

B.Sc. (H) ZOOLOGY

**THREE-YEAR FULL-TIME PROGRAMME
(Six-Semester Course)**



COURSE CONTENTS

(Effective from the Academic Year 2010-2011)

UNIVERSITY OF DELHI

DELHI – 110 007

Course Structure

YEAR-1

PART I: Semester – 1

Paper 1	LSPT 101	Biology-I(Introduction to Biology)
Paper 2	ZOHT 101	Biodiversity I: Non-Chordata
Paper 3	CHCT 301	Chemistry-I
Paper 4	ENAT 101*/ CSAT 101*	Technical Writing and Communication in English / Computational skills

PART I: Semester – 2

Paper 5	ZOHT 202	Biodiversity II: Chordata-I
Paper 6	ZOHT 203	Biodiversity III: Chordata-II
Paper 7	CHCT 402	Chemistry -II
Paper 8	ENAT 201*/ CSAT 201*	Technical writing and Communication in English / Computational skills

***The college will have an option to take either of the two papers in a particular semester for a particular course, while students have to appear in both the papers**

In addition, there shall be one qualifying paper in self-learning mode called Environmental Studies offered in Semester-2

YEAR-2

PART II: Semester – 3

Paper 9	ZOHT 304	Animal Physiology and Functional Histology -I
Paper 10	MACT 303	Mathematics and Statistics
Paper 11	CBHT 301	Cell Biology - I
Paper 12	MBHT 301	Molecular Biology - 1

PART II: Semester – 4

Paper 13	ZOHT 405	Animal Physiology and Functional Histology-II
Paper 14	ZOHT 406	Biochemistry
Paper 15	CBHT 402	Cell Biology II
Paper 16	MBHT 402	Molecular Biology - II

YEAR-3**PART III: Semester – 5**

Paper 17	ZOHT 507	Immunology
Paper 18	ZOHT 508	Ecology
Paper 19	ZOHT 509	Developmental Biology
Paper 20	GGHT 501	Genetics & Genomics -I

PART III: Semester – 6

Paper 21	ZOHT 610	Evolutionary Biology
Paper 22	ZOHT 611	Biotechnology
Paper 23a/b/c	ZOHT 612 / LSPT 409/ BTHT 509	Applied Zoology/Bioinformatics/ Environmental Management
Paper 24	GGHT602	Genetics & Genomics - II

PREAMBLE

The ongoing B.Sc. (H) Zoology course was introduced by the Faculty of Sciences from the academic year 2005-2006. The new course that will be effective from the academic year 2010-2011, will follow the Semester mode. It has been prepared keeping in view the unique requirements of B.Sc. (H) Zoology students.

The contents have been drawn-up to accommodate the widening horizons of the discipline of Biological Sciences. They reflect the current changing needs of the students; specifically, the subjects on Mathematics and Statistics and Computation skills have been included. A special feature of this program has been the introduction of six new papers on Cell & Molecular Biology and Genetics that cover major disciplines in newer areas of Biological Sciences where a tremendous progress has been made during the past decade. A new paper on Biotechnology will also provide a glimpse of the application aspect. While the endeavor is to provide the student with the latest, nevertheless the classical zoology has been given due weightage.

The course content also lists the new practical exercises so that the students get a hands-on experience of the latest techniques that are in current usage.

Paper 1-LSPT 101: BIOLOGY-I (INTRODUCTION TO BIOLOGY)

THEORY

Marks: 100

Unit 1: Biological systems, evolution and biodiversity

a. Introduction to concepts of biology

(Ch 1 Campbell)

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

(Ch 25 Campbell)

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

(Ch 25 Raven)

Kingdoms of Life –Prokaryotes, Eukaryotes, Archaea

d. Darwinian view of life and origin of species

(Ch22, 24 Campbell)

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

e. Genetic approach to Biology

(Ch 1 Griffiths)

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 2: Chemical context of living systems

a. Chemistry of life

(Ch 2 Campbell)

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

(Ch 3 Campbell)

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

c. Carbon and life

(Ch 4 Campbell)

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

d. Structure and function of biomolecules

(Ch 5 Campbell)

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

LSPP 101: INTRODUCTION TO BIOLOGY

PRACTICALS

Marks: 50

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

Paper 2-ZOHT 101: BIODIVERSITY-I “NON-CHORDATA”

THEORY

Marks: 100

General characters and outline classification of different phyla:

- Unit 1. Protozoa** (Ch 2 Barnes)
General characters and outline classification
Locomotion and reproduction in Protozoa.
- Unit 2. Metazoa** (Ch 3 Barnes)
Origin of metazoa, metamerism and coelom.
- Unit 3. Phylum Porifera** (Ch 4 Barnes)
General characters and outline classification
Structural organization of *Sycon*.
- Unit 4. Phylum Cnidaria** (Ch 5 Barnes)
General characters and outline classification
Polymorphism in Cnidarians; corals and coral reefs
- Unit 5. Phylum Platyhelminthes** (Ch 7 Barnes)
General characters and outline classification
Fasciola: life history; parasitic adaptations and evolution of parasitism
- Unit 6. Phylum Aschelminthes** (Ch 9 Barnes)
General characters and outline classification
Life history of *Ascaris* and its parasitic adaptations.
- Unit 7. Phylum Annelida** (Ch 10 Barnes)
General characters and outline classification
Adaptive radiations in Polychaeta.
- Unit 8. Phylum Arthropoda** (Ch 12, 13 Barnes)
General characters and outline classification.
Larval forms of crustacea; social life, moulting and metamorphosis in Insecta; vision in Arthropoda.
- Unit 9. Affinities of Onychophora**
- Unit 10. Phylum Mollusca** (Ch 11 Barnes)
General characters and outline classification
Torsion and detorsion; modifications of shell and foot
- Unit 11. Phylum Echinodermata** (Ch 19 Barnes)
General characters and outline classification
Water-vascular system and larval forms

