

# Faculty of Life Sciences

**B.Sc. (General) Biochemistry, Microbiology and Chemistry**

**THREE YEAR FULL TIME PROGRAMME**



**PDM UNIVERSITY BAHADURGARH  
DELHI- NCR**

*Note: Syllabi applicable for students seeking admission in B.Sc.(General) Biochemistry, Microbiology and Chemistry Course from the academic year 2018*

## Details of Course Under Undergraduate Programme

### (B.Sc.) Course

(Theory+ Practical)

**Credits**

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#### **I. Core Course**

12X4= 48

(12 Papers)

04 Courses from each of the 03 disciplines of choice

#### **Core Course Practical**

12X2=24

(12 Practicals) 04 Courses from each of the 03 Disciplines of choice

#### **II. Elective Course**

6x4=24

(6 Papers) Two papers from each discipline of choice including papers of interdisciplinary nature.

#### **Elective Course Practical**

6 X 2=12

(6 Practical) Two Papers from each discipline of choice including paper of interdisciplinary nature

- **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6<sup>th</sup> Semester**

#### **III. Ability Enhancement Courses**

1. Ability Enhancement Compulsory

2 X 2=4

(2 Papers of 2 credits each)

Environmental Science

English/MIL

Communication

2. Ability Enhancement Elective

4 X 2=8

(Skill Based)

(4 Papers of 2 credits each)

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**Total credits = 120**

**COURSE: B.Sc.(General) Biochemistry, Microbiology and Chemistry (BMC)**

Semester	Course Title	Course Name	Course Code	Credit	
I	Ability Enhancement Compulsory Course - I	English Communication	ENGL1101	2	
	CC -1 Theory	Chemistry of Biomolecules	BCHG1101	4	
	CC -1 Practical	Chemistry of Biomolecules Practical	BCHG1102	2	
	CC -2 Theory	Introduction to Microbiology and Microbial Diversity	MICG1101	4	
	CC -2 Practical	Introduction to Microbiology and Microbial Diversity Practical	MICG1102	2	
	CC-3 Theory	Conceptual Organic Chemistry	CHEM1101	4	
	CC -3 Practical	Conceptual Organic Chemistry practical	CHEM1102	2	
		Foreign Language-I		2	
	II	Ability Enhancement Compulsory Course - I	Environmental Science	ENVS1102	2
		CC-4Theory	Biochemical and Biophysical Techniques	BCHG1103	4
CC -4 Practical		Biochemical and Biophysical Techniques Practical	BCHG1104	2	
CC -5 Theory		Bacteriology and Virology	MICG1103	4	
CC -5 Practical		Bacteriology and Virology Practical	MICG1104	2	
CC-6 Theory		Molecules of Life	CHEM1103	4	
CC -6 Practical		Molecules of Life Practical	CHEM1104	2	
		Foreign Language-II		2	
III		CC-7Theory	Intermediary Metabolism	BCHG2105	4
		CC -7 Practical	Intermediary Metabolism Practical	BCHG2106	2
	CC -8 Theory	Microbial Genetics, Physiology and Metabolism	MICG2105	4	
	CC -8 Practical	Microbial Genetics, Physiology and Metabolism Practical	MICG2106	2	
	CC-9Theory	Chemical Bonding	CHEM2101	4	
	CC -9 Practical	Chemical Bonding Practical	CHEM2102	2	
	SEC-I	Skill Enhancement Course-I		2	
		Minor Group Project*			

