl_4 .

Distribution of marks

- | | | |
|----|------------|----------|
| 1. | Section I | 13 marks |
| 2. | Section II | 23 marks |
| 3. | Viva-voce | 10 marks |
| 4. | Lab Record | 04 marks |

SEMESTER - III
PAPER-305
BOTANY III (PLANT ANATOMY, REPRODUCTION & BIOTECHNOLOGY)

THEORY

UNIT 1

Plant Anatomy: Classification and structure of tissues; Organization of root and shoot apex; basic structure of dicot and monocot leaf; secondary growth in roots and stems; Anatomical adaptations of hydrophytes and xerophytes; Anomalous secondary growth in *Boerhaavia*, *Tecoma* and *Dracaena*; Applications of anatomy in systematics, forensics and pharmacognosy

UNIT 2

Plant reproduction: Structure of male and female gametophyte; microsporogenesis and megasporogenesis, Pollination and fertilization; pollen-pistil Interaction; self incompatibility and methods to overcome self incompatibility; endosperm types and functions; embryogenesis and polyembryony

UNIT 3

Plant tissue culture: Historical perspective; composition of media; totipotency; physico-chemical conditions for propagation of plant cells and tissues; somatic embryogenesis; protoplast isolation, culture and fusion; cybrids; micropropagation; methods and significance of haploid culture

UNIT 4

Plant Genetic Engineering: Brief concept of different gene transfer methods, special emphasis on *Agrobacterium* mediated gene transfer, Role of Plant Biotechnology in crop improvement with special reference to transgenic plants and genetically modified food, Application of plant biotechnology for production of quality oil, industrial enzymes and edible vaccines

PRACTICALS

1. Understanding of staining technique for preparation of permanent slides
2. Preparation of temporary and permanent slides of T.S. of available root and stem (any four)
3. Study of anomalous secondary structure in stem of *Boerhaavia*, *Tecoma* and *Dracaena*.
4. To study ecological adaptations in locally available hydrophytes and xerophytes.
5. Studies of different anthers, pollen grains, ovule and endosperm from permanent slides/photographs
6. Pollen germination: in different media and calculation of percentage germination.
7. Acquaintance with laboratory instruments - Autoclave, Incubator, Clinical centrifuge, Analytical balance, pH Meter, Colorimeter, Water bath, Distillation plant.
8. Preparation of MS media, aseptic culture of different explants, methods of *in vitro* sterilization, inoculation and subculture methods

SUGGESTED READINGS

1. Dickinson, W.C. (2000) Integrative Plant Anatomy. Harcourt Academic Press, USA
2. Fahn, A., 1990, *Plant Anatomy*, Pergamon Press, Oxford.
3. Raghavan, V. (2000) Developmental Biology of Flowering plants, Springer, Netherlands.
4. Bhojwani, S.S. and Bhatnagar SP (2004) The Embryology of Angiosperms, Vikas Publishing House
5. Shivanna, K.R. (2003) Pollen Biology and Biotechnology, Science Publishers.
6. Bhojwani, S.S. and Razdan (2004) Plant Tissue Culture and Practice. Smith, R.H., 2000, *Plant Tissue Culture, Technique and Experiments*, Academic Press, New York.
7. Slater, A., Scott, N.W. & Fowler, M.R. (2008) Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press

SEMESTER - IV
PAPER-401

THEORY

Unit I

The Plasma Membrane

Structure; Transport of small molecules, Endocytosis

Cell Wall, the Extracellular Matrix and Cell Interactions

Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions.

Unit II

Cell Signaling

Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks.

The Cell Cycle

Eukaryotic Cell Cycle, Regulation of Cell cycle progression

Unit III

The Cell Cycle

Events of Mitotic Phase, Meiosis and Fertilization.