ZOHP 101: BIODIVERSITY-I “NON-CHORDATA”

PRACTICALS

Marks: 50

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).

Annelida:

7. **Dissections:** digestive and nervous systems of earthworm.
8. **Temporary mounts:** Ovary, pharyngeal and septal nephridia of earthworm.
9. **Slides:** T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
10. **Specimens:** *Aphrodite*, *Heteronereis*, *Chaetopterus*, *Pheretima*, *Tubifex*, *Hirudinaria*.

Arthropoda:

11. **Dissections:** digestive and nervous systems of cockroach.
12. **Temporary mounts:** salivary glands and mouth parts of cockroach.
13. **Specimens/slides:** *Limulus*, spider, crustacean larvae, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, termite, louse, wasp, honeybee, silkworm and *Peripatus*.

Mollusca:

14. **Dissections:** digestive system of *Pila*; Temporary mounts- radula and gill of *Pila*.
15. **Specimens:** *Chiton*, *Dentalium*, *Unio*, *Ostrea*, *Teredo*, *Loligo*, *Sepia*, *Octopus* and *Nautilus*.

Echinodermata:

16. **Slides:** T. S. arm of *Pentaceros*, Echinoderm larvae.
17. **Specimens:** *Pentaceros*, *Ophiura*, *Clypeaster*, *Echinu*, *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.

Paper 3-CHCT 301: CHEMISTRY-1

THEORY

Marks: 100

Section A: Inorganic Chemistry

(30 Periods)

Unit 1 : Atomic Structure: *Recapitulation of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Need of a new approach to Atomic structure.*

What is Quantum mechanics? Time independent Schrodinger equation ($H\Psi = E\Psi$) and meaning of various terms in it. Significance of Ψ and Ψ^2 , Schrodinger equation for hydrogen atom in Cartesian coordinates (x,y,z). Need of polar coordinates, transformation of Cartesian coordinates (x,y,z) into polar coordinates (r,θ,φ). Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. (Only graphical representation), Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distances with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s . Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit 2: Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and hydration energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: *VB Approach* Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of, linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures.

Unit 3: Chemical Thermodynamics

What is thermodynamics? State of a system, state variables, intensive and extensive variables, concept of heat and work, thermodynamic equilibrium, thermodynamic properties, various types of systems and processes. First Law of thermodynamics. Calculation of work (w), heat (q), changes in internal energy (ΔU) and enthalpy (ΔH) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w , q , ΔU and ΔH for processes involving changes in physical states. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution.

Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Various statements of Second Law of thermodynamics, Carnot cycle, concept of entropy, Gibbs free energy and Helmholtz energy, Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity. Gibbs - Helmholtz equation. Maxwell's relations. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit 4: Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect, Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts - applications of solubility product principle. Qualitative treatment of acid base titration curves (calculation of pH at various stages of HCl –NaOH titration only). Theory of acid – base indicators.

Section A: Inorganic Chemistry

Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO_4 .
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .
4. Estimation of Fe(II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
5. Estimation of Cu(II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$.
6. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.

Section B: Physical Chemistry

(I) Surface tension measurement (use of organic solvents excluded)

Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

(II) Viscosity measurement (use of organic solvents excluded)

Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

(III) Kinetic studies

Study of the kinetics of the following reaction by integrated rate method: Acid hydrolysis of methyl acetate with hydrochloric acid volumetrically

SUGGESTED BOOKS

1. Barrow, G. M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J. C., Treichel, P. M. & Townsend, J. R. *General Chemistry* Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. Mahan, B. H. *University Chemistry* 3rd Ed. Narosa (1998).
5. J. D. Lee : *A new Concise Inorganic Chemistry*, E L. B. S.
6. F. A. Cotton & G. Wilkinson : *Basic Inorganic Chemistry*, John Wiley.
7. Douglas, McDaniel and Alexander : *Concepts and Models in Inorganic Chemistry*, John Wiley.
8. James E. Huheey, Ellen Keiter and Richard Keiter : *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
11. Vogel's Qualitative Inorganic Analysis, A.I. Vogel , Prentice Hall ,7th Edition.
12. Vogel's Quantitative Chemical Analysis, A.I. Vogel , Prentice Hall ,6th Edition.
13. Senior Practical Physical Chemistry, B.D.Khosla, R. Chand & Co.

**Paper 4/8-ENAT 101/201: TECHNICAL WRITING AND
COMMUNICATION IN ENGLISH**

Marks: 100

Unit 1

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

Unit 2

Writing Skills; Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

Unit 3

Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.