<b>IV</b>	CC-10 Theory	Molecular Biology and Immunology	BCHG2107	4
	CC -10 Practical	Molecular Biology and Immunology Practical	BCHG2108	2
	CC -11 Theory	Industrial and Medical Microbiology	MICG2107	4
	CC -11 Practical	Industrial and Medical Microbiology Practical	MICG2108	2
	CC-12 Theory	Physical Chemistry for Biosciences	CHEM2103	4
	CC -12 Practical	Physical Chemistry for Biosciences Practical	CHEM2104	2
	SEC-II	Skill Enhancement Course- II		2
		Minor Individual Project*		
<b>V</b>	SEC-III	Skill Enhancement Course-III		2
	DSE-I Theory	Discipline Specific Elective-I (Biochemistry-I)	BCHG3209	4
	DSE-I Practical	Discipline Specific Elective-I (Biochemistry-I) Practical	BCHG3210	2
	DSE-II Theory	Discipline Specific Elective-II (Microbiology-I)	MICG3209	4
	DSE-II Practical	Discipline Specific Elective-II (Microbiology-I) Practical	MICG3210	2
	DSE-III Theory	Discipline Specific Elective-III (Chemistry-I)	CHEM3201	4
	DSE-III Practical	Discipline Specific Elective-III (Chemistry-I) Practical	CHEM3202	2
		Major Group Project*		
<b>VI</b>	SEC-IV	Skill Enhancement Course-IV		2
	DSE-IV Theory	Discipline Specific Elective-IV (Biochemistry-II)	BCHG3211	4
	DSE-IV Practical	Discipline Specific Elective-IV (Biochemistry-II) Practical	BCHG3212	2
	DSE-V Theory	Discipline Specific Elective-V (Microbiology-II)	MICG3211	4
	DSE-V Practical	Discipline Specific Elective-V (Microbiology-II) Practical	MICG3212	2
	DSE-VI Theory	Discipline Specific Elective-VI (Chemistry-II)	CHEM3203	4
	DSE-VI Practical	Discipline Specific Elective-VI (Chemistry-II) Practical	CHEM3204	2
		Major Individual Project*		

## Curriculum Structure of B.Sc. (General) Biochemistry, Microbiology and Chemistry

	<b>CORE COURSE[12]</b>	<b>Ability Enhancement Compulsory Courses [2]</b>	<b>Skill Enhancement Courses (SEC) [4]</b>	<b>Discipline Specific Elective (DSE) [6]</b>
I	CC-Biochemistry I	English communication		
	CC-Microbiology I			
	CC-Chemistry I			
II	CC-Biochemistry II	Environmental Science		
	CC-Microbiology II			
	CC-Chemistry II			
III	CC-Biochemistry III		SEC-I	
	CC-Microbiology III			
	CC-Chemistry III			
IV	CC-Biochemistry IV		SEC-II	
	CC-Microbiology IV			
	CC-Chemistry IV			
V			SEC-III	DSE-Biochemistry I
				DSE- Microbiology I
				DSE-3 Chemistry I
VI			SEC-IV	DSE-Biochemistry II
				DSE- Microbiology II
				DSE-3 Chemistry II

**CORE COURSES (12 Courses) Total Credits – 48**  
(6 credits each Theory 4 credits + Practical 2 credits =6)

**Core Courses –Biochemistry**

CC 1: Chemistry of Biomolecules	Theory 4 credits + Practical 2 credits
CC 2: Biochemical and Biophysical Techniques	Theory 4 credits + Practical 2 credits
CC 3: Intermediary Metabolism	Theory 4 credits + Practical 2 credits
CC 4: Molecular Biology and Immunology	Theory 4 credits + Practical 2 credits

**Core Courses –Microbiology**

CC 1: Introduction to Microbiology and Microbial Diversity credits	Theory 4 credits + Practical 2
CC 2: Bacteriology and Virology	Theory 4 credits + Practical 2 credits
CC 3: Microbial Genetics, Physiology and Metabolism	Theory 4 credits + Practical 2 credits
CC 4: Industrial and Medical Microbiology	Theory 4 credits + Practical 2 credits

**Core Courses –Chemistry**

CC 1: Conceptual Organic Chemistry	Theory 4 credits + Practical 2 credits
CC 2: Molecules of Life	Theory 4 credits + Practical 2 credits
CC 3: Chemical Bonding	Theory 4 credits + Practical 2 credits
CC 4: Physical Chemistry for the Biosciences	Theory 4 credits + Practical 2 credits