Cell Death and Cell Renewal

Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

Unit IV

Cancer

Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

PRACTICALS

1. To demonstrate the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
2. Study of polyploidy in Onion root tip by colchicine treatment.
3. Preparations of temporary mount of Grasshopper testis / onion flower bud anthers and study the different stages of Meiosis.
4. Study of mitosis and meiosis from permanent slides.
5. Identification and study of cancer cells- Slides/Photomicrographs.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

SEMESTER - IV
PAPER-402
MOLECULAR BIOLOGY-II

THEORY

Unit I

Mechanism of Transcription

RNA Polymerase and the transcription unit

Transcription in Prokaryotes

Transcription in Eukaryotes

Unit II

RNA Modifications

Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

Transcription Regulation in Prokaryotes

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons

Unit III

Transcription Regulation in Eukaryotes

Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing

Regulatory RNAs

Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X-inactivation

Unit IV

Translation (Prokaryotes and Eukaryotes)

Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation

PRACTICALS

1. Preparation of culture medium (LB) for *E.coli* (both solid and liquid) and raise culture of *E.coli*.
2. Demonstration of antibiotic resistance. (Culture of *E.coli* containing plasmid (pUC 18/19) in LB medium with/without antibiotic pressure and interpretation of results).
3. Isolation and quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A₂₆₀ measurement).
4. To perform Ames test in *Salmonella/E.coli* to study mutagenicity.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

**SEMESTER -IV
PAPER-403
ANIMAL ECOLOGY**

THEORY

Unit I

Introduction to Ecology

Relevance of studying ecology, its history, autecology, synecology. Species- Sympatric, parapatric and Allopatric, Population, Community.

Ecosystem, Biome, Biosphere and Ecosphere

Abiotic Factors: Laws of limiting factors- Liebig's law of minimum and Shelford's law of tolerance. A brief account of light and temperature as limiting factors, soil types and soil erosion.

Unit II

Population

Unitary and modular populations, its unique and group attributes- population density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio. Population dispersal and distribution patterns.

Population growth

Exponential/Malthusian and Sigmoid growth patterns, Verhulst-Pearl growth equation, 'r' and 'k' strategies.

Unit III

Population Growth regulation

Intrinsic mechanism- Density dependant fluctuations and oscillations, Extrinsic mechanism- Density independent, environmental and climatic factors, population interactions- types in a tabular form with examples.

Niche concept, Gause's principle of competitive exclusion with laboratory and field examples, Lotka Volterra Equation for prey predator interaction, functional and numerical responses of prey and predator

Unit IV

Ecosystem and Community

Ecosystems- terrestrial (grassland), marine, and aquatic (pond).

Community

Characteristics of community diversity, diversity index, types of biodiversity species richness, abundance, species area relationship, community stratification, ecotone/edge effect, succession, stages of primary succession, climax community. Energy flow through an ecosystem- food chains, food web, trophic levels, grazing and detritus type of food chain, Y- shaped food chain in forest, one example of food web- Terrestrial or Aquatic, Nutrient cycle, Nitrogen cycle.

PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quadrat method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for -pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

SUGGESTED BOOKS

1. Colinaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E. P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Ricklefs, R. E., (2000). Ecology. V Edition. Chiron Press

SYLLABUS
B.Sc. (Hons) Zoology
SEMESTER - I
PAPER-404
Chemistry IV (Subsidiary)

THEORY

Section-A

Non-aqueous Solvents

Physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2

Acids and Bases, HSAB Concept

Arrhenius, Bronsted – Lowry, the Lux – Flood, Solvent system and Lewis concepts of acids & bases, relative strength of acids & bases, Concept of Hard and Soft Acids & Bases.

Chemistry of f – block elements

Lanthanides

Occurrence, Electronic structure, oxidation states and ionic radii and lanthanide contraction and complex formation of lanthanide compounds.

Actinides

General features and chemistry of actinides, Comparison of properties of Lanthanides and Actinides and with transition elements. Elementary idea about the transuranic elements.

Section-B

Thermodynamics

Third law of thermodynamics: Nernst heat theorem, Thermodynamic functions G, H, E, A & S . Criteria for thermodynamic equilibrium and spontaneity of a process in terms of thermodynamic functions.

Chemical Equilibrium

Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium. Clapeyron equation and Clausius – Clapeyron equation its applications.

