

B.Sc. Life Sciences

PREAMBLE

B.Sc. Life Sciences

The ongoing B.Sc. Life Sciences course was introduced by the Faculty of Science from the academic year 2005-2006. Broadly, the same course has now been changed to semester-based scheme and shall be effective from the current academic year 2010-2011. However, the opportunity presented by the semester-based scheme has been used for some revision to accommodate the widening horizons of the discipline of biological sciences. Specifically, the subjects on computational skills and bioinformatics have been included so that students can keep pace with the new and expanding information in the field. Two new disciplines: “Food, Nutrition and Health” in Semester II and “Introduction to Medical Diagnostics” in Semester III have been introduced to provide better employment opportunities to Graduate students. In addition, six papers of chemistry covering almost major streams of chemical sciences that should be taught to biology students have also been included.

The course content also lists new practical exercises, especially in molecular biology so that the students get a hands-on experience of the latest techniques that are in current usage both in the advanced research laboratories and in Industry.

PAPER-1

CHP-101: Chemistry-1 (Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons)

Section A: Inorganic Chemistry-1

(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,θφ). 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 solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Lande 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 in various inorganic and organic compounds.

MO Approach : Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non-bonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO⁺. Comparison of VB and MO approaches.

Section B: Organic Chemistry-I

(30 Periods)

Unit 3. Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules : Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckel's rule.

Unit 4. 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).

Unit 5. Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes:(Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions:* *cis*-addition (alk. KMnO₄) and *trans*-addition (bromine). Addition of HX (Markownikoff's and anti-Markownikoff's addition). Hydration, Ozonolysis, oxymercuration-demercuration, hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC₂ and conversion into higher alkynes; by dehalogenation of tetra halides, dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO₄, ozonolysis and oxidation with hot alk. KMnO₄.

SUGGESTED READINGS

Section A:

1. J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
2. James E. Huheey, *Ellen Keiter and Richard Keiter : Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.

Section B:

1. I. L. Finar : *Organic Chemistry* (Vol. I & II), E. L. B. S.
2. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
3. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand
4. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.

PRACTICALS

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 $\text{Na}_2\text{S}_2\text{O}_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N,S,Cl,Br,I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given)
 - (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
 - (b) Identify and separate the sugars present in the given mixture by paper chromatography.

PAPER-2
BIOLOGY-1
INTRODUCTION TO BIOLOGY

THEORY

Unit 1. Biological systems, evolution and biodiversity

a. Introduction to concepts of biology (Ch 1 Campbell) (4 Periods)

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) (6 Periods)

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) (8 Periods)

Kingdoms of Life –Prokaryotes, Eukaryotes, Archaea

d. Darwinian view of life and origin of species (Ch22, 24 Campbell) (10 Periods)

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

e. Genetic approach to Biology (Ch 1 Griffiths) (8 Periods)

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) (6 Periods)

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) (5 Periods)

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

c. Carbon and life (Ch 4 Campbell) (5 Periods)

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

d. Structure and function of biomolecules (Ch 5 Campbell) (8 Periods)

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

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

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*.

PAPER-3

TECHNICAL WRITING AND COMMUNICATION IN ENGLISH

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

COMPUTATIONAL SKILLS

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) *I-Tax, Reservations, Banking*

SUGGESTED BOOKS

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

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>

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

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.

PAPER-5

CHP202: Chemistry-2 (Thermodynamics, Equilibria & Functional Group Organic Chemistry-1)

Section A: Physical Chemistry-1

(30 Lectures)

Unit 1. 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, 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 2. Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

Unit 3. 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.

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Unit 4. Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions : (Case benzene) : Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation). (Upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (Upto 4 carbons on benzene).

Unit 5. Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN₂, SN₁ and SN_i) reactions. *Preparation*: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & iso-nitrile formation.

Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides *Preparation*: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene)*: Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH₂/NH₃ (or NaNH₂/NH₃).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit 6. Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: *Preparation*: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO₄, acid. dichromate, con. HNO₃). Oppeneauer oxidation

Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation*: Cumene hydroperoxide method, from diazonium salts. *Reactions*: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer - Tiemann Reaction, Gattermann-Koch Reaction, Houben – Hoesch Condensation, Schotten – Baumann Reaction

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Unit 7. Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) *Preparation*: from acid chlorides and from nitriles. *Reactions* – Reaction with HCN, ROH, NaHSO₃, NH₂-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf Verley reduction.

SUGGESTED READINGS

Section A:

- 1 Barrow, G. M. *Physical Chemistry* Tata McGraw Hill (2007).
2. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Mahan, B. H. *University Chemistry* 3rd Ed. Narosa (1998).

Section B:

1. I. L. Finar : *Organic Chemistry* (Vol. I & II), E. L. B. S.
2. R. T. Morrison & R. N. Boyd : *Organic Chemistry*, Prentice Hall.
3. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand
4. Peter Sykes : *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.

PRACTICALS

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO₃, NH₄Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH .

Section B: Organic Chemistry

- 1) Purification of organic compounds by crystallization (from water and alcohol) and distillation.
- 2) Criteria of Purity: Determination of melting and boiling points.
- 3) Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
 - (a) Bromination of Phenol/Aniline
 - (b) Benzoylation of amines/phenols
 - (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

PAPER-6

BIOLOGY-2

THEORY

Cell and Cellular Processes

Unit 1. Techniques in Biology (Ch 1 Sheeler) (12 Periods)

Principles of microscopy; Light Microscope; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis

Unit 2. Cell as a unit of Life (Ch 6 Campbell) (10 Periods)

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components

Unit 3. Cell Organelles (Ch 15, 16, 17,18,19,20 Sheeler) (22 Periods)

- **Mitochondria:**
Structure, marker enzymes, composition; mitochondrial biogenesis; Semiautonomous organelle; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA
- **Chloroplast**
Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA
- **ER, Golgi body & Lysosomes**
Structures and roles. Signal peptide hypothesis, N-linked glycosylation, Role of golgi in O-linked glycosylation. Cell secretion, Lysosome formation.
- **Peroxisomes and Glyoxisomes:**
Structures, composition, functions in animals and plants and biogenesis
- **Nucleus:**
Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4. Cell Membrane and Cell Wall (Ch 7 Campbell / Ch 15 Sheeler / Ch 3 Raven) (8 Periods)

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane;

Faces of the membranes; Selective permeability of the membranes; Cell wall

Unit 5. Cell Cycle: Interphase, Mitosis and Meiosis (Ch 12, 13 Campbell) (8 Periods)

Role of Cell division; Overview of Cell cycle; Molecular controls; Meiosis

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. Sheeler, P and Bianchi, D.E. (2006) Cell and Molecular Biology, 3rd edition, John Wiley & sons NY

PRACTICALS

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
5. Preparation of temporary mounts of striated muscle fiber
6. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus green.
7. To prepare temporary stained squash from root tips of *Allium cepa* and to study the various stages of mitosis.
8. Study the effect of temperature, organic solvent on semi permeable membrane.
9. Demonstration of dialysis of starch and simple sugar.
10. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
11. Measure the cell size (either length or breadth/diameter) by micrometry.
12. Study the structure of nuclear pore complex by photograph (from Gerald Karp)

PAPER-7

FOOD, NUTRITION AND HEALTH

THEORY

Unit 1

2 Periods

Basic concept of food and nutrition

Unit 2

12 Periods

Functions of food

Components of food-nutrients (Macro and micronutrients): their biochemical role and dietary sources.