**DISCIPLINE SPECIFIC ELECTIVE (4 Courses)**

**Total Credits – 24 (6 Credits each –Theory 4 credits + Practical 2 credits =2)**

**DSE Courses- Biochemistry**

DSE 1: Genetic Engineering and Biotechnology	Theory 4 credits + Practical 2 credits
DSE 2: Advance Cell Biology	Theory 4 credits + Practical 2 credits
DSE 3: Human Physiology	Theory 4 credits + Practical 2 credits

**DSE Courses- Microbiology**

DSE 1: Environmental Microbiology	Theory 4 credits + Practical 2 credits
DSE 2: Advances in Microbiology	Theory 4 credits + Practical 2 credits
DSE 3: Microbial Biotechnology	Theory 4 credits + Practical 2 credits

**DSE Courses- Chemistry**

DSE 1: Analytical Methods in Chemistry	Theory 4 credits + Practical 2 credits
DSE 2: Molecular Modelling & Drug Design	Theory 4 credits + Practical 2 credits
DSE 3: Research Methodology for Chemistry	Theory 4 credits + Practical 2 credits
DSE 4: Green Chemistry	Theory 4 credits + Practical 2 credits
DSE 5: Bio-inorganic & Environmental Chemistry	Theory 4 credits + Practical 2 credits
DSE 6: Instrumental Methods of Analysis	Theory 4 credits + Practical 2 credits

## **SKILL ENHANCEMENT COURSES (2 Courses)**

**Total Credits – 8 (4 credits each)**

### **SEC- Biochemistry**

**SEC 1:** Clinical biochemistry Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 2:** Medical diagnostics Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 3:** Public Health and Hygiene Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 4:** Bioinformatics Theory 4 credits / Theory 2 credits + Practical 2 credits

### **SEC- Microbiology**

**SEC 1:** Biofertilisers Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 2:** Microbial diversity  
and Human welfare Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 3:** Fermentation technology Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 4:** Mushroom Culture Technology Theory 4 credits / Theory 2 credits + Practical 2 credits

### **SEC- Chemistry**

**SEC 1:** IT Skills for Chemists Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 2:** Basic Analytical Chemistry Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 3:** Chemical Technology & Society Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 4:** Business Skills for Chemists Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 5 :** Pharmaceutical chemistry Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 6:** Chemistry of Cosmetics  
and Perfumes Theory 4 credits / Theory 2 credits + Practical 2 credits

**SEC 7:** Pesticide chemistry Theory 4 credits / Theory 2 credits + Practical 2 credits

## **ABILITY ENHANCEMENT COMPULSORY COURSES (2 Courses)**

**Total Credits – 4 (2 credits each)**

**AEC 1:** Environmental Science Theory 2 credits

**AEC 2:** English/MIL Communication Theory 2 credits

**Total Credits = 72 Core+ 36 DSC + 8 SEC+ 4 AECC = 120**

**Core Course: Biochemistry**  
**CC I: Chemistry of Biomolecules**      **Paper code: BCHG1101**  
**(Credits: Theory-4, Practicals-2)**

**THEORY**

**Unit – I: Carbohydrates**

Carbohydrates: Classification, monosaccharides, D and L designation, open chain and cyclic structures, epimers and anomers, mutarotation, reactions of carbohydrates, Structure and biological importance of disaccharides, trisaccharides, structural polysaccharides and storage polysaccharides, Glycosaminoglycans, Bacterial cell wall polysaccharides, glycoproteins, glycolipids and blood group substances.

**Unit – II: Lipids**

Lipids: Classification, saturated and unsaturated fatty acids, structure and properties of fats and oils, saponification and iodine values, rancidity. General properties and structures of phospholipids, sphingolipids and cholesterol. Prostaglandins- structure and biological role of PGD<sub>2</sub>, PGE<sub>2</sub> and PGF<sub>2</sub> α. Lipoproteins, Biomembranes, formation of micelles, bilayers, vesicles, liposomes. Membrane composition and organization – Fluid mosaic model.