Electrochemistry

Electrolytic and Galvanic cells – reversible & Irreversible cells, conventional representation of electrochemical cells. EMF of cell and its measurement, Weston standard cell, activity and activity coefficients.

Calculation of thermodynamic quantities of cell reaction (ΔG , ΔH & K).

, Nernst equation, prediction of single electrode potential and EMF of cell. Reference electrodes; standard hydrogen electrode & calomel electrode standard electrode potential, sign convention, electrochemical series and its applications.

Section-C

Infrared (IR) absorption spectroscopy

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups. 2.

Amines

Structure and nomenclature of amines, physical properties. Separation of a mixture of primary, secondary and tertiary amines.

Structural features affecting basicity of amines. . Gabriel-phthalimide reaction, Hofmann bromamide reaction.

electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid.

Diazonium Salts

Mechanism of diazotisation, structure of benzene diazonium chloride, Replacement of diazo group by H, OH, F, Cl, Br, I, NO_2 and CN groups.

Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, advantage of oxidation of alcohols with chromium trioxide (Sarett reagent) pyridinium chlorochromate (PCC) and pyridinium dichromate... Comparison of reactivities of aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin and aldol, condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction.

PRACTICAL

Section-A

1. Gravimetric Analysis

Quantitative estimations of, Cu^{2+} as copper thiocyanate and Ni^{2+} as Ni – dimethylglyoxime.

2. Colorimetry:

To verify Beer - Lambert law for $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ and determine the concentration of the given $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ solution.

Section- B (Organic)

Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple mono and bifunctional organic compounds:

Naphthalene, anthracene, acenaphthene, benzyl chloride, *p*-dichlorobenzene, *m*-dinitrobenzene, *p*-nitrotoluene, resorcinol, hydroquinone, α -naphthol, β -naphthol, benzophenone, ethyl methyl ketone, benzaldehyde, vanillin, oxalic acid, succinic acid, benzoic acid, salicylic acid, aspirin, phthalic acid, cinnamic acid, benzamide, urea, acetanilide, benzanilide, aniline hydrochloride, *p*-toluidine, phenyl salicylate (salol), glucose, fructose, sucrose, *o*-, *m*-, *p*-nitroanilines, thiourea.

Distribution of marks

1.	Section I	13 marks
2.	Section II	23 marks
3.	Viva-voce	10 marks
4.	Lab Record	04 marks

SEMESTER - IV
PAPER-405
ENVIRONMENTAL MANAGEMENT

THEORY

Unit I

Introduction:

Human population increase; carrying capacity, exploitation of resources due to anthropogenic activities like agriculture, horticulture, urbanization and industrialization.

Effect of human activities:

Depletion of resources; Generation of waste; types (agricultural, municipal, industrial); management of wastes and disposal (emphasis on concepts of reduce, reuse and recycle); Pollution of air, water, soil, noise, and due to radioactive substances; causes and methods of prevention and control; Eutrophication; bioremediation; Depletion of forests; threats to biodiversity, extinction of species.

Unit II

Natural resources:

Land, Water, Air, Bioresources and biodiversity.

Conservation of resources

Soil – Contour farming, afforestation and reforestation; Water – Rainwater harvesting, aquifers, groundwater recharge, watershed management; Biodiversity – In-situ conservation (Sanctuaries, National Parks, Biosphere Reserves, World Heritage Sites), Project Tiger and other conservation efforts. social forestry and Joint forestry Management; ex-situ conservation (botanical gardens, gene banks, cryopreservation).

Role of organizations like NBPGR, BSI, ZSI, WWF, IUCN and conventions like Convention on Biological diversity; Ramsar Convention, National Action Plan on Conservation of Biodiversity; Environmental laws and acts.

Unit III

Global environment change

Greenhouse effect and global warming; climate change; shrinking of glaciers and polar ice caps and consequent effects on river and sea levels; ozone layer depletion; vegetation and biota; international efforts to control these effects (Vienna Convention, Montreal Protocol, UNFCCC, Kyoto Protocol, Copenhagen Summit, etc.); IPCC; Biosafety of GMOs and LMOs.