Food groups and the concept of a balanced diet.

Causes of food spoilage; Food adulteration

Nutrition through the life cycle- Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, preschool and school children, adolescents and elderly.

Unit 3

18 Periods

Nutritional Biochemistry

Carbohydrates, Lipids, Proteins - Definition, Classification, Structure and properties

Significance of acid value, iodine value and saponification value of lipids;

Essential and Non-essential amino acids;

Enzymes- Definition, Classification, Properties; Coenzymes

Vitamins- Fat-soluble and Water-soluble vitamins; their Structure and properties

Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their structure and properties

Unit 4

Health

24 Periods

Introduction to health- Definition and concept of health.

Major nutritional deficiency diseases- Protein Energy Malnutrition, Vitamin A deficiency, Iron deficiency anemia, Iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any.

Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary/lifestyle modifications.

Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS).

Common ailments- cold, cough, fevers, diarrhoea, constipation- their causes and dietary treatment.

Unit 5

4 Periods

Food hygiene

Potable water- sources and methods of purification

Food and Water borne infections

SUGGESTED BOOKS

1. Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
2. Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
3. Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
4. Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
5. Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.
6. Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
7. Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
8. Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd.
9. Jain P et al. Poshan va swasthya ke mool siddhant (Hindi); First Ed; 2007; Academic Pratibha.
10. Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing.
11. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

PRACTICALS

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
2. To determine absorbed oil content in fried foods.
3. Estimation of lactose in milk.
4. Ascorbic acid estimation in food by titrimetry.
5. Estimation of calcium in foods by titrimetry.
6. Preparation of temporary mounts of various stored grain pests.
7. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups.

OR

Identify nutrient rich sources of foods, their seasonal availability and price; study of nutrition labeling on selected foods.

PAPER-8

MATHEMATICS AND STATISTICS

THEORY

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 Produce of matrices upto order 3.

Unit 3. (20 Periods)

Mesures 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-9

CHG-303: Chemistry-3 (Solutions, Conductance, Electrochemistry and Functional Group Chemistry-2)

Section A: Physical Chemistry-2

(30 Lectures)

Unit 1. Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapor pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.

Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids. Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Unit 2. Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $\text{FeCl}_3\text{-H}_2\text{O}$ and Na-K only).

Unit 3. Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit 4. Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG , ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry-3

(30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Unit 5. Carboxylic acids and their derivatives

Carboxylic acids (aliphatic and aromatic) *Preparation:* Acidic and Alkaline hydrolysis of Esters. *Reactions:* Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and their inter-conversion. *Reactions:* Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Unit 6. Active methylene compounds:

Preparation : Claisen ester condensation. Keto-enol tautomerism

Reactions: Synthetic uses of ethylacetoacetate (preparation of non-hetero molecules having upto 6 carbon).

Unit 7. Amines and Diazonium Salts

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. *Reactions:* Hofmann Vs Saytzeff elimination,

Carbylamine test, Hinsberg test, with HNO₂, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines. *Reactions:* conversion to benzene, phenol, dyes.

Unit 8. 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 disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

SUGGESTED READINGS

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. Petrucci, R. H. (1985) *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. T. W. Graham Solomon's : *Organic Chemistry*, John Wiley and Sons.
7. R. T. Morrison & R. N. Boyd : *Organic Chemistry*, Prentice Hall.
8. I. I. Finar : *Organic Chemistry (Vol. I & II)* E. L. B. S.
9. Jerry March : *Advanced organic Chemistry*, John Wiley & Sons
10. Peter Sykes : *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
11. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand

PRACTICALS

Section A: Physical Chemistry

1. pH measurements

a) Measurement of pH of different solutions, like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:

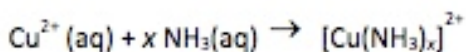
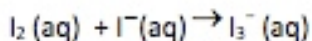
(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

2, Distribution

Study of the equilibrium of one of the following reactions by the distribution method:



Section B: Organic Chemistry

Preparations: Mechanism of various reactions involved to be discussed.
Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

- (a) Nitration of Nitrobenzene
- (b) Preparation of carboxylic acid by alkaline hydrolysis of ester/amide.
- (c) Oxidation of alcohol/aldehydes/hydrocarbons to carboxylic acid
- (d) Osazone from glucose/fructose
- (e) Amides and anilides from carboxylic acid.
- (f) Preparation of methyl orange.

PAPER-10

BIODIVERSITY-I MICROBES

THEORY

Unit 1. Introduction to microbial world and to study its diversity (2 Period)

Unit 2. Viruses (Ch 13 Tortora et al. / Ch 16, 17, 18 Prescott) (11 Periods)

Discovery; Physiochemical and biological characteristics; Classification (including Baltimore's); Replication, Lytic and Lysogenic cycle; Structure of DNA virus (bacteriophage T₄), RNA virus (TMV), Oncogenic virus (HIV); Symptoms, transmission and management of diseases caused by viruses in plants and in animals- with special reference to Mosaics and Vein clearing; and Dengue and AIDS

Unit 3. Prokaryotes (Ch 11 Tortora et al. / Ch 21,22,23,24 Prescott) (11 Periods)

Discovery of bacteria; Ecology and distribution; General structure; Comparison of Archaea and Eubacteria; Wall-less forms (L-forms, Mycoplasma, Protoplasts and Sphaeroplasts) Nutrition; Reproduction—vegetative, asexual and recombination; Economic importance; Symptoms, transmission and management of diseases caused by bacteria and mycoplasma on plants; Detailed study of two diseases each **on plants** (with special reference to: Crown gall and Citrus canker), and **on animals** (with special reference to: Tuberculosis and Cholera).

Unit 4. Algae (Ch 2, 4, 7,8,9,12,13 Sharma OP) (12 Periods)

General characteristics; Ecology and distribution (with reference to distribution in Indian peninsula); Range of thallus organization and reproduction; Basic criteria used in classification (Fritsch, 1945);

Important classes in relation to Applied Phycology listed below

Cyanophyceae- *Nostoc*

Chlorophyceae- *Chlamydomonas*, *Volvox*, *Chlorella*

Bacillariophyceae-Diatoms

Phaeophyceae- *Fucus* and Kelps

Rhodophyceae- *Porphyra* and *Gracilaria*

Unit 5. Fungi and their allies

(24 Periods)

General characteristics; Ecology and distribution; Range of thallus organization; Cell structure; Wall composition; Nutrition; Growth; Reproduction and spores; Heterokaryosis and parasexuality; Basic criteria used in classification. **(Ch 1 Webster and Weber)**

Myxomycetes: General characteristics; Ecology and significance (*Physarum* as an experimental tool); Reproduction; Life cycle of *Stemonitis /Physarum*.

(Ch 29, Alexopoulos et al.)