**Unit-III: Amino Acids and Peptides**

Amino Acids: Classification, structure, stereochemistry, chemical reactions of amino acids due to carbonyl and amino groups. Titration curve of glycine and pK values. Essential and non-essential amino acids, non-protein amino acids. Peptide bond - nature and conformation. Naturally occurring peptides – glutathione, enkephalin.

**Unit-IV: Proteins**

Proteins: Classification based on solubility, shape and function. Determination of amino acid composition of proteins, General properties of proteins, denaturation and renaturation of proteins, Structural organization of proteins- primary, secondary, tertiary and quaternary structures (Eg. Hemoglobin and Myoglobin), forces stabilizing the structure of protein, Outlines of protein sequencing, Enzymes, the chemical and physical characteristics of enzymes, Effect of pH, temperature and other factors on enzyme action, Allosteric enzymes, enzyme-substrate interaction and the Michaelis-Menten constant, Inhibition of enzymes - General principles. Co-enzymes and co-factors: Brief introduction

**Unit-V : Nucleic Acids**

Nature of nucleic acids, Structure of purines and pyrimidines, nucleosides, nucleotides, Stability and formation of phosphodiester linkages, Effect of acids, alkali and nucleases on DNA and RNA, Structure of Nucleic acids- Watson-Crick DNA double helix structure, introduction to circular DNA, super coiling, helix to random coil transition, denaturation of nucleic acids- hyperchromic effect, T<sub>m</sub>-values and their significance Re-association kinetics, cot curves and their significance. Types of RNA and DNA.



**PRACTICALS**  
**Chemistry of Biomolecules (Lab)                      Paper code: BCHG1102**

1. Qualitative identification of carbohydrates- glucose, fructose, ribose/xylose, maltose, sucrose, lactose, starch/glycogen.
2. Qualitative identification of amino acids – histidine, tyrosine, tryptophan, cysteine, arginine.
3. Qualitative identification of lipids- solubility, saponification, acrolein test, Salkowski test, Lieberman-Burchard test.
4. Preparation of Osazones and their identification
5. Qualitative Identification of DNA, RNA and Nitrogen Bases
6. Isolation of casein from milk.

**Suggested Readings**

1. Lehninger's Principles of Biochemistry – Nelson.D.L. and Cox.M.M., W.H. Freeman & Co.
2. Fundamentals of Biochemistry – Voet.D and Voet., J.G., John Wiley & Sons .
3. Harper's Illustrated Biochemistry – Murray, R.K., Granner.D.K. & Rodwell,V.W., McGraw-Hill
4. Biochemistry-Lippincott's Illustrated Reviews. Champe, P.C. and Harvey, R. A. Lippincott
5. Fundamentals of Biochemistry –Jain, J.L., Jain, S., Jain, N. S. Chand & Co.
6. Biochemistry – Satyanarayana. U and Chakrapani. U, Books & Allied Pvt. Ltd.
7. Biochemistry by L. Stryer, W.H. Freeman and Co.

## Core Course: Biochemistry

CC –II: Biochemical and Biophysical techniques

Paper code: BCHG1103

(Credits: Theory-4, Practicals-2)

### THEORY

#### Unit – I: Biophysical Concepts

Concept of molar, molal, and normal solutions, Physiological saline, Water as a biological solvent and its role in biological processes, Biological relevance of pH, Importance and measurement of pH, Buffer strength, Buffer capacity, Biological Buffers, Donnan membrane equilibrium. Significance of osmotic pressure in biological systems

#### Unit-II: Biochemical Techniques I

Methods of tissue homogenization: (Potter-Elvehjem, mechanical blender, sonicator and enzymatic). Principle and applications of centrifugation techniques- differential, density gradient. Ultra-centrifugation- preparative and analytical.  
Principle and applications of chromatographic techniques- paper, thin layer, gel filtration, ion- exchange and affinity chromatography. Elementary treatment of an enzyme purification.  
Electrophoresis- principles and applications of paper, polyacrylamide (native and SDS) and agarose gel electrophoresis.