Unit IV

Sustainable Development:

Definition; Brundlandt Report; Threats to sustainable development, green technologies, eco-cities, Ecological footprint, National Environmental Policy.

Energy:

Conventional & non-conventional fuel resources.

PRACTICALS

Student would be required to submit a detailed project report based on the practical work on any topic mentioned in the theory paper. Evaluation of the project will be based on the detailed report and presentation.

SUGGESTED READINGS

1. Joseph, B., Environmental studies, Tata Mc Graw Hill.
2. Mohapatra Textbook of environmental biotechnology IK publication.
3. Thakur, I S, Environmental Biotechnology, I K Publication.
4. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Rana SVS, Environmental pollution – health and toxicology, Narosa Publication.
7. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.
8. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
9. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Pub.
10. Sinha, S. 2010. Handbook on Wildlife Law Enforcement in India. TRAFFIC, India.

SEMESTER - V
PAPER-501
GENETICS AND GENOMICS-I

THEORY

Unit I

Introduction to Genetics

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information.

Mitosis and Meiosis

Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).

Mendelian Genetics and its Extension

Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

Unit II

Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping. Introduction to concept of Epigenetics.

Unit III

Mutations

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

Sex Determination

Chromosomal mechanisms, Environmental factors determining sex determination, Barr bodies, Dosage compensation.

Unit IV

Extrachromosomal Inheritance

Chloroplast mutation/Variation in Four o' clock plant and *Chlamydomonas*, Mitochondrial mutations in *Neurospora* and yeast, Maternal effects, Infective heredity- Kappa particles in *Paramecium*.

Quantitative Genetics

Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

PRACTICALS

1. Mendelian laws and gene interaction using *Drosophila* crosses.
2. Chi-square and probability.
3. Study of Linkage, recombination, gene mapping using marker based data from *Drosophila*.
4. Study of Human and *Phlox/Allium*. Karyotype (normal and abnormal).
5. Pedigree analysis of some human inherited traits.
6. Study of Hardy-Weinberg Law using simulations (seeds).

SUGGESTED BOOKS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
7. Griffiths, A.J.F., Wessler, S.R., Lewontin R.C. and Carroll, S.B. IX Edition., Introduction to Genetic Analysis.

SEMESTER - V
PAPER-502
EVOLUTIONARY BIOLOGY

THEORY

Unit I

Introduction

Lamarckism, Darwinism, Neo-Darwinism.

Life's beginning

An overview (chemogeny, biogeny, the RNA World).

Unit II

Evidences of evolution

Paleontological evidences.

Molecular evidences, phylogeny of horse

Process of evolutionary change

Organic variations

Population genetics

Natural selection

Unit III

Products of evolutionary change

Species concept

Isolating mechanisms and modes of speciation.

Extinction and mass extinction

Unit IV

Origin and evolution of man

Phylogenetic trees

Multiple sequence alignment, Construction of Phylogenetic tree, interpretation of trees.

PRACTICALS

1. DNA databases and Sequence retrieval from databases.
2. Designing primer for a gene (exemplified by 16S rRNA).
3. Demonstration of editing the sequences.
4. Multiple Sequence Alignments.
5. Construction of Phylogenetic trees and interpretation of results.

SUGGESTED BOOKS

1. Ridley, M. (2004) Evolution. III Edition. Blackwell Publishing
2. Barton, N. H., Briggs, D.E.G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring Harbour Laboratory Press.
3. Hall, B.K. and Hallgrimsson, B. (2008) Evolution. IV Edition. Jones and Bartlett Publishers
4. Pevsner, J. (2009) Bioinformatics and functional genomics. II Edition. Wiley-Blackwell

**SEMESTER-V
PAPER-503
IMMUNOLOGY-I**

THEORY

Unit I

Overview of Immune system

Historical perspective of Immunology, Early theories of Immunology.

Components of immune system

Innate, Adaptive (cell mediated and humoral) - Passive: Artificial and Natural Immunity, Active: Artificial and Natural Immunity.

Unit II

Cells and Organs of the Immune System

Haematopoiesis and role of haematopoietic factors, Cells of the immune system, Organs of the Immune system: Primary and Secondary lymphoid organs, Lymphatic system.