Oomycetes: General characteristics; Ecology and significance; Thallus organization, Reproduction; Life cycle of *Albugo*. **(Ch 4, 5 Webster and Weber)**

General characteristics; Ecology and significance; Thallus organization, Reproduction; Life cycle of *Rhizopus (Zygomycetes)*, *Claviceps and its telomorphs (Ascomycetes)* *Puccinia*, *Agaricus*, **(Basidiomycetes)** and *Alternaria (Deuteromycetes)* *Penicillium* (Anamorphic fungi). Symptoms, transmission and management of fungal diseases on plants; Two diseases each **on plants** (with special reference to Rust of wheat and Early blight of potato), and on humans (with special reference to Candidiasis and Dermatophytes to be studied in detail). **(Ch 7,8,11,19,22 Webster and Weber / Ch 1,2,5,14,17,20 Alexopoulos et al.)**

Associations of Fungi: Lichens: General account; Reproduction;

Mycorrhizae: General account and its significance. **(Sharma 2005)**

SUGGESTED BOOKS

1. Tortora, G.J, Funke, B.R, Case, C.L. (2010). 10th edition Microbiology: An Introduction, Pearson.
2. Prescott's Microbiology by Willey, Joanne; Sherwood, Linda; Woolverton, Chris, 8th edition (2011) McGraw Hill.
3. Sharma, OP (2002) Textbook of Thallophytes, Tata McGraw Hill Publishing Co. New Delhi.
4. Sharma, PD (2005). Fungi and Allied Organisms, Narosa Publishing House, New Delhi.
5. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996) Introductory Mycology, John Wiley & Sons, Inc. USA.
6. Webster J. and Weber, R.W.S; (2007) Introduction to Fungi (3rd Edition) Cambridge Univ. Press, U.K.
7. Fritsch F.E. 1935, 45 (Vol. I & II) The structure and reproduction of the Algae. Vikas Publishing House Ltd. Delhi
8. Sahoo Dinabandhu. 2000. Farming the ocean Aravali International, Delhi

PRACTICALS

1. Viruses: EM/ Model of TMV, bacteriophage and HIV. Infected specimens of any plants infected with mosaic virus and vein clearing virus.
2. Bacteria: Study of bacteria through permanent slides (cocci, bacilli, spirilli); EM of bacterial cell (surface details and sectional view); EM of endospore, binary fission, conjugation. Specimens/ photographs and permanent slides of root nodules.
3. *Nostoc*, w.m. and permanent slides. EM of heterocyst. Photographs of Actinomycetes.
4. Study of algae through permanent slides: *Volvox*, *Oedogonium*, *Fucus*, *Polysiphonia*.
5. Study of phaneroplasmodium from specimens or photographs; Study of habit and sporangia of *Physarum/ Stemonitis* from temporary mounts.
6. Study of symptoms of plants infected with *Albugo*; Asexual and sexual structures through sections/ tease mounts and permanent slides.
7. Study of fungi through temporary preparations and permanent slides: *Penicillium*, *Puccinia*, and *Alternaria*; Study of symptoms of plants infected with rust and early blight; Study *Agaricus* (through specimens and permanent slides only).
8. Study of *Rhizopus* through temporary preparations.
9. Study of lichens from permanent slides and specimens; Study of mycorrhizae through photographs.

PAPER-11

BIODIVERSITY-II ANIMALS

THEORY

- Unit 1. Protista** (Chapter 3, Ruppert, Fox & Barnes) (4 Periods)
General characters of Protozoa; Life cycle of Plasmodium
- Unit 2. Porifera** (Chapter 5, Ruppert, Fox & Barnes) (3 Periods)
General characters and canal system in Porifera
- Unit 3. Radiata** (Chapter 7, Ruppert, Fox & Barnes) (3 Periods)
General characters of Cnidarians and polymorphism
- Unit 4. Aceolomates** (Chapter 10, Ruppert, Fox & Barnes) (3 Periods)
General characters of Helminthes; Life cycle of Taenia solium
- Unit 5. Pseudocoelomates** (Chapter 11, Barnes) (3 Periods)
General characters of Nemethelminthes; Parasitic adaptations
- Unit 6. Coelomate Protostomes** (Chapter 13, Ruppert, Fox & Barnes) (3 Periods)
General characters of Annelida ; Metamerism.
- Unit 7. Arthropoda** (Chapter 16, Ruppert, Fox & Barnes) (4 Periods)
General characters. Social life in insects.
- Unit 8. Mollusca** (Chapter 12, Ruppert, Fox & Barnes) (3 Periods)
General characters of mollusca; Pearl Formation
- Unit 9. Coelomate Deuterostomes** (Chapter 28, Ruppert, Fox & Barnes) (3 Periods)
General characters of Echinodermata, Water Vascular system in Starfish.
- Unit 10. Protochordata** (Ch 2 and 3, J Z Young) (2 Periods)
Salient features
- Unit 11. Pisces** (Ch 5, J Z Young) (6 Periods)
Osmoregulation, Migration of Fishes
- Unit 12. Amphibia** (Ch, 12 J Z Young) (5 Periods)
Origin of tetrapods
- Unit 13. Reptilia** (Ch 34, Campbell & Reece/ Ch, 14 J Z Young) (5 Periods)
Amniotes; Origin and evolutionary radiation of reptiles
- Unit 14. Aves:** (Ch 34, Campbell & Reece/ Ch, 15&17 J Z Young) (5 Periods)
The origin of birds; Flight adaptations

Unit 15. Mammalia (Ch 34, Campbell & Reece/ Ch. 22 & 24 J Z Young) (7 Periods)

Early evolution of mammals; Primates; Evolution of Man.

SUGGESTED BOOKS

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
3. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
4. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
5. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

PRACTICALS

Non-Chordata

1. Study of following specimens:
Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Dentalium, Octopus, Asterias, and Antedon.
2. Study of Permanent Slides:
Cross section of Sycon, Sea anemone and *Ascaris*(male and female).
T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. T. S. of arm of Starfish. Bipinnaria and Pluteus larva.
3. Dissections
Digestive and nervous system of Cockroach.
4. Temporary mounts
Septal & pharyngeal nephridia and ovary of earthworm.

Chordata

5. Study of following specimens
Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/ Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.
6. Dissections
Afferent Branchial System of *Scoliodon*
7. Temporary mounts
Unstained mounts of Placoid scales.

PAPER-12

INTRODUCTION TO MEDICAL DIAGNOSTICS

THEORY

Unit 1. Biomedical basis of Disease (Ch 3, 18, 20 Davidson, Ch 7, 14 Robbins, Ch 2, 3 7, 14, 16 Weinberg) (22 Periods)

Cause and molecular or cellular progression of key diseases -

- Infectious (Bacterial-Tuberculosis, Anthrax, Typhoid; Viral- AIDS, Poliomyelitis, Hepatitis; Protozoan- Leishmaniasis, Malaria)
- Inherited/genetic diseases (Diabetes, Hypertension, Down Syndrome)
- Immunological diseases (Autoimmune hemolytic anemia (AHA), Hashimoto's disease, Di George's Syndrome, Systemic Lupus Erythematosus (SLE))

Cancer- Nature/ types; genetic basis; Metastasis; Treatment

How pathogenesis relates to symptoms, diagnosis and treatment

Ageing- Theories, Morphological changes, Clinical implications

Diseases impacting on Western versus developing societies

Social and economic factors of disease including role of health services and other organizations

Unit 2. Statistical Analysis and Interpretation (Ch-14 Daniel W.W.) (6 Periods)

Descriptive and analytical statistical methods /tools for evaluation of health of various human groups of interest