#### Unit-III: Biochemical Techniques II

Colorimetry and Spectrophotometry- Laws of light absorption- Beer-Lambert law. UV and visible absorption spectra, molar extinction coefficient, biochemical applications of spectrophotometer. Principle of fluorimetry.  
Tracer techniques: Radio isotopes, units of radio activity, half life,  $\beta$  and  $\gamma$ - emitters, use of radioactive isotopes in biology.

**Unit- IV: Immunological Techniques:** Immunodiffusion, Immunoelectrophoresis, radioimmunoassay, ELISA, Immunofluorescence.

### Practicals

Biochemical and Biophysical techniques (Lab)

Paper code: BCHG1104

1. Preparation of buffers (acidic, neutral and alkaline) and determination of  $pH$ .
2. Separation of amino acids by paper chromatography.
3. Separation of serum proteins by paper electrophoresis.
4. Separation of plant pigments by TLC.
5. Absorption spectra of protein-BSA, nucleic acids- Calf thymus DNA.

## **Suggested Readings**

- 1.** Practical Biochemistry by K. Wilson and I. Walker. 5th edition, Cambridge University press
- 2.** Practical Biochemistry by Shawney
- 3.** Analytical Biochemistry by P.Asokan, China publications
- 4.** Physical Biochemistry by David Frifelder. W. H. Freeman
- 5.** Instrumental Methods of Chemical Analysis by Galen Wood Ewing Mcgraw- Hill College
- 6.** Introduction to Instrumental Analysis by Robert D. Braun, Pharma Book Syndicate

## Core Course: Biochemistry

### CC-III: Intermediary Metabolism

Paper code: BCHG2105

(Credits: Theory-4, Practicals-2)

### THEORY

#### Unit- I: Carbohydrate Metabolism

Concept of anabolism and catabolism, Glycolytic pathway, energy yield, Fate of pyruvate- formation of lactate and ethanol, Pasteur effect, Citric acid cycle, regulation, energy yield, amphipathic role, Anaplerotic reactions. Glycogenolysis and glycogenesis, Pentose phosphate pathway, Gluconeogenesis. Photosynthesis- Light and Dark reactions, Calvin cycle, C<sub>4</sub> Pathway. Disorders of carbohydrate metabolism- Diabetes Mellitus

#### Unit- II: Lipid Metabolism

Catabolism of fatty acids ( $\beta$ - oxidation) with even and odd number of carbon atoms, Ketogenesis, *de novo* synthesis of fatty acids, elongation of fatty acids in mitochondria and microsomes, Biosynthesis and degradation of triacylglycerol and lecithin. Biosynthesis of cholesterol. Disorders of lipid metabolism.

#### Unit- III: Metabolism of Amino acids

General reactions of amino acid metabolism- transamination, decarboxylation and deamination, Urea cycle and regulation, Catabolism of carbon skeleton of amino acids- glycolytic and ketogenic amino acids, Metabolism of glycine, serine, aspartic acid, methionine, phenylalanine and leucine. Biosynthesis of creatine, Inborn errors of aromatic and branched chain amino acid metabolism.

#### Unit- IV: Nitrogen Fixation

Nitrogen cycle, Non-biological and biological nitrogen fixation, Nitrogenase system, Utilization of nitrate ion, Ammonia incorporation into organic compounds, Synthesis of glutamine and regulatory mechanism of glutamine synthase.

#### Unit- V: Metabolism of Nucleic acid and heme:

Biosynthesis and regulation of purine and pyrimidine nucleotides, *de novo* and salvage pathways, Catabolism of purines and pyrimidines, Biosynthesis of deoxyribonucleotides- ribonucleotide reductase and thymidylate synthase and their significance, Disorders of nucleotide metabolism- Gout, Lesch-Nyhan syndrome. Biosynthesis and degradation of heme.