Unit III

Antigens

Antigenicity and immunogenicity, Immunogens, Adjuvants and Haptens, Factors influencing immunogenicity, B and T-cell epitopes.

Unit IV

Immunoglobulins

Structure and Functions, Basic structure, deducing antibody structure, classes and function, Antigenic determinants on immunoglobulins, Antigen-antibody interactions, Polyclonal sera, Monoclonal antibodies, Hybridoma technology.

PRACTICALS

1. Dissection/demonstration through CD etc and display of lymphoid organs.
2. Ouchterlony's double immunodiffusion method.
3. ABO blood group determination.
4. Preparation of single cell suspension of spleen.
5. Preparation of single cell suspension of bone marrow.

SUGGESTED BOOKS

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., Kuby, J. (2006). VI Edition. Immunology. W.H. Freeman and Company.
2. Delves, P. J., Martin, S. J., Burton, D. R., Roitt, I.M. (2006). XI Edition. Roitt's Essential Immunology, Blackwell Publishing

SEMESTER - V
PAPER-504
BIOCHEMISTRY & METABOLISM

THEORY

Unit I

Carbohydrates:

Structures and properties of important mono-, di- and polysaccharides.

Carbohydrate Metabolism

Glycolysis, Fermentation, Citric acid cycle, pentose phosphate pathway, Gluconeogenesis, Shuttle systems (Malate-aspartate shuttle, Glycerol 3-phosphate shuttle, and Cori cycle), Glycogen metabolism.

Unit II

Lipids

Structures, properties and functional significance of fatty acids, triglycerides and steroids.

Lipid Metabolism

Biosynthesis and β -oxidation of saturated fatty acids, Ketogenesis,

Unit III

Amino acids and Proteins

Structure and general properties of amino acids.

Protein Metabolism

Catabolism of amino acids: Transamination, Deamination and Urea cycle, Fate of glucogenic and ketogenic amino acids with examples of serine and leucine respectively.

Enzymes

Introduction, kinetics, mechanism of action, inhibition, allosteric enzymes.

Unit IV

Intermediary metabolism

Inter-relationship of carbohydrates, lipid and protein metabolism.

Oxidative Phosphorylation

Oxidative phosphorylation in mitochondria, Respiratory chain, ATP synthase, Inhibitors and Uncouplers.

PRACTICALS

1. Qualitative techniques:

1. Qualitative analysis of functional group in the given solution of carbohydrate.
2. Qualitative analysis of functional group in the given solution of proteins.

2. Quantitative techniques:

1. Colorimetric estimation of glucose in the given solution.
2. Colorimetric estimation of total protein in the given solution.

3. Enzymology:

1. Study of the action of salivary amylase at optimum condition.
2. Effect of pH on the action of salivary amylase.
3. Effect of temperature on the action of salivary amylase.
4. Effect of inhibitor on the action of salivary amylase.
5. Study the activity of Trypsin using fresh tissue extracts.
6. Detection of abnormal constituents in urine.

SUGGESTED BOOKS

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H Freeman and Co.
3. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/McGraw-Hill.

SEMESTER - V
PAPER-505
COMPUTER AND BIOSTATISTICS

THEORY

Unit I

Computer Fundamentals

Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers; Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices; User Interface with the Operating System, System Tools

Data Representation

Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of binary numbers, BCD, ASCII, Unicode.

Unit II

Networks terminology

Types of networks, router, switch, server-client architecture

Multimedia

Introduction, Characteristics, Elements, Applications

Problem Solving

Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet

General Awareness

IT Act, System Security (virus/firewall etc.), I-Tax, Reservations, Banking.

Unit III

Measures of central tendency. Measures of dispersion; skewness, kurtosis. Elementary Probability and basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean and Variance of Binomial, Poisson and Normal distribution. Sample mean and Sampling variance.

Unit IV

Hypothesis testing using standard normal variate. Curve Fitting. Correlation and Regression. Emphasis on examples from Biological Sciences.