Interpretation of statistical data in scientific publications

Unit 3. Analytical Technology (Ch-1, 17, 21, 22 Hage and Carr) (20 Periods)

Brief and relevant description of the following

Wet techniques in Analytical Chemistry

Spectroscopic techniques such as UV

Chromatography Methods such as LC, HPLC and GC-MS

Nuclear Magnetic Resonance Spectroscopy (NMR)

Atomic Force and Scanning Electron Microscopy (AFM and SEM)

Electrochemistry

Molecular Modeling and Chemical Databases

Unit 4. Diagnostic Methods

(Ch-11 Guyton, Ch-1 Brant, Ch-4 Stryer) (12 Periods)

Outline methods used in hospital histopathology, biochemistry, haematology and microbiology laboratories, and apply some of these in the laboratory

Theoretical Knowledge- ECG, Echo, X-ray, CT, MRI, Ultrasound

SUGGESTED BOOKS

1. Daniel W.W. (2009) Biostatistics-A Foundation for Analysis in the Human Health, 9th Edition, John Wiley & Sons.
2. Robbins S.L. (1974) Pathological basis of Disease. W B Saunders Company
3. Macleod J.: Davidson's Principles & Practice of Medicine: A textbook for students and doctors' 14th Edition. Churchill Livingstone.
4. Guyton A.C. and Hall J.E. (2006) Textbook of Medical Physiology 11th edn. Saunders
5. Hage D S and Carr J D, (2010) Analytical Chemistry & Quantitative Analysis, Prentice Hall
6. Berg J.M., Tymoczko J.L., Stryer L. Biochemistry, 5th edn. W.H. Freeman & Co.
7. Brant W.E. and Helms C.A. (2007) Fundamentals of Diagnostic Radiology, 3rd edn. Lippincott Williams &Wilkins.

PRACTICALS

1. Determination of bleeding and blood coagulation time.
2. Enumeration of RBC, WBC (TLC, DLC) using haemocytometer.
3. Determination of Erythrocytic Sedimentation Rate.
4. Blood platelet count by hemocytometer.
5. Estimation of Haemoglobin content of blood using Sahli's haemoglobinometer.
6. Testing of blood glucose using glucometer /colorimeter
7. Detection of abnormal constituents in urine.
8. Clinical estimation of glucose, cholesterol by kits
9. Determination of total sperm count (million/ml) and motility grading (WHO grading) from Rat
10. Demonstration of Electrocardiogram or ECG
11. Physiological Measurements: Blood Pressure (normal & under stress) and Temperature.
12. Introduction to medical imaging-X-ray, CT, MRI, Ultrasound. (Students would be required to interpret the images under various pathological conditions)

PAPER-13

CHP-404: Chemistry-4 (Chemistry of s & p block elements, States of Matter and Phase Equilibrium)

Section A: Inorganic Chemistry-2

(30 Lectures)

Unit 1. General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent. Hydrometallurgy. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

Unit 2. s- and p- Block Elements

Periodicity in s- and p- block elements, w.r.t. electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mullikan, and Alred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Unit 3. Compounds of s- and p- Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements. Concept of multicentre bonding (diborane). Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry.

Hydrides of nitrogen (NH₃, N₂H₄, N₃H, NH₂OH)

Oxoacids of P, S and Cl

Halides and oxohalides: PCl₃, PCl₅, SOCl₂ and SO₂Cl₂

Section B: Physical Chemistry-3

(30 Lectures)

Unit 1. Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor. Causes of deviation. van der Waals equation of state for real gases. Boyle temperature derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO₂.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square

velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Unit 2. Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Unit 3. Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X-Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Unit 4. Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

SUGGESTED READINGS

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. Petrucci, R. H. (1985) *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee :*A New Concise Inorganic Chemistry*, E.L.B.S.
7. F.A. Cotton & G. Wilkinson :*Basic Inorganic Chemistry*, John Wiley.
8. D. F. Shriver and P. W. Atkins : *Inorganic Chemistry*, Oxford University Press.
9. Gary Wulfsberg : *Inorganic Chemistry*, Viva Books Pvt. Ltd.

PRACTICALS

Section A: Inorganic Chemistry

Semi-micro qualitative analysis using H₂S of mixtures not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH₄⁺, Pb²⁺, Ag⁺, Bi³⁺, Cu²⁺, Cd²⁺, Sn²⁺, Fe³⁺, Al³⁺, Co²⁺, Cr³⁺, Ni²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, K⁺,
Anions : CO₃²⁻, S²⁻, SO₃²⁻, S₂O₃²⁻, NO₃⁻, CH₃COO⁻, Cl⁻, Br⁻, I⁻, NO₃⁻, SO₄²⁻, PO₄³⁻, BO₃³⁻, C₂O₄²⁻, F⁻

(Spot tests should be carried out wherever feasible.)

Section B: Physical Chemistry

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

- a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
- b) Study of the variation of surface tension of a detergent solution with concentration.

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

- a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
- b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III) Phase equilibria

- a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
- b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
- c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

PAPER-14

MOLECULAR BIOLOGY

THEORY

Unit 1. Genetic material: (Ch 2, 3 Russell / Ch 14 De Robertis) (18 Periods)

DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.

DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming, θ (theta) mode of replication, replication of linear, ds-DNA, replicating the 5' end of linear chromosome including enzymes.

Unit 2. Transcription (Prokaryotes and Eukaryotes): (Ch 5, 6 Russell / Ch 20 De Robertis / Ch 14, 15 Klug and Cummings) (20 Periods)

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; initiation, elongation and termination of RNA chains.

Translation (Prokaryotes and eukaryotes): features of genetic code and deciphering, universality of genetic code and exceptions in some systems.

Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides.

Unit 3. Regulation of gene expression (Ch 19 Russell) (8 Periods)

Prokaryotes: Lac operon and Tryptophan operon ; and in Eukaryotes

Unit 4. Apoptosis (Cell Death) & Cell Renewal (Ch 17 Cooper et al) (7 Periods)

Mechanism of apoptosis, Intrinsic and extrinsic pathways. Role of apoptosis in human diseases

Stem Cells and Maintenance of adult tissues

Unit 5. Cancer (Ch 22 Russell) (7 Periods)

Relationship of the cell cycle to cancer, Genes and Cancer, Telomere shortening and Human Cancer. Chemicals and Radiations as carcinogen

SUGGESTED BOOKS

1. Cooper, G.M., Hausman, R.E. The Cell: A molecular approach. (2009) ASM Press and Sinauer Associates (Fifth Edition).
2. De Robertis, E.D.P. Cell and Molecular Biology.(2008) Lippincott Williams and Williams (Sixth Edition).
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *iGenetics- A Molecular Approach*. III Edition. Benjamin Cummings.

PRACTICALS

1. Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
2. Preparation of polytene chromosomes from dipteran larva.
3. Preparation of barr body (sex chromatin)
4. Study DNA packaging by micrographs.
5. Preparation of the karyotype and ideogram from the given photograph of somatic metaphase chromosome.
6. To make temporary squash preparation of grasshopper testis and study the various stages of meiosis

PAPER-15

BIODIVERSITY-III PLANTS

THEORY

Unit 1. Introduction (Ch 29 Raven *et al.*/ Ch 29, 35 Campbell, Reece) (7 Periods)

Different types of tissue; their organization into root, stem & leaf (monocot & dicot); Concept of stele and its evolution.