## **PRACTICAL**

### **Intermediary Metabolism (Lab)**

**Paper code: BCHG2106**

1. Estimation of amino acid by Ninhydrin method.
2. Estimation of protein by Biuret method.
3. Estimation of protein by Lowry method.
4. Estimation of glucose by DNS method.
5. Estimation of glucose by Benedict's titrimetric method.
6. Estimation of total carbohydrates by Anthrone method.

### **Suggested Readings**

1. Campbell and Farrell, Biochemistry, Brooks/Cole Pub Co.
2. Davidson and Sittman, Biochemistry NMS, Lippincott. Williams and Wilkins.
3. Donald Voet, J.G. Voet and John Wiley, Biochemistry.
4. Kuchel and Ralston, Biochemistry, Schaum's Outlines McGraw Hill.
5. Murray, et al., Harper's Biochemistry, McGraw Hill.
6. Nelson and Cox, Lehninger's Principles of Biochemistry, McMillan Worth.
7. Biochemistry by Stryer, W. H. Freeman

**Core Course: Biochemistry**  
**CC -IV: Molecular Biology and Immunology**  
**(Credits: Theory-4, Practicals-2)**

**Paper code: BCHG2107**

**THEORY**

**Unit- I : DNA Replication and Transcription**

Nature and structure of the gene. DNA replication- models of replication, Meselson-Stahl's experimental proof for semi-conservative model. DNA polymerases I, II and III of *E.coli*, helicase, topoisomerases, primase, ligase. Bidirectional replication model. Okazaki fragments, leading and lagging strands of DNA synthesis. Inhibitors of DNA replication.

Transcription - RNA synthesis, RNA polymerases of prokaryotes. Promoters, Initiation- sigma factors and their recognition sites. Elongation- role of core enzyme. Termination- rho dependent and rho independent.

**Unit- II: Protein Synthesis and Regulation of Gene Expression**

Introduction to protein synthesis- Genetic code, deciphering of genetic code, Nirenberg's and Khorana's experiments, wobble hypothesis, degeneracy of genetic code.

Protein synthesis- activation of amino acids (aminoacyl t-RNA synthetases). Ribosome structure. Initiation, elongation and termination of protein synthesis. Post- translational modifications- signal hypothesis. Inhibitors of protein synthesis. Regulation of prokaryotic gene expression- induction and repression. Lac operon.

**Unit- III: Recombinant DNA technology**

Outlines of cloning strategies. DNA sequencing- Maxam Gilbert and Sanger's methods. Tools of r-DNA technology: Enzymes- Restriction endonucleases, ligase, phosphatases, reverse transcriptase, polynucleotide kinases, terminal transferase nucleases-S<sub>1</sub> and RNAase H. Restriction mapping. Cloning vectors- Plasmid, Expression vector - Host- *E.coli*.

Construction of c-DNA and genomic libraries. Isolation and sequencing of cloned genes- colony hybridization, nucleic acid hybridization. Polymerase chain reaction- principle and applications. Outlines of blotting techniques-Southern, Northern and Western.

Applications of gene cloning- production of insulin and human growth hormone, production of Bt cotton and edible vaccines.

**Unit- IV : Immunology**

Organization of immune system. Organs and cells of immune system. Innate and acquired immunity. Cell mediated and humoral immunity (T- and B- cells). Classification of immunoglobulins, structure of IgG. Epitopes / antigenic determinants. Concept of haptens. Adjuvants. Monoclonal antibodies.

Antigen-antibody reactions- agglutination, immunoprecipitation, immunodiffusion. Blood group antigens. Immunodiagnosics- ELISA. Vaccines and their classification. Traditional vaccines-live and attenuated. Modern vaccines- recombinant and peptide vaccines. Outlines of hypersensitivity reactions.