PRACTICALS

1. Defined projects will be done by the students and evaluated by the instructor.
2. Document Preparation
3. Presentation Software
4. Familiarizing with the Operating System, Control Panel, Networking Configuration, Firewall setting
5. Spreadsheet Handling, Working with worksheets, Creating a spreadsheet, entering and formatting information, basic functions and formulas, creating charts, tables and graphs.
6. Numerical Problems related all statistical parameters.

SUGGESTED READINGS

1. H. S. Bear: *Understanding Calculus*, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : *Introduction to Mathematics for Life Scientists*, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. A. Edmondson and D. Druce : *Advanced Biology Statistics*, Oxford University Press; 1996.
4. W. Danial : *Biostatistics : A foundation for Analysis in Health Sciences*, John Wiley and Sons Inc; 2004.
5. V Rajaraman, *Fundamentals of Computers*, Fourth Edition, PHI.
6. Anita Goel, *Fundamentals of Computers*; Forthcoming title in Pearson-Education
7. Mahajan, *Statistics for Medical students*
8. SC Gupta, *Statistics*

Note: 1). It is desirable that softwares should be used for demonstrating visual, graphical and application oriented approaches.

2) Use of Open Office/Star Office is recommended, as they are freely downloadable.

Reference manual for Open Office available at: <http://www.openoffice.org> and

Reference manual for Star Office available at: <http://www.sun.com/software/staroffice/>

SEMESTER - VI
PAPER-601
GENETICS AND GENOMICS II

THEORY

Unit I

Genetic Analysis and Mapping in Bacteria and Bacteriophages

Conjugation; Transformation; Transduction, Recombination.

Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses

Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in *Drosophila*; Uses of transposons; Eukaryotic Viruses.

Unit II

Developmental Genetics and Model System

Study of model systems in developmental genetics-*Drosophila melanogaster*, *Sachharomyces cerevisiae*, *Caenorhabditis elegans*, *Arabidopsis thaliana*, and *Xenopus laevis*.

Genomics

Genomes of bacteria, *Drosophila* and Human.

Unit III

Genomics, Bioinformatics and Proteomics

Human genome project; Evolution and Comparative Genomics.

Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification.

Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction.

Unit IV

Genomic Analysis- Dissection of Gene Function

Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology.

Population Genetics

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.

Evolutionary Genetics

Genetic variation and Speciation.

PRACTICALS

1. Genomic DNA isolation from *E.coli* (without plasmid).
2. Restriction enzyme digestion of genomic DNA from *E.coli*.
3. Isolation of plasmid DNA and genomic DNA together from *E.coli* and restriction enzyme digestion.
4. Restriction enzyme digestion (*EcoR* I) of genomic and plasmid DNA (obtained from Expt.3).
5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
6. Construction of Restriction digestion maps from data provided.
7. Demonstration of DNA fingerprinting.

SUGGESTED BOOKS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *i* Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
7. Introduction to Genetic Analysis. Griffiths, A.J.F., Wessler, S.R., Lewontin R.C. and Carroll, S.B. IX Edition.
8. Ghosh, Z. and Mallick, V. (2008). Bioinformatics-Principles and Applications. Oxford Univ. Press

SEMESTER - VI
PAPER-602
APPLIED ZOOLOGY

THEORY

Unit I

Human Diseases

Epidemiology of infectious diseases, transmission, prevention and control of diseases: Tuberculosis, Dengue, Malaria, and Swine flu.

Brief account of *Rickettsia*, *Borellia*, *Treponema* and *Leptospira*.

Life history and pathogenicity of *Faciolopsis buski*, *Schistosoma*, *Ancylostoma duodenale* and *Wuchereria bancrofti*.

Unit II

Reproductive health & human welfare

Implantation and placental physiology in pregnancy; placental secretions and their regulation; Parturition; Lactation;

Infertility in male and female: cause, diagnosis and management

Assisted Reproductive Technology, Sex selection, sperm banks, frozen embryos, *in vitro* fertilization, ET, IFT, IUT, ZIFT, GIFT, ICSI, PROST.

Modern contraceptive technologies; Demographic terminology used in family planning.