SUGGESTED READINGS

1. M. Frank. Writing as thinking: *A guided process approach, Englewood Cliffs*, Prentice Hall Regents.
2. L. Hamp-Lyons and B. Heasley: Study Writing; *A course in written English*. For academic and professional purposes, Cambridge Univ. Press.
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik: *A comprehensive grammar of the English language*, Longman, London.
4. Daniel G. Riordan & Steven A. Panley: “*Technical Report Writing Today*” - Biztantra.

Additional Reference Books

5. Daniel G. Riordan, Steven E. Pauley, Biztantra: *Technical Report Writing Today*, 8th Edition (2004).
6. *Contemporary Business Communication*, Scot Ober, Biztantra, 5th Edition (2004).

Paper 4/8-CSAT 101/201: COMPUTATIONAL SKILLS

THEORY

Marks: 100

Computer Fundamentals

(12 Periods)

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

(8 Periods)

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

Networks terminology

(4 Periods)

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

Multimedia

(4 Periods)

Introduction, Characteristics, Elements, Applications

Problem Solving

(10 Periods)

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

General Awareness

(4 Periods)

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

CSAP 101/201: COMPUTATIONAL SKILLS

PRACTICALS

Marks: 50

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.

SUGGESTED BOOKS

[1] V Rajaraman, **Fundamentals of Computers**, Fourth Edition, PHI.

[2] Anita Goel, **Fundamentals of Computers**; Forthcoming title in Pearson-Education

Note: Use of Open Office/Star Office is recommended, as they are freely downloadable.

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

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

Paper 5-ZOHT 202: BIODIVERSITY-II “CHORDATA (I)”

THEORY

Marks: 100

General account of Chordates:

Unit 1. Chordates

(Ch 17 Hall & Hallgrimsson)

Introduction and origin.

Unit 2. Protochordates

(Ch 2 Kent)

General features and Phylogeny of Hemichordates, Urochordates and Cephalochordates. Retrogressive metamorphosis.

Unit 3. Agnatha

(Ch 2 Young)

General features of living Agnatha and classification upto classes.

Unit 4. Pisces

(Ch 5 Young)

Classification of Placodermi upto subclasses, Chondrichthyes upto suborders and Osteichthyes upto orders. Osmoregulation, Migration and Parental care.

Unit 5. Amphibia

(Ch 13 Young)

Classification upto orders.

Origin and evolution of terrestrial ectotherms, Parental care.

Unit 6. Reptiles

(Ch 15 Young)

Classification upto orders.

Origin, Poisonous and non- poisonous snakes in India, Biting mechanism in snakes, Affinities of *Sphenodon*.

Unit 7. Aves

(Ch 18 Young)

Classification upto orders.

Origin, Flight adaptations, Mechanism of flight and Migration.

Unit 8. Mammals

(Ch 19 Young)

Classification upto orders.

Origin of Mammals.

Comparative Anatomy

Unit 9. Integument

(Ch 5 Kent)

Structure and derivatives of integument.

Unit 10. Digestive System

(Ch 11 Kent)

Alimentary canal and associated glands.

ZOHP 202: BIODIVERSITY-II “CHORDATA (I)”

PRACTICALS

Marks: 50

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*, *Cirrihina*, *Heteropneustes*, *Mystus*, *Exocoetus*.
Dissections: Afferent branchial system, V, VII, IX and Xth 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 Delhi
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 Hallgrímsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers, Inc.

Paper 6-ZOHT 203: BIODIVERSITY-III “CHORDATA (II)”

THEORY

Marks: 100

Comparative Anatomy of Chordates:

Unit 1. Respiratory system

(Ch 12 Kent)

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

Unit 2. Circulatory System

(Ch 13 Kent)

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

Unit 3. Skeleton System

(Ch 9 Kent)

Axial and appendicular skeleton, Jaw suspensorium and Visceral arches.

Unit 4. Nervous System

(Ch 15 Kent)

Central & Autonomic Nervous System, Cranial nerves.

Unit 5. Sense Organs

(Ch 16 Kent)

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

Unit 6. Urinogenital System

(Ch 14 Kent)

Succession of kidney, Evolution of urinogenital ducts.

ZOHP 203: BIODIVERSITY-III “CHORDATA (II)”

PRACTICALS

Marks: 50

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

Dissections:

1. Arterial, venous and urinogenital system of frog
2. 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.

Paper 7-CHCT-402: CHEMISTRY-2

THEORY

Marks: 100

Section A: Basic Organic Chemistry

(30 Periods)

Unit 1: Fundamentals of Organic Chemistry

Concept of hybridization of carbon. Cleavage of a covalent bond: homolysis and heterolysis.

Electronic effects and their applications (inductive, electromeric, hyperconjugation and resonance). Structure and stability of reactive intermediates (carbocations, carbanions and free radicals). Relative strength of carboxylic acids (aliphatic, aromatic and halo-substituted aliphatic), alcohols, phenols and nitro-phenols. Relative basic strength of amines (aliphatic and aromatic) Intermolecular and intramolecular forces: types of intermolecular forces and their characteristics (ion-dipole, dipole-dipole, dipole-induced dipole and dispersion forces). Intermolecular and intramolecular hydrogen bonding. Effect of intermolecular and intramolecular forces on properties such as solubility, vapour pressure, melting and boiling points of organic compounds.