Unit 2. Bryophytes (Ch 29 Raven *et al.*) (9 Periods)

Classification, characteristic features of different groups; Adaptations to land habit; Study of vegetative and reproductive structures (including anatomical details) in *Marchantia* & *Funaria*.

Unit 3. Pteridophytes (Ch 29 Raven *et al.*) (11 Periods)

Classification, characteristic features of different groups; Study of vegetative and reproductive structures (including anatomical details) in *Selaginella* (with concept of heterospory and seed habit), *Equisetum* & *Pteris*; Apogamy and Apospory.

Unit 4. Gymnosperms (Ch 29 Raven *et al.* / Ch 30 Campbell, Reece) (11 Periods)

Classification, characteristic features of different groups; Study of vegetative and reproductive structures (including anatomical details) in *Cycas* & *Pinus*.

Unit 5. Angiosperms (Ch 29 Raven *et al.*/ Ch 30 Campbell, Reece) (22 Periods)

- (i) Structure of flower, types of inflorescence; Classification; Four systems of classification (Artificial, Natural, Phylogenetic & Modern system); Special reference to Bentham & Hooker's system of classification; its application with reference to identification of Solanaceae, Brassicaceae, Asteraceae and Poaceae.
- (ii) Importance of Cultivated plants: Centres of origin of cultivated plants; Economically important plants (botanical name, family, part used and important uses) with reference to cereals (Wheat & Rice); legumes (Gram & Groundnut); spices (Black pepper & Fennel); beverages (Tea & Coffee); fibres (Cotton & Jute); timber (Teak & Pine); fatty oil (Mustard & Linseed); medicinal (*Rauwolfia* & *Digitalis*) plants.

SUGGESTED BOOKS

1. Raven P.H. *et al.* (2006) Biology 7th edn. Tata McGraw Hill Publishers, ND
2. Singh, G. (2004) Plant Systematics: Theory and Practice 2nd edition. Oxford & IBH Publishing Co. Delhi.
3. Mauseth, J. D. (2003) Botany, An Introduction to Plant Biology 3rd edn. Jones and Barlett Publishers.
4. Raven, P. H. et al. (2005) Biology of Plants 7th edition. W.H. Freeman and Co.
5. Kochhar, S.L. (2009) Economic Botany: In the Tropics 3rd edition. Mac Millan Publishers India Ltd.
6. Campbell N.A. & Reece, J.B. (2005) Biology. Pearson Education, Inc. and Dorling Kindersely Publishing, Inc.

PRACTICALS

1. Study of plant tissues (parenchyma, collenchyma, sclerenchyma, xylem & phloem) through permanent slides only.
2. *Marchantia*: Morphology of thallus (vegetative and with gemma cup), W.M. rhizoids, gemmae, V.S. thallus through gemma cup, Morphology of male & female thallus, Permanent slide showing L.S. sporophyte.
3. *Funaria*: Morphology, W.M. rhizoids, leaf, operculum, peristome teeth and spores, Permanent slides showing antheridial and archegonial heads, L.S. capsule, protonema.
4. *Selaginella*: Morphology, W.M. leaf with ligule, W.M. strobilus, W.M. mega- and micro-sporangia, W.M. spores, Permanent slides showing T.S. stem and L.S. strobilus.
5. *Equisetum*: Morphology, T.S. stem through internode, L.S. & T.S. strobilus, W.M. sporangiphore, W.M. spores (wet & dry).
6. *Pteris*: Morphology, T.S. rachis, V.S. sporophyll, W.M. sporangia, W.M. spores, Permanent slides showing fern prothallus.
7. *Cycas*: Morphology (coralloid roots, bulbil, leaf), T.S. rachis, V.S. leaflet Male cone, V.S. microsporophyll, Megasporophyll, Permanent slides showing T.S. coralloid root and L.S. Ovule.
8. *Pinus*: Morphology (long and dwarf shoots), Male cone, L.S. male cone, W.M. microsporophyll & microspores, Permanent slide showing T.S. stem, V.S. needle.
9. Angiosperms: Study of floral characters of the following families for their identification according to Bentham & Hooker's system of classification:

- Solanaceae: *Solanum* / *Withania*
- Brassicaceae: *Brassica* / *Alyssum*
- Asteraceae: *Calendula* / *Helianthus*
- Poaceae: *Triticum* / *Avena*

11. Study of economically important plants as mentioned in the theory syllabus:

- Cereals: Wheat & rice –Study through herbarium specimens and microchemical tests.
- Legumes: Gram and peanut –Study through herbarium specimens and microchemical tests.

PAPER-16

COMPUTERS FOR BIOLOGY/ BIOINFORMATICS

THEORY

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.

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.

PRACTICALS

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.

PAPER-17

CHG-505: Chemistry-5 (Chemistry of d-block elements, Quantum Chemistry and Spectroscopy)

Section A: Inorganic Chemistry-3

(30 Lectures)

Unit 1. Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanides and actinides: Electronic configurations, Oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Unit 2. Coordination Chemistry

Valency Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

Drawbacks of VBT. IUPAC system of Nomenclature.

Unit 3. Crystal Field Theory

Crystal field effect, Octahedra symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δ . Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion. Square planar coordination.

Section B: Physical Chemistry-4

(30 Lectures)

Unit 4. Quantum Chemistry & Spectroscopy

Spectroscopy and its importance in chemistry. Wave-particle duality. Link between spectroscopy and quantum chemistry. Electromagnetic radiation and its interaction with matter. Types of spectroscopy. Difference between atomic and molecular spectra. Born-Oppenheimer approximation: Separation of molecular energies into translational, rotational, vibrational and electronic components.

Postulates of quantum mechanics, quantum mechanical operators.

Free particle. Particle in a 1-D box (complete solution), quantization, normalization of wavefunctions, concept of zero-point energy.

Rotational Motion: Schrödinger equation of a rigid rotator and brief discussion of its results (solution not required). Quantization of rotational energy levels. Microwave (pure rotational) spectra of diatomic molecules. Selection rules. Structural information

derived from rotational spectroscopy.

Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels. Selection rules, IR spectra of diatomic molecules. Structural information derived from vibrational spectra. Vibrations of polyatomic molecules. Group frequencies. Effect of hydrogen bonding (inter- and intramolecular) and substitution on vibrational frequencies.

Electronic Spectroscopy: Electronic excited states. Free Electron model and its application to electronic spectra of polyenes. Colour and constitution, chromophores, auxochromes, bathochromic and hypsochromic shifts.

Unit 5. Photochemistry

Laws of photochemistry. Lambert-Beer's law. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions. Photoelectric cells.

SUGGESTED READINGS

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. Petrucci, R. H. (1985) *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee : *A New Concise Inorganic Chemistry*, E.L.B.S.
7. F.A. Cotton & G. Wilkinson : *Basic Inorganic Chemistry*, John Wiley.
8. D. F. Shriver and P. W. Atkins : *Inorganic Chemistry*, Oxford University Press.
9. Gary Wulfsberg : *Inorganic Chemistry*, Viva Books Pvt. Ltd.