Unit III

Applied Entomology

Bionomics and control of crop pests: *Earias vittella*, *Pectinophora gossypiella*, *Heliothis armigera*.

Bionomics of the following stored grain pests and their management for control: *Corcyra cephalonica*, *Trogoderma granarium*, *Callosobruchus chinensis*.

Classification of insect control with reference to chlorinated hydrocarbons, organophosphates, carbamates and synthetic pyrethroid.

General aspects of Integrated Pest Management (IPM).

Unit IV

Economic Zoology

Zebrafish as a model for biotechnology.

Genetic improvements in aquaculture industry.

Induced breeding and transportation of fish seed.

Outlines of apiculture, sericulture & Lac culture.

PRACTICALS

1. Study of permanent slides and specimen of protozoan, helminthes parasites and arthropod vectors associated with human diseases.
2. Study of slides of liver cirrhosis and its comparison with normal liver slides.
3. Study of modern contraceptive devices.
4. Visit to centers of proficiency in reproductive physiology.
5. Economic importance of the following insect pests based on identification of their adult: *Earias vittella*, *Heliothis armigera*, *Papilio demoleus*, *Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis*. Preparation of life cycles of these insect pests.
6. Study of damage caused by commonly occurring insect pests.
7. Study of beneficial insects, their life stages and products.
8. Maintenance of freshwater aquarium.

SUGGESTED BOOKS

1. Park, K. (2007) Preventive and social medicine. XVI Edition. B.B Publisher.
2. Arora, D.R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributers.
3. Chaudhury, S.K. (1996) Practice of fertility Control, A Comprehensive Textbook. B.I.Churchill Livingston Pvt Ltd, India.
4. Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher.
5. Hafez, E. S. E. and Evans, T. N. (1973). Human Reproduction: Contraception and Conception. Harper and Row, New York.
6. Atwal, A. S. (1993) Agricultural Pests of India and South East Asia. Kalyani Publishers, New Delhi.
7. Pradhan, S (1983) Insect Pests of Crops. National Book Trust, India.
8. Prost, P.J. (1962) Apiculture. Oxford and IBH, New Delhi.
9. Knobil, E. & Neill, J.D. (2006) The Physiology of Reproduction, Vol. 2, Elsevier Pub.
10. Srivastava, C.B.L. (1999) Fishery Science and Indian Fisheries. Kitab Mahal publications, India.
11. Dunham R.A. (2004) Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.

SEMESTER - VI
PAPER-603
IMMUNOLOGY-II

THEORY

Unit I

Major Histocompatibility Complex

Structure, polymorphism and functions, MHC and immune responsiveness.

Unit II

Antigen Processing and Presentation

The cytosolic pathway: endogenous pathway and the endocytic pathway and exogenous pathway.

Immune Effectors Mechanisms

Cytokines: properties and functions, general structure of cytokine receptors, Complement system: components, activation and functions.

Unit III

Hypersensitivity

Gell and Coombs classification, IgE mediated (type I), antibody mediated (type II), Immune complex mediated (type III) and T-DTH mediated hypersensitivity (type IV).

Unit IV

Immune System in Health & Disease

Vaccines: bacterial, viral, toxoid and III generation vaccines, Immunodeficiency-SCID, AIDS etc, Autoimmunity.

PRACTICALS

1. Viability and cell counting of peritoneal macrophages.
2. Immunoelectrophoresis.
3. To perform Enzyme-linked immunosorbent assay (ELISA)
4. To raise antisera against any antigen

SUGGESTED BOOKS

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., Kuby, J. (2006). VI Edition. Immunology. W.H. Freeman and Company.
2. Delves, P. J., Martin, S. J., Burton, D. R., Roitt, I.M. (2006). XI Edition. Roitt's Essential Immunology, Blackwell Publishing

SEMESTER - VI
PAPER-604
ANIMAL BIOTECHNOLOGY

THEORY

Unit I

Introduction

Concept and scope of biotechnology, Tools and techniques in biotechnology.

Animal Cell and Tissue Culture

Cell culture media (natural and defined), Preparation and sterilization, Primary cell culture, Cell lines, Pluripotent stem cells, Cryopreservation of cultures.