Unit 2: Stereochemistry

Conformations w.r.t. ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds) . Threo and erythro; D and L; *cis - trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Section B: Chemistry of Biomolecules

(30 Periods)

Unit 3: Carbohydrates

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Unit 4: Amino Acids, Peptides and Proteins

Preparation of Amino Acids: Strecker synthesis, using Gabriel's phthalimide synthesis.

Zwitter ion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of -COOH group, acetylation of -NH_2 group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

CHCP 402: CHEMISTRY-2

PRACTICALS

Marks: 50

Organic Chemistry

1. Detection of extra elements (N,S,Cl,Br,I) in organic compounds (containing up to two extra elements).
2. Systematic **Qualitative Organic Analysis** of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1° amines) and preparation of one derivative.

SUGGESTED BOOKS

1. T. W. Graham Solomons : *Organic Chemistry, John Wiley and Sons.*
2. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry, S. Chand.*
3. E. L. Eliel: *Stereochemistry of Carbon Compounds, Tata McGraw Hill.*
4. I. L. Finar: *Organic Chemistry (Vol. I & II), E. L. B. S.*
5. R. T. Morrison & R. N. Boyd: *Organic Chemistry, Prentice Hall.*
6. Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
7. Practical Organic Chemistry, Mann F. G. & Saunders B. C, Orient Longman, 1960.

Paper 9-ZOHT 304: ANIMAL PHYSIOLOGY AND FUNCTIONAL HISTOLOGY -I

(With reference to human)

THEORY

Marks: 100

Unit 1. Tissues and Glands

(Ch 4, Tortora & Grabowski)

Concepts and classification- Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue and Types of glands.

Unit 2. Bone

(Ch 6, Tortora & Grabowski)

Structure and types, Ossification, bone growth, resorption and bone disorders.

Unit 3. Nervous System

(Ch 12, 17, Tortora & Grabowski)

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, Neuromuscular junction; Reflex activity-reflex arc; Types of reflexes, Physiology of hearing and vision.

Unit 4. Muscle

(Ch 6, 7, Guyton & Hall/ Ch 10, Tortora & Grabowski)

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 5. Reproductive System

(Ch 28, Tortora & Grabowski)

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

Unit 6. Endocrine System

(Ch 18, Tortora & Grabowski)

Histology and functions of endocrine glands; Nature of hormones; Regulation of hormone secretion; Mode of action of hormones, Signal transduction pathways utilized by steroidal and nonsteroidal hormones; 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.

ZOHP 304: ANIMAL PHYSIOLOGY AND FUNCTIONAL HISTOLOGY -I

PRACTICALS

Marks: 50

1. Recording of simple muscle twitch with electrical stimulation.
2. Demonstration of the knee jerk reflex.
3. Preparation of temporary mounts: Squamous epithelium, Ciliated epithelium, Striated muscle fibres and nerve cells.
4. Examination of sections of Mammalian skin, Cartilage, Bone, Pancreas, Testis, Ovary, Pituitary, Adrenal, Thyroid, Parathyroid.
5. Preparation of permanent slide of any five mammalian tissues- Microtomy.

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.

Paper 10-MACT 303: MATHEMATICS AND STATISTICS

Marks: 100

Unit 1

(24 Periods)

Sets. Functions and their graphs : polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Intuitive idea of algebraic relationships and convergence. Infinite Geometric Series. Series formulas for e^x , $\log(1+x)$, $\sin x$, $\cos x$. Step function. Intuitive idea of discontinuity, continuity and limits. Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

Unit 2

(14 Periods)

Points in plane and space and coordinate form. Examples of matrices inducing Dilation, Rotation, Reflection and System of linear equations. Examples of matrices arising in Physical, Biological Sciences and Biological networks. Sum and Product of matrices upto order 3.

Unit 3

(20 Periods)

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

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.

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

Paper 11-CBHT 301: CELL BIOLOGY-I

THEORY

Marks: 100

Unit 1. An Overview of Cells

(Ch 1 Cooper *et al.*/ Ch 1 Karp)

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

Unit 2. Tools and techniques of Cell Biology

(Ch 1 Cooper *et al.*/ Ch 18 Karp/ Ch 3 De Robertis)

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

Analytical-Flow cytometry- fluochromes, 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 3. Composition of Cells

(Ch 2 Cooper *et al.*)

Molecules of cell, cell membranes and cell Proteins.

Unit 4. The Nucleus

(Ch 9 Cooper *et al.*)

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

Unit 5. Protein Sorting and Transport

(Ch 10 Cooper *et al.*)

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

Unit 6. Mitochondria, Chloroplasts and Peroxisomes

(Ch 11 Cooper *et al.*)

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

Unit 7. Cytoskeleton and Cell Movement

(Ch 12 Cooper *et al.*)

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

CBHP 301: CELL BIOLOGY-I

PRACTICALS

Marks: 50

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. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th 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. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Paper 12-MBHT 301: MOLECULAR BIOLOGY-I

THEORY

Marks: 100

Unit 1. Nucleic Acids convey Genetic Information

(Ch 2 Watson)

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

Unit 2. The Structures of DNA and RNA / Genetic Material

(Ch 6 Watson/ Ch 18 Becker)

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 3. Genome Structure, Chromatin and the Nucleosome

(Ch 7 Watson/ Ch 18 Becker)

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 4. The Replication of DNA (Prokaryotes and Eukaryotes)

(Ch 8 Watson/ Ch 19 Becker)

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), Θ (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

Unit 5. The Mutability and Repair of DNA

(Ch 9 Watson)

Replication Errors, DNA Damage and their repair.