PRACTICALS

Section A: Inorganic Chemistry

1. Estimation of the amount of nickel present in a given solution as Bis(dimethylglyoximate) nickel(II) or aluminium as oxinate in a given solution gravimetrically.
2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric

titration.

4. To draw calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given coloured compound and estimate the concentration of the same in a given solution.

5. Determination of the composition of the Fe^{3+} - salicylic acid complex / Fe^{2+} - phenanthroline complex in solution by Job's method.

6. Determination of concentration of Na^+ and K^+ using Flame Photometry.

Section B: Physical Chemistry

(I) Potentiometric measurements

- (a) Strong acid with strong base
- (b) Weak acid with strong base
- (c) Mohr's salt with potassium dichromate

(II) Conductometric measurements.

- (a) Determination of the cell constant.
- (b) Study of the variation of molar conductivity of a strong electrolyte (KCl) and of a weak electrolyte (acetic acid) with concentration.
- (c) Conductometric titrations for the following systems
 - (i) strong acid - strong base
 - (ii) weak acid - strong base

(III) Kinetic studies

Study of the kinetics of the following reactions by integrated rate method:

- a. Acid hydrolysis of methyl acetate with hydrochloric acid, volumetrically or conductometrically
- b. Iodide-persulphate reaction.

PAPER-18

BIOCHEMISTRY AND IMMUNOLOGY

THEORY

Unit 1. Carbohydrate Metabolism: (Chapter 14, 15, 16, Lehninger) (8 Periods)

Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism

Unit 2. Lipid Metabolism: (Chapter 17, Lehninger) (4 Periods)

Biosynthesis and β -oxidation of palmitic acid

Unit 3. Protein Metabolism: (Chapter 18, Lehninger) (5 Periods)

Transamination, Deamination and Urea cycle.

Unit 4. Enzymes: (Chapter 6, Lehninger) (10 Periods)

Introduction, kinetics, mechanism of action, inhibition, allosteric enzymes and regulation

Unit 5. Oxidative Phosphorylation: (Chapter 13, Lehninger) (5 Periods)

Electron transport chain, Oxidative phosphorylation and ATP synthase

Unit 6. Overview of Immune System: (Chapter 1, Kuby)(5 Periods)

Historical perspective of Immunology, Early theories of Immunology, Innate, Adaptive (cell mediated and humoral) - Passive: Artificial and Natural Immunity, Active: Artificial and Natural Immunity

Unit 7. Cells and Organs of the Immune System: (Chapter 2, Kuby)(7 Periods)

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

Unit 8. Antigens: (Chapter 3, Kuby)(3 Periods)

Properties of antigens, Adjuvants and Haptens

Unit 9. Immunoglobulins: (Chapter 4, Kuby)(3Periods)

Basic structure, classes and function, Polyclonal sera, Monoclonal antibodies

Unit 10. Major Histocompatibility Complex: (Chapter 7, Kuby)(2 Periods)

Structure and functions

Unit 11. Antigen Processing and Presentation: (Chapter 1, Kuby)(2 Periods)

Endogenous pathway and exogenous pathway of antigen presentation

Unit 12. Immune System in Health and Disease: (Chapter 19, Kuby)(6 Periods)

SUGGESTED BOOKS

1. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H Freeman and Co.
2. 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.
3. Kindt, T. J., Goldsby, R. A., Osborne, B. A., Kuby, J. (2006). VI Edition. Immunology. W.H. Freeman and Company.
4. Delves, P. J., Martin, S. J., Burton, D. R., Roitt, I.M. (2006). XI edition. Roitt's Essential Immunology, Blackwell Publishing

PRACTICALS

1. Color reaction to identify functional group in the given solution of carbohydrate.
2. Color reaction to identify functional group in the given solution of proteins.
3. Study of the action of salivary amylase at optimum condition.
4. Study the activity of Trypsin using fresh tissue extracts.
5. Dissection and display of lymphoid organs.
6. Ouchterlony's double immunodiffusion method.
7. ABO blood group determination.
8. Viability and cell counting of peritoneal macrophages using trypan blue.

PAPER-19
DEVELOPMENTAL BIOLOGY & PLANT
PHYSIOLOGY

THEORY

Unit 1. Developmental Biology: Introduction and scope; significance of polarity.
(Ch-22 Raven P.H. *et al.*) (2 Periods)

Unit 2. Structural organization of flower: Initiation and differentiation of floral organs; structure and development of anther, microsporogenesis, structure and types of ovule, megasporogenesis, types of embryo sacs

(Bhojwani & Bhatnagar Chapter-1, 2,3,4,5, 2nd Edition) (10 Periods)

Unit 3, Fertilization: Pollination, pollen-pistil interaction; double fertilization.

(Bhojwani & Bhatnagar Chapter-6, 7, 2nd Edition) (4 Periods)

Unit 4. Plant – water relationship: significance of water, water potential, water absorption and transport, transpiration, mechanism of opening and closing of stomata.

(Ch 2 Hopkins & Huner) (5 Periods)

Unit 5. Mineral nutrition: essential elements, micro and macronutrients, soil factors affecting their availability, physiological basis of deficiency, symptoms, ion uptake and role of mycorrhiza

(Ch 3, 4 Hopkins & Huner) (6 Periods)

Unit 6. Role of physical factors in growth of plants: response to light photomorphogenesis, role of phytochrome and cryptochrome, photoperiodism, biological clock, response to temperature – vernalization. (Ch 7,24,25,26 Hopkins & Huner) (8 Periods)

Unit 7. Role of growth regulators-auxin, gibberellins, cytokinins, ABA, ethylene, Brassinosteroids and Jasmonates; signal transduction (overview). (Ch 18,19,20,21 Hopkins & Huner) (11 Periods)

Unit 8. Photosynthesis- brief history, pigments, mechanism of light absorption and energy transfer, PSI & PSII e-transport, ATP synthesis C₃ C₄ & CAM Photorespiration

(Ch 7,8,9,10 Hopkins & Huner) (10 Periods)

Unit 9. Solute transport- Transport of inorganic and organic components, transport pathways-xylem and phloem.

(Ch 3, 9 Hopkins & Huner) (4 Periods)

SUGGESTED BOOKS

1. Hopkins WG & Huner PA (2009) 4th edn. Introduction to Plant Physiology. John Wiley and Sons
2. Dickinson WC 2000 Integrative Plant Anatomy, Harcourt Academic Press, USA
3. Raghavan V 2000 Developmental Biology of Flowering Plants, Springer-Verlag, New York
4. Bhojwani, S.S. & Bhatnagar, S.P. (1999), Embryology of Angiosperms, 4th ed. Vikas Pub. House Pvt. Ltd., New Delhi
5. Raven P.H., Evert R.F. and Eichhorn S.E. (2005), Biology of Plants, v W.H. Freeman Company Publishers. USA. 7th edn.

PRACTICALS

1. Structure of young anther wall, microsporogenesis, mature anther (permanent slides).
2. Study of monosporic (Polygonum) type of embryo sac development (permanent slides/photographs).
3. Study of embryo sac through electron micrographs showing egg apparatus.
4. Determination of stomatal index of leaf of the given plant material.
5. Determination of stomatal frequency of the leaf of given plant material.
6. Determination of a effect of an environmental factor on the rate of transpiration by an excised twig using photometer.
7. Study the effect of CO₂ concentration on the rate of photosynthesis.
8. Study the effect of light intensity on the rate of photosynthesis.
9. Demonstrate Hill's reaction using crude extract o leaves.
10. Demonstrate the activity of nitrate reductase in leaf discs.
11. Study the *Avena* coleoptile curvature test.