**Practicals**  
**Molecular Biology and Immunology (Lab)**

**Paper code: BCHG2108**

1. Isolation of DNA from onion/liver/coconut endosperm.
2. Estimation of DNA by diphenylamine method.
3. Estimation of RNA by orcinol method.
4. Sequence alignments of insulin/BSA with other proteins using BLAST and FASTA.
5. Dot Blot ELISA
6. Immunization Programme- Field visit.

**Suggested Readings**

1. Karp, G., Cell and Molecular Biology: Concepts and Experiments, John Wiley Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F, Cell and Molecular Biology, Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E., The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

## Discipline Specific Elective: Biochemistry

DSE I: Genetic Engineering and Biotechnology

Paper code: BCHG3209

### THEORY

#### Unit 1 Introduction to recombinant DNA technology

Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, separation of DNA by gel electrophoresis. Extraction and purification of plasmid and bacteriophage DNA.

#### Unit 2 Cloning vectors for prokaryotes and eukaryotes

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and  $\lambda$  bacteriophage. Vectors for yeast, higher plants and animals.

#### Unit 3 Joining of DNA fragments

Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides, synthesis and use.

#### Unit 4 Introduction of DNA into cells and selection for recombinants

Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants - insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Introduction of DNA into animal cells, electroporation.

#### Unit 5 Methods for clone identification

The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

#### Unit 6 Polymerase chain reaction

Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products. Cloning PCR products. Real time PCR.

#### Unit 7 DNA sequencing

DNA sequencing by Sanger's method, modifications based on Sanger's method. Automated DNA sequencing. Pyrosequencing.

#### Unit 8 Expression of cloned genes

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Challenges in producing recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

#### Unit 9 Applications of genetic engineering in Biotechnology

Site-directed mutagenesis and protein engineering. Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns.



**Practicals**  
**DSE I: Genetic Engineering and Biotechnology (Lab)**

**Paper code: BCHG3210**

1. Isolation of plasmid DNA from *E. coli* cells.
2. Digestion of plasmid DNA with restriction enzymes.
3. Amplification of a DNA fragment by PCR.
4. Transformation of *E. coli* cells with plasmid DNA.

**SUGGESTED READINGS**

1. Gene Cloning and DNA Analysis (2010) 6<sup>th</sup> ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. Principles of Gene Manipulation and Genomics (2006) 7<sup>th</sup> ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4<sup>th</sup> ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

**Discipline Specific Elective: Biochemistry**

**DSE II: Advance Cell Biology          Paper code: BCHG3211**

**(Credits: Theory-4, Practicals-2)**

**THEORY**

**Unit 1 Plasma Membrane and Nuclear Transport**

Properties and Composition of Cell Membrane; Structure of Nuclear Envelope; Nuclear Pore Complex; Transport Across Nuclear Envelope; Regulation of Nuclear Protein Import and Export.

**Unit 2 Cell-Cell Interaction**

Cell-Cell Interactions and Cell-Matrix Interactions; Components of Extracellular Matrix: Collagen and Non- Collagen Components; Tight Junctions; Gap Junctions; Desmosomes; Hemidesmosomes; Focal Adhesions And Plasmodesmata; Cell Wall; Role Of Cell Interaction In Development.

**Unit 3 Cell Cycle and Programmed Cell Death**

Overview of The Cell Cycle; Eukaryotic Cell Cycle; Events Of Mitotic Phase; Cytokinesis; Events Of Meiosis And Fertilization; Regulation Of Cell Division And Cell Growth; Apoptosis And Necrosis, Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning.

**Unit 4 Cancer Biology**

Development and causes Of Cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses; Molecular Approach to Cancer Treatment.

**Unit 5 Advanced Methods in Cell Biology**

Ultracentrifugation, Fluorescence Microscopy- FACS, Confocal Microscopy, Electron Microscopy, Plant and Animal Cell Culture, Immunohistochemistry.

**Practical  
Advanced Cell Biology (Lab)  
BCHG3212**

**Paper code:**

1. Isolation of organelles by sub-cellular fractionation.
2. Study of cell viability /death assay by use of trypan blue and MTT assay.
3. Study of apoptosis through analysis of DNA fragmentation patterns in mitochondria.
4. Identification and study of cancerous cells using permanent slides and photomicrographs.