MBHP 301: MOLECULAR BIOLOGY-I

PRACTICALS

Marks: 50

1. Preparation of Polytene chromosome from *Chironomous* 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. 6th edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th 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. 7th 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 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.

**Paper 13-ZOHT 405: ANIMAL PHYSIOLOGY AND FUNCTIONAL
HISTOLOGY -II
(With reference to Human)**

THEORY

Marks: 100

Unit 1. Digestive System

(Ch 64-66, Guyton & Hall)

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; Disorders of the digestive system.

Unit 2. Respiratory System

(Ch 23, Tortora & Grabowski)

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 3. Excretory System

(Ch 26, 27, Tortora & Grabowski)

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

Unit 4. Blood

(Ch 32, 36, Guyton & Hall)

Composition; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis; Coagulation of blood; Disorders of blood.

Unit 5. Heart

(Ch 20 Tortora & Grabowski)

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.

ZOHP 405: ANIMAL PHYSIOLOGY AND FUNCTIONAL HISTOLOGY -II

PRACTICALS

Marks: 50

1. Enumeration of red blood cells using haemocytometer.
2. Estimation of haemoglobin using Sahli's haemoglobinometer.
3. Preparation of haemin and haemochromogen crystals.
4. Enumeration of total and differential count of white blood cells.
5. Recording of frog's heart beat *in situ* and with perfused heart.
6. Recording of blood pressure using a sphygmomanometer
7. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, spleen, trachea, lung, kidney.

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.

Paper 14-ZOHT 406: BIOCHEMISTRY

THEORY

Marks: 100

Unit 1. Carbohydrates:

(Ch 11, Stryer)

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

Unit 2. Lipids:

(Ch 12, Stryer)

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

Unit 3. Amino acids and Proteins

(Ch 2, Stryer)

Structure and general properties of amino acids, Four levels of structures in proteins

Unit 4. Carbohydrate Metabolism

(Ch 16,17,20,21, Stryer)

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

Unit 5. Lipid Metabolism

(Ch 22, 26, Stryer)

Biosynthesis and β -oxidation of saturated fatty acids, Ketogenesis, Types and properties of lipoproteins.

Unit 6. Protein Metabolism

(Ch 23, Stryer)

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

Unit 7. Intermediary metabolism

(Ch 27, Stryer)

Inter-relationship of carbohydrates, lipid and protein metabolism.

Unit 8. Enzymes

(Ch 8, Stryer)

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

Unit 9. Oxidative Phosphorylation

(Ch 18, Stryer)

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

ZOHP 406: BIOCHEMISTRY

PRACTICALS

Marks: 50

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.

Paper 15-CBHT 402: CELL BIOLOGY-II

THEORY

Marks: 100

Unit 1. The Plasma Membrane

(Ch 13 Cooper *et al.*)

Structure; Transport of small molecules, Endocytosis

Unit 2. Cell Wall, the Extracellular Matrix and Cell Interactions

(Ch 14 Cooper *et al.*)

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

Unit 3. Cell Signaling

(Ch 15 Cooper *et al.*)

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

Unit 4. The Cell Cycle

(Ch 16 Cooper *et al.*)

Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization.

Unit 5. Cell Death and Cell Renewal

(Ch 17 Cooper *et al.*)

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

Unit 6. Cancer

(Ch 18 Cooper *et al.*)

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

CBHP 402: CELL BIOLOGY-II

PRACTICALS

Marks: 50

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. 6th edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th 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. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Paper 16-MBHT 402: MOLECULAR BIOLOGY-II

THEORY

Marks: 100

Unit 1. Mechanism of Transcription

(Ch 12 Watson/ Ch 21 Becker)

RNA Polymerase and the transcription unit

Transcription in Prokaryotes

Transcription in Eukaryotes

Unit 2. RNA Modifications

(Ch 13 Watson)

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

Unit 3. Translation (Prokaryotes and Eukaryotes)

(Ch 14 Watson/ Ch 22 Becker/ Ch 21 DeRobertis)

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

Translation-dependent regulation of mRNA and Protein Stability.

Unit 4. Transcription Regulation in Prokaryotes

(Ch 16 Watson)

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

Unit 5. Transcription Regulation in Eukaryotes

(Ch 17 Watson)

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

Unit 6. Regulatory RNAs

(Ch 18 Watson)

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

MBHP 402: MOLECULAR BIOLOGY-II

PRACTICALS

Marks: 50

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. 6th edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. 8th 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. 7th 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 (6th edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

Paper 17-ZOHT 507: IMMUNOLOGY

THEORY

Marks: 100

Unit 1. Overview of Immune system

(Ch 1, Kindt *et al.*)

Historical perspective of Immunology, Early theories of Immunology.