List of suggested experiment that should be demonstrated in the class and these may be kept for comments in the practical examination

1. To study the dynamics of growth.
2. To study the effect of ethrel application on fruit ripening.
3. To demonstrate bolting in any rosette plant.
4. To demonstrate effect of auxin on rooting/abscission/apical dominance.
5. Delaying of leaf senescence by application of cytokinn.

PAPER-20

GENETICS AND GENOMICS

THEORY

Unit 1. Heredity: (Ch 3, 5, 6 Pierce; Ch 3, 4 Klug and Cummings / Ch 11, 12, 13 Russell / Ch 20 Gardner) (16 Periods)

- Brief life history of Mendel
- Terminologies
- Laws of Inheritance
- Modified Mendelian Ratios: 2:1- lethal Genes; 1:2:1- Co- dominance, incomplete dominance; 9:7; 9:4:3; 13:3; 12:3:1.
- Chi Square
- Pedigree Analysis
- Cytoplasmic Inheritance: Shell Coiling in Snail, Kappa particles in *Paramecium*, leaf Variegation in *Mirabilis jalapa*, Male Sterility.
- Multiple Allelism
- Pleiotropism
- Chromosome theory of Inheritance.

Unit 2. Sex-determination and Sex-linked Inheritance: (Ch 4 Pierce / Ch 7 Klug and Cummings / Ch 4 Gardner) (8 Periods)

- Sex determination in Human, *Drosophila* & plants
- Sex linked inheritance

Unit 3. Linkage and Crossing over: (Ch 7 Pierce / Ch 5 Klug and Cummings / Ch 7 Gardner) (8 Periods)

- Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two factor crosses.
- Crossing over: concept and significance, cytological proof of crossing over.

Unit 4. Mutations: (Ch 10 Pierce; Ch 16 Klug and Cummings / Ch 11 Gardner) (6 Periods)

- Types of mutations, effects of physical & chemical mutagens
- CLB method of detection of mutations

Unit 5. Chromosomal Aberrations: (Ch 9 Pierce / Ch 8 Klug and Cummings / Ch 17 Russell) (14 Periods)

- Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy

- Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.

Unit 6. Genomics: (Ch 20 Pierce / Ch 10 Russell) (8 Periods)

Introductions to OMICS: Genomics, Proteomics, transcriptomics, metabolomics, glycomics

- Structural Genomics: Sequencing Strategies, Human Genome project.
- Functional Genomics
- Comparative Genomics: Homologs, Paralogs & orthologs, Synteny, Comparative genomics of Chimpanzees and human, Mice and Humans.
- Model organisms: *Escherichia coli*, *Drosophila melanogaster*, *Arabidopsis thaliana*

SUGGESTED BOOKS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
3. Russell, P. J. (2009). *iGenetics- A Molecular Approach*. III Edition. Benjamin Cummings.
4. Pierce, B. A. (2008). *Genetics- A Conceptual Approach*. W. H. Freeman& co. NY

PRACTICALS

1. Gene Interactions with the help of *Drosophila* culture for the following dihybrid F2 segregation ratios: 9:7; 9:4:3; 13:3; 12:3:1
2. Construction of linkage map based on recombination frequency data obtained from a two- point cross (use real life data).
3. Chi square analysis of a dihybrid F2 population data
4. Meiosis – *Allium cepa* Buds
5. Pedigree analysis of hemophilia in Queen Victoria family
6. Colour blindness- Ishihara’s Chart
7. Study of the following with the help of photographs: Sex chromosomes in *Melandrium/ Coccinia*, Multivalents, Inversion bridge, Laggards, Translocation Ring (*Rhoeo*), Human Genetic Syndromes (Down’s, Turner’s, Klinefelter’s), Barr Bodies.

PAPER-21

CHP-606: Chemistry-6 (Organometallics, Bio-inorganic Chemistry, Proteins and UV-IR Spectroscopy)

Section A: Inorganic Chemistry-4

(30 Lectures)

Unit 1. Chemistry of 3d metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties).

Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Unit 2. Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, σ , π and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π - acceptor behaviour of carbon monoxide. Synergic effects (VB approach). (MO diagram of CO can be referred to for synergic effect to IR frequencies).

Unit 3. Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+ , K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Section B: Organic Chemistry-4

(30 Lectures)

Unit 1. Polynuclear and Heteronuclear aromatic compounds: Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, and Pyridine.

Unit 2. 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.

Unit 3. Application of Spectroscopy to Simple Organic Molecules

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules.

Electromagnetic radiations, electronic transitions, λ_{\max} & ϵ_{\max} , chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{\max} of conjugated dienes and α,β – unsaturated compounds.

Infrared radiations and types of molecular vibrations, functional group and Finger print region. IR spectra of alkanes, alkenes and simple alcohols (inter and intra molecular Hydrogen bonding), aldehydes, ketones, carboxylic acids and derivatives (effect of substitution on $>C=O$ stretching absorptions).

SUGGESTED READINGS

1. James E. Huheey, Ellen Keiter and Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
2. G.L. Miessler and Donald A. Tarr: *Inorganic Chemistry*, Pearson Publication.
3. J.D. Lee : *A New Concise Inorganic Chemistry*, E.L.B.S.
4. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.
5. I. L. Finar: *Organic Chemistry* (Vol. I & II). E.L.B.S.
6. John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds*, Prentice Hall.
7. R.M. Silverstein, G.C. Bassler and T.C. Morrill: *Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
8. R.T. Morrison & R.N. Boyd: *Organic Chemistry*, Prentice Hall.
9. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
10. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand

PRACTICALS

Section A: Inorganic Chemistry

1. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given)

Paper chromatographic separation of Fe^{3+} , Al^{3+} and Cr^{3+}

or

Paper chromatographic separation of Ni^{2+} , Co^{2+} , Mn^{2+} and Zn^{2+}

2. Preparation of any two of the following complexes and measurement of their conductivity:

(i) tetraamminecarbonatocobalt (III) nitrate

(ii) tetraamminecopper (II) sulphate

(iii) potassium trioxalatoferrate (III) trihydrate

Compare the conductance of the complexes with that of M/1000 solution of NaCl, MgCl₂ and LiCl₃.

Section B: Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1° amines) and preparation of one derivative.

PAPER-22

APPLIED BIOLOGY AND BIOTECHNOLOGY

THEORY

Unit 1. Human diseases

(Ch3, 5 Park) (10 Periods)

Epidemiology of infectious disease, transmission, prevention and control of human diseases-Tuberculosis, Amoebiasis, Dengue, Malaria, Filariasis, Japanese encephalitis

Unit 2. Food and industrial microbiology (Ch 28, 29 Pelczar) (12Periods)

Microbiology of fermented food and food-borne diseases, food preservation, Micro-organism as food (e.g. SCP), Major products of industrial microbiology-antibiotics, amino acids, organic acids, vitamins, pharmaceuticals.