Unit II

Molecular Techniques in Gene manipulation

Introduction to the concept of Recombinant DNA Technology, Cloning vectors, Restriction and modifying enzymes, Transformation techniques (microbial, plants and animals), Construction and screening of DNA libraries, Agarose and Polyacrylamide Gel Electrophoresis, Molecular analysis of DNA, RNA and Proteins (i.e. Southern, Northern and Western blotting), DNA sequencing (Maxam-Gilbert and Sanger methods), Polymerase chain reaction and DNA microarrays.

Unit III

Transgenic Animal Technology

Production of transgenic animals-nuclear transplantation, Retroviral method, DNA microinjection method, Applications of transgenic mice, fish, & Dolly, Scientific significance, Therapeutic applications, Human cloning, Ethical issues of transgenic animals.

Patenting & Biosafety

Intellectual property rights, Biosafety levels and guidelines.

Unit IV

Applications of Biotechnology

Molecular diagnosis of genetic diseases (Cystic fibrosis, Huntington's disease, Sickle cell anemia), RFLP, RAPD and DNA fingerprinting, Vaccines and therapeutic agents, Recombinant DNA in medicines (recombinant insulin and human growth hormone), Gene therapy, Enzymes in detergents and leather industries, Heterologous protein production, Bioremediation.

PRACTICALS

1. Transformation of *E.coli* (pUC 18/19) and calculation of transformation efficiency.
2. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).
3. Restriction digestion of lambda (λ) DNA using *EcoR* I and *Hind* III.
4. DNA ligation (lambda DNA *EcoR*I/*Hind* III digested).
5. Restriction digestion (pUC 18/19) with *EcoR*I and ligation of linear pUC 18/19 DNA with *EcoR*I -digested lambda (λ) DNA.
6. Transformation with ligated DNA in *E.coli* and selection of transformants on X-gal and IPTG.
7. Separation of proteins by SDS-PAGE.
8. To perform dry lab experiments using data to demonstrate the significance of various enzymes like alkaline phosphatase, frequent cutters etc.

SUGGESTED BOOKS

1. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
2. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
3. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.
4. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M., (1983) Recombinant DNA. II Edition. Freeman and Co., N.Y., USA.
5. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
6. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California, USA.

SEMESTER - VI
PAPER-605

THEORY

Unit I

Introduction

History, Anatomical tradition, Principles of development-life cycles, Developmental patterns and evolution of differentiation,

Early Embryonic Development

Gametogenesis- Spermatogenesis and oogenesis, Types of eggs, Fertilization- changes in gametes, mono- and polyspermy; The early development of *C. elegans*; The early development of *Xenopus*- cleavage, Gastrulation, Embryonic induction and organizers; The early development of chick-cleavage, Gastrulation.

Unit II

Later Embryonic Development

Differentiation of germ layers- Formation of neural tube (development of CNS and eye), skin, notochord, somites, coelom and digestive tube (upto rudiments), Extra-embryonic membranes in birds and human, Implantation of embryo, placentation – structure, types and physiology of placenta.

Unit III

Post-Embryonic Development

Metamorphosis- changes and hormonal regulation of metamorphosis in insects and amphibians, Regeneration- modes of regeneration-epimorphosis, Morphallaxis and compensatory regeneration (with one example), Ageing- concepts and model (*C. elegans*)

Unit IV

Implications of Developmental Biology

Medical implications: Infertility –Diagnosing Infertility, IVF, Teratogenesis – teratogenic agents and effect of teratogens on embryonic development

Experimental embryology, Role of genes in development, Amniocentesis.

PRACTICALS

1. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole.
2. Chick - Study of developmental stages - primitive streak, 21h, 24h, 28h, 33h, 36h, 48h, 72h, 96h (H.H. stages) by raising chick embryo in the laboratory.
3. *Drosophila* -Study the developmental stages and the life cycle from fruit fly stock culture.
4. Sections of placenta.
5. Examination of frog/rat sperm and ova.

SUGGESTED BOOKS

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press .
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.