Unit 2. Components of immune system

(Ch 1- 3, Kindt *et al.*/ Ch 1- 2, Delves *et al.*)

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

Unit 3. Cells and Organs of the Immune System

(Ch 2, Kindt *et al.*/ Ch 2, Delves *et al.*)

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

Unit 4. Antigens

(Ch 4, Kindt *et al.*/ Ch 3-5, Delves *et al.*)

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

Unit 5. Immunoglobulins

(Ch 5, Kindt *et al.*/ Ch 6, Delves *et al.*)

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

Unit 6. Major Histocompatibility Complex

(Ch 8 Kindt *et al.*/ Ch 6 Delves *et al.*)

Structure, polymorphism and functions, MHC and immune responsiveness.

Unit 7. Antigen Processing and Presentation

(Ch 6, 8 Kindt *et al.*/ Ch 5 Delves *et al.*)

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

Unit 8. Immune Effectors Mechanisms

(Ch 12 Kindt *et al.*/ Ch 9 Delves *et al.*)

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

Unit 9. Hypersensitivity

(Ch 15 Kindt *et al.*/ Ch 15 Delves *et al.*)

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 10. Immune System in Health & Disease

(Ch 18,19 Kindt *et al.*/ Ch 13,18 Delves *et al.*)

Vaccines: bacterial, viral, toxoid and III generation vaccines, Immunodeficiency, Autoimmunity.

ZOHP 507: IMMUNOLOGY

PRACTICALS

Marks: 50

1. Dissection and display of lymphoid organs.
2. Ouchlerlony'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.
6. Viability and cell counting of peritoneal macrophages.
7. Immunoelectrophoresis.
8. To perform Enzyme-linked immunosorbent assay (ELISA) (no quantification required).

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

Paper 18-ZOHT 508: ECOLOGY

THEORY

Marks: 100

Unit 1. Introduction to Ecology

(Ch-1 Krebs/ Ch-1 Colinvaux/ Ch-1, 8 Odum)

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

Unit 2. Ecosystem, Biome, Biosphere and Ecosphere

(Ch-3, 7 Krebs/ Ch-5 Odum)

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 3. Population

(Ch-3, 7 Krebs/ Ch-5 Odum)

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.

Unit 4. Population growth

(Ch-7 Odum/ Ch-6 Colinvaux)

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

Unit 5. Population Growth regulation

(Ch-6 Colivaux/ Ch-7, 8 Odum)

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 6. Ecosystem and Community

(Ch-9 Ricklefs)

Definition, Types and examples of ecosystem- terrestrial (grassland) and aquatic (pond).

Unit 7. Community

(Ch-10, 11, 26, 27, 28 Ricklefs/ Ch-2 Colivaux/ Ch-15 Odum)

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. Application of the study of ecology in wild life conservation and sustainable development.

ZOHP 508: ECOLOGY

PRACTICALS

Marks: 50

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. Colinvaux, 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

Paper 19-ZOHT 509: DEVELOPMENTAL BIOLOGY

THEORY

Marks: 100

Unit 1. Introduction

(Ch 1- 2, Gilbert)

History, Anatomical tradition, Principles of development-life cycles, Developmental patterns and evolution of differentiation, Experimental embryology, Role of genes in development, Amniocentesis.

Unit 2. Early Embryonic Development

(Ch 8, 11, Gilbert)

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 3. Later Embryonic Development

(Ch 12, 14, 15, Gilbert)

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

Unit 4. Post-Embryonic Development

(Ch 18, Gilbert)

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 5. Implications of Developmental Biology

(Ch 21, Gilbert)

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

ZOHP 509: DEVELOPMENTAL BIOLOGY

PRACTICALS

Marks: 50

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.

Paper 20-GGHT 501: GENETICS AND GENOMICS-I

THEORY

Marks: 100

Unit 1. Introduction to Genetics

(Ch 1 Klug and Cummings)

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

Unit 2. Mitosis and Meiosis

(Ch 2 Klug and Cummings)

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

Unit 3. Mendelian Genetics and its Extension

(Ch 3-4 Klug and Cummings)

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

Unit 4. Linkage, Crossing Over and Chromosomal Mapping (Ch 5 Klug and Cummings, Ch 7 Gardner)

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.

Unit 5. Mutations

(Ch 8 Klug and Cummings/ Ch 11 Gardner)

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.

Unit 6. Sex Determination

(Ch 7 Klug and Cummings)

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

Unit 7. Extrachromosomal Inheritance

(Ch 9 Klug and Cummings/ Ch 20 Gardner)

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

Unit 8. Quantitative Genetics

(Ch 25 Klug and Cummings/ Ch 21, Gardner)

Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

GGHP 501: GENETICS AND GENOMICS-I

PRACTICALS

Marks: 50

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). *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. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis. W. H. Freeman and Co.

ADDITIONAL READINGS

Both students as well as teachers of genetics can further benefit from knowledge of following topics as given below-

- **Epigenetics-** <http://www.nature.com/nrg/focus/epigenetics/index.html>
- **Tetrad Analysis in fungi**
- **Centromere Mapping**
- **Cytogenetic Mapping**

Paper 21-ZOHT 610: EVOLUTIONARY BIOLOGY

THEORY

Marks: 100

Unit 1. Introduction

Lamarckism, Darwinism, Neo-Darwinism.