Unit 3. Molecular Techniques in Gene manipulation (Ch 1, Ch 3, 4 Glick & Pasternak) (16 Periods)

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. Applications of Biotechnology (Ch 9, 10, 11, 12, 19, 20, 21, 23 Glick & Pasternak) (22 Periods)

Molecular diagnosis of genetic diseases (Cystic fibrosis, Huntington's disease and Sickle cell anemia), Recombinant vaccines, Recombinant DNA in medicines (Recombinant insulin and Human growth hormone), Gene therapy (ADA and Cystic fibrosis) and Stem Cells, Bioremediation, Production and applications of transgenic plants (biotic, abiotic and improvement of nutritional quality) and transgenic animals (generation of medicines and hormones), Ethics and regulation of GM organisms

SUGGESTED BOOKS

1. Pelczar, M.J. *et al* (2001) Microbiology 5th edition Tata McGraw-Hill Co. New Delhi
2. Park, K (2007) Preventive and social medicine B.B publishers
3. Glick, B.R. and Pasternak, J. J. (2010) Molecular Biotechnology- Principles and applications of recombinant DNA, ASM press, Washington.
4. Watson, J.D., Myers, R.M., Caudy, A., Witkowski, J.K. (2007) Recombinant DNA- Genes and Genomes- A short course. 3rd edition. Freeman and Co. NY.

PRACTICALS

1. Isolation of plasmid DNA from *E. coli*.
2. Transformation of *E.coli* (pUC 18/19) and calculation of transformation efficiency.
3. Restriction Endonuclease Digestion of plasmid DNA.
4. Ligation of Target DNA.
5. Gene amplification using PCR
6. DNA sequencing: Interpretation of sequence from the data provided.
7. Analysis of DNA fingerprint
8. Separation of proteins by SDS-PAGE.
9. Study of protozoan, helminth parasites and arthropod vectors associated with human diseases.

PAPER-23
DEVELOPMENTAL BIOLOGY AND
ANIMAL PHYSIOLOGY

THEORY

Unit 1. Principals of development biology (Ch 1, 2 Gilbert) (3 Periods)

History, Anatomical aspects of development biology

Unit 2. Animal development (Ch 47 Campbell) (12 Periods)

Gametogenesis, fertilization, cleavage, gastrulation, cell fate

Unit 3. Digestion & absorption of food (Ch 15 Vander) (6 Periods)

Structure & function of gastrointestinal tract

Unit 4. Functioning of excitable tissue (nerve & muscle) (Ch 6 Sec A, B, C; Ch 9 Sec A Vander) (12 Periods)

Neural tissue, generation & propagation of nerve impulse, skeletal muscle –molecular mechanism of contraction.

Unit 5. Respiration & Renal physiology (Ch 13 Vander/ Ch 44 Campbell) (12 Periods)

Transport of oxygen & carbon dioxide in blood. Functional anatomy of kidney, water balance & counter-current mechanism

Unit 6. Cardiovascular physiology (Ch 12 Sec A, B, E Vander) (9 Periods)

Heartbeat coordination, cardiac cycle. Cardiovascular pattern in health & disease.

Unit 7. Endocrine system and reproduction (Ch 45, 46 Campbell) (6 Periods)

Common features of endocrine system, functional role of endocrine glands.

SUGGESTED BOOKS

1. Campbell N.A. & Reece, J.B. (2005) 8th edn. Biology. Pearson Education, Inc. and Dorling Kindersely Publishing, Inc.
2. Gilbert, S.F. (2006) 8th edn. Developmental Biology, Sinauer Associates, Inc.
3. Widmaier E.P., Raff, H., Strang, K.T. (2004) 9th edn. Vander's Human Physiology, Mc Graw Hill

PRACTICALS

1. Study of development stages of frog: - cleavage types, blastula, gastrula, neurula (neural fold, neural tube), external gill stage of tadpole.
2. Study of development stages of chick 18h, 24h, 28h, 36h, 48h, 72h by raising chick embryo in the laboratory.
3. Preparation of haemin and hemochromogen crystals.
4. Study the reflex action in a spinal frog
5. Recording of frog's heart beat *in situ*.
6. Histological slides- Examination of sections of mammalian skin, salivary glands, oesophagus, duodenum, ileum, rectum, liver, pancreas, spleen, trachea, lung, kidney, cartilage, bone, pituitary, adrenal, thyroid, ovary, testis

PAPER-24

ECOLOGY AND ENVIRONMENTAL MANAGEMENT

THEORY

**Unit 1. Introduction to Ecology, Community and Ecosystem (Ch 4 Allaby,
Ch 20, 21, 22 Smith/ Ch 3 Miller) (18 Periods)**

Inter-relationships between the living world and environment, Biosphere, biomes, ecosystem and its components (abiotic and biotic). Environment related concepts and laws (theory of tolerance, laws of limiting factors). Community characteristics-organization and concept of habitats and niche. Bioenergetics. Biogeochemical cycles, Hydrologic cycle. Concept of habitat and niche.

**Unit 2. Population and Community Ecology (Part 4 and 5 Smith /Ch 6, 7 Miller)
(6 Periods)**

Population attributes, density, natality, mortality, age ratio, sex ratio, dispersal and dispersion of population, exponential and logistic growth, life history strategies, population interactions, predation-types, predator-prey system, functional and numerical response, host-parasite interactions, social parasitism, symbiosis

Unit 3. Biogeography (Part 23, 24, 25 Smith) (10 Periods)

Phytogeography, Phytogeographic realms, major plant communities of the world, Vegetation of India, Zoogeography: Zoogeographic realms, Threatened species of animals

**Unit 4. Bioresource management (Unit 4 Mishra/ Ch 6 Allaby/ Ch 4, 8, 9 Miller)
(14 Periods)**

Biodiversity and regional conservation strategies success stories with reference to India and sustainable utilization. Principles of wildlife management, wildlife sanctuaries, parks and biosphere reserves in India, endangered and threatened species of plants and animals in India, germplasm banks.

**Unit 5. Environmental Issues, Policies and regulation (Unit 8 Mishra/ Ch 27, 29
Smith/ Ch 11, 15, 16 Miller) (10 Periods)**

Impact of urbanization and industrialization, EIA-Environmental Impact Assessment (Global, National and Local), restoration of degraded ecosystems, bioremediation, environmental pollution, global climatic change

SUGGESTED BOOKS

1. Mishra, A. (2005) Environmental Studies Selective and Scientific Books, New Delhi
2. Allaby, M. (2002) Basics of Environmental Science Routledge
3. Smith, T.M. and Smith, R.C. (2006) Elements of Ecology 1st edn Pearson Publications
4. Miller, G.T (2006) Environmental Science 11th edition Brooks/Cole

PRACTICALS

1. Study of the biotic and abiotic components of any one ecosystem
2. Study of population density by using different methods – natural and hypothetical community
3. Study of life tables and Survivorship curves
4. Measurement of soil pH, temperature and texture- sieve method, soil analysis by rapid field method
5. Ecological adaptations of two animals and two plants
6. **Project work** - any one
 - Restoration of biodiversity
 - Collection of data on- water or air pollution
 - Conventional sources of energy
 - Visit to a National Park or wild life sanctuary
 - One Ecosystem – Natural or Human modified