(Ch 1-2, Hall and Hallgrimsson)

Unit 2. Life's beginning

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

(Ch 6-8, Hall and Hallgrimsson)

Unit 3. Evidences of evolution

Paleontological evidences.

Molecular evidences, Phylogeny of horse

(Ch 3, Hall and Hallgrimsson)

Unit 4. Process of evolutionary change

Organic variations

Population genetics

Natural selection

(Ch 5- 7, Ridely)

Unit 5. Products of evolutionary change

Species concept

Isolating mechanisms and modes of speciation.

(Ch 13-14, Ridely)

Unit 6. Extinction and mass extinction

(Ch 23, Ridely)

Unit 7. Origin and evolution of man

(Ch 25, Barton)

Unit 8. Phylogenetic trees

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

(Ch 15, Ridely/ Ch 1, Pevsner)

ZOHP 610: EVOLUTIONARY BIOLOGY

PRACTICALS

Marks: 50

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

Paper 22-ZOHT 611: BIOTECHNOLOGY

THEORY

Marks: 100

Unit 1. Introduction

(Ch 1-3, Glick & Pasternak)

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

Unit 2. Animal Cell and Tissue Culture

(Ch 3-5, Butler)

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

Unit 3. Molecular Techniques in Gene manipulation

(Ch 1, 3, 4 Glick & Pasternak)

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 4. Transgenic Animal Technology

(Ch 15, Glick & Pasternak)

Production of transgenic animals-nuclear transplantation, Retroviral method, DNA microinjection method, Applications of transgenic mice, sheep, goat, pig, birds and fish, Dolly and Polly, Scientific significance, Therapeutic applications, Human cloning, Ethical issues of transgenic animals.

Unit 5. Transgenic Plants

(Ch 14, Glick & Pasternak)

Production of transgenic plants: *Agrobacterium* mediated transformation, Microprojectile method of gene transfer, nuclear transplantation, Examples of transgenic plants (insecticide, herbicide and virus resistant plants).

Unit 6. Applications of Biotechnology

(Ch 8-10, 13, 17, Glick & Pasternak/ Ch 13, Griffith *et al*)

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.

Unit 7. Patenting & Biosafety

(Ch 19, Glick & Pasternak/ Ch 8, Brown)

Intellectual property rights, Biosafety levels and guidelines.

ZOHP 611: BIOTECHNOLOGY

PRACTICALS

Marks: 50

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 *EcoRI* and *Hind III*.
4. DNA ligation (lambda DNA *EcoRI/Hind III* digested).
5. Restriction digestion (pUC 18/19) with *EcoRI* and ligation of linear pUC 18/19 DNA with *EcoRI*-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.

Paper 23a- ZOHT 612: APPLIED ZOOLOGY

THEORY

Marks: 100

Unit 1. Human Diseases

(Ch 3, 5 Park /Arora & Arora)

Epidemiology of infectious diseases, transmission, prevention and control of diseases: Tuberculosis, Amoebiasis, 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*.

Histopathology of Liver Cirrhosis, Alcoholic cirrhosis, Biliary cirrhosis, Haemochromatosis and Wilson's disease.

Unit 2. Reproductive health & human welfare

(Hafes & Evans / Chaudhury/ Neill)

Implantation and placental physiology in pregnancy; placental secretions and their regulation; Parturition; Lactation; Health and Diseases during pregnancy.

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 3. Animal Husbandry

(Hafez)

Semen collection, Preservation and artificial insemination in cattle.

Induction of early puberty and synchronization of estrus in cattle.

Unit 4. Applied Entomology

(Atwal / Pradhan / Prost)

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*.

Outlines of apiculture, sericulture with emphasis on *Bombyx mori*; Lac culture.

Insect control: Mechanical, physical, cultural.

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

General aspects of Integrated Pest Management (IPM).

Unit 5. Fish Technology

(Dunham/ Srivastava)

Zebrafish as a model for biotechnology.

Genetic improvements in aquaculture industry.

Induced breeding and transportation of fish seed.

ZOHP 612: APPLIED ZOOLOGY

PRACTICALS

Marks: 50

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.

Paper 23b- LSPT 409: BIOINFORMATICS

THEORY

Marks: 100

Unit 1. Introduction to Bioinformatics

(Ch 1 Ghosh and Mallick / Ch 1 Pevsner)
(5 Periods)

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2. Databases in Bioinformatics

(Ch 3 Ghosh and Mallick / Ch 2 Pevsner)
(5 Periods)

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3. Biological Sequence Databases

(Ch 4 Ghosh and Mallick / Ch 4, 5 Pevsner)
(25 Periods)

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.

EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.

DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.

Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.

Swiss-Prot: Introduction and Salient Features.

Unit 4. Sequence Alignments

(Ch 6, 8 Ghosh and Mallick / Ch 6 Pevsner)
(10 Periods)

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5. Molecular Phylogeny

**(Ch 8 Ghosh and Mallick / Ch 7 Pevsner)
(8 Periods)**

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Unit 6. Applications of Bioinformatics

**(Ch 11 Ghosh & Mallick / Ch 20 Pevsner)
(7 Periods)**

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

LSPP 409: BIOINFORMATICS

PRACTICALS

Marks: 50

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

SUGGESTED BOOKS

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

Paper 23c- BTHT 509: ENVIRONMENTAL MANAGEMENT

THEORY

Marks: 100

Unit 1: Introduction:

(4 Periods)

Man as a biological species in the ecosystem; population increase; carrying capacity, exploitation of resources due to activities like agriculture, horticulture, urbanization and industrialization. **(Ch 1, 2 Miller)**

Unit 2: Public awareness of Environment issues:

(5 Periods)

Role of Government, NGO's, International organizations, treaties and conventions. Environmental movements. **(State of the World 2003, 2006, 2009)**

Unit 3: Natural resources:

(4 Periods)

Land, Water, Air, Bioresources and biodiversity.

Unit 4: Effect of human activities:

(14 Periods)

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. **(Singh *et al.*, MoEF Annual report, 2009)**

Unit 5: Sustainable Development:

(5 Periods)

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

Unit 6: Energy:

(6 Periods)

Conventional Fuel – wood, fossil fuels; Non-conventional or alternate sources - sun, wind, bio-energy, geothermal, ocean, hydrogen, nuclear. **(Miller)**

Unit 7: Conservation of resources**(10 periods)**

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. **(Singh et al., Sinha, Ghosh and Singh)**

Unit 8: Global environment change**(8 Periods)**

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. **(Miller, IPCC Report 2007, State of the World 2009)**

Unit 9: Environmental impact assessment**(2 Periods)**

Concept, aim and steps. **(MoEF Annual report, 2009)**

BTHP 509: ENVIRONMENTAL MANAGEMENT

PRACTICALS

Marks: 50

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.

Paper 24- GGHT 602: GENETICS AND GENOMICS II

THEORY

Marks: 100

Unit 1. Genetic Analysis and Mapping in Bacteria and Bacteriophages (Ch 6, Klug and Cummings/ Ch 5, Griffith *et al.*)

Conjugation, Transformation, Transduction, Recombination.

Unit 2. Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses (Ch 22, Klug and Cummings/ Ch 14, Griffith *et al.*)

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 3. Developmental Genetics and Model System (Ch 19, Klug and Cummings)

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

Unit 4. Genomics, Bioinformatics and Proteomics (Ch 21, Klug and Cummings/Ch 8-9, Russell/ Ch2, 3, 4 Ghosh, Z. and Mallick,V.)

Genomes of bacteria, *Drosophila* and Humans; 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 5. Genomic Analysis- Dissection of Gene Function (Ch 23, Klug and Cummings)

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

Unit 6. Population Genetics (Ch 27, Klug and Cummings)

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

Unit 7. Evolutionary Genetics (Ch 28, Klug and Cummings)

Genetic variation and Speciation.

GGHP 602: GENETICS AND GENOMICS II

PRACTICALS

Marks: 50

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 (*EcoRI*) 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. 8th edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. 2009 Principles of Genetics. 5th edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. 2009 Concepts of Genetics. 9th Edition. Benjamin Cummings.
4. Russell, P. J. 2009 Genetics- A Molecular Approach. 3rd 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. 2nd edition. John Wiley & Sons.
7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. 9th Edition. Introduction to Genetic Analysis.
8. Ghosh, Z. and Mallick, V. 2008 Bioinformatics-Principles and Applications. Oxford Univ. Press

SEMESTER SYSTEM AT THE UNDERGRADUATE LEVEL

Course of Study **B.Sc (Honours) Zoology**

Total number of papers: 24

Semester I

Paper 1
Biology-I
(Introduction to
Biology)

LSPT - 101

Paper 2
Biodiversity-I
Nonchordata

ZOHT - 101

Paper 3
Chemistry-I

CHCT - 301

Paper4
Technical writing &
Communication in
English/Computatio
nal Skills

ENAT – 101/
CSAT - 101

Semester II

Paper 5
Biodiversity-II
Chordata I

ZOHT - 202

Paper 6
Biodiversity-III
Chordata II

ZOHT - 203

Paper 7
Chemistry-II

CHCT - 402

Paper 8
Technical writing &
Communication in
English/Computatio
nal Skills

ENAT – 201/
CSAT - 201

Semester III

Paper 9
Animal Physiology
and Functional
Histology I

ZOHT - 304

Paper 10
Mathematics &
Statistics

MACT - 303

Paper 11
CELL BIOLOGY I

CBHT - 301

Paper 12
MOLECULAR
BIOLOGY-I
MBHT - 301

Semester IV

Paper 13
Animal Physiology
and Functional
Histology- II

ZOHT - 405

Paper 14
Biochemistry

ZOHT -406

Paper 15
CELL BIOLOGY II

CBHT - 402

Paper 16
MOLECULAR
BIOLOGY-II
MBHT - 402

Semester V

Paper 17
Immunology

ZOHT-507

Paper 18
Ecology

ZOHT -508

Paper 19
Developmental
Biology
ZOHT-509

ZOHT-509

Paper 20
GENETICS &
GENOMICS-I
GGHT-501

GGHT-501

Semester VI

Paper 21
Evolutionary
Biology

ZOHT - 610

Paper 22
Biotechnology

ZOHT-611

Paper 23
Applied Zoology/
Bioinformatics/
Environmental
Management
ZOHT-612
LSPT-409
BTHT-509

Paper 24
GENETICS &
GENOMICS-II
GGHT-602