**SUGGESTED READINGS**

1. Cooper, G.M. and Hausman, R.E. 2009 *The Cell: A Molecular Approach*. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. Karp, G. 2010 *Cell and Molecular Biology: Concepts and Experiments*. 6 edition. John Wiley & Sons. Inc.
3. Alberts, B., Johnson, A., Lewis, J., and Enlarge, M. 2008 *Molecular Biology of the Cell*. 5th ed., Garland Science (Princeton),
4. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J. 2012. *Molecular Cell Biology*. 7th ed., W.H. Freeman & Company (New York), 5. 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.

## Discipline Specific Elective: Biochemistry

DSE III: Human Physiology

Paper code: BCHG3211

(Credits: Theory-4, Practicals-2)

### THEORY

#### **Unit 1 Homeostasis and the organization of body fluid compartments**

Intracellular, extracellular and interstitial fluid. Homeostasis, control system and their components. Plasma as an extracellular fluid, RBC, molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Anemias, polycythemia, haemophilia and thrombosis.

#### **Unit 2 Cardiovascular physiology**

Pressure, flow and resistance. Anatomy of heart. Physiology of the cardiac muscle, automaticity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction.

#### **Unit 3 Respiration**

Organization of the pulmonary system. Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport. Regulation of respiration. Pulmonary oedema and regulation of pleural fluid. Hypoxia, hypercapnea, pulmonary distress, emphysema, ARDS.

#### **Unit 4 Renal physiology**

Anatomy of the kidney and the nephron. Regulation of renal blood flow. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Micturition reflex and voluntary control of micturition. Regulation of ECF electrolyte and water content, blood volume and long term blood pressure. Blood buffer systems, renal and pulmonary control of blood pH, renal clearance. Assessment of kidney function. Acidosis and alkalosis. Glomerular nephritis, renal failure, dialysis and diuretics.

#### **Unit 5 Gastrointestinal and hepatic physiology**

Histology of the gastrointestinal tract. Propulsion and motility of food and digested material. Enteric reflexes, secretory functions of the gastrointestinal tract, digestion and absorption of macro and micronutrients. Peptic ulcer, Sprue, celiac disease, IBD, regurgitation, diarrhoea and constipation. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. enterohepatic cycle, reticuloendothelial system, metabolic importance of liver. Liver function tests. Jaundice, liver cirrhosis and fatty liver.

#### **Unit 6 Musculoskeletal system**

Bone structure and formation. Physiology of muscle contraction in striated and non-striated muscle.

#### **Unit 7 Reproductive physiology**

Sex determination and differentiation. Development of female and male genital tracts. Spermatogenesis, capacitation and transport of sperm, blood testis barrier. Ovarian function and its control. Uterine changes, fertilization and implantation. Placenta as a feto- maternal unit, gestation and parturition.

## **Unit 8 Neurochemistry and neurophysiology**

Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Membrane potentials. Synaptic transmission. Neurotransmitters. Sensory receptors and neural pathways. Somatic sensation, EEG, sleep, coma, learning and memory.

## Practicals

### DSE III: Human Physiology

Paper code: BCHG3212

1. RBC and WBC counting
2. Differential leucocyte count.
3. Clotting time.
4. Estimation of haemoglobin.
5. Determination of total iron binding capacity.
6. Histology of connective tissue, liver and/ brain permanent slides.
7. Case studies (Renal clearance, GFR, ECG).

### SUGGESTED READINGS

1. Vander's Human Physiology (2008) 11<sup>th</sup> ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York), ISBN: 978-0-07-128366-3.
2. Harper's Biochemistry (2012) 29<sup>th</sup> ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.
3. Textbook of Medical Physiology (2011) 10<sup>th</sup> ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.
4. Fundamental of Anatomy and Physiology (2009), 8<sup>th</sup> ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13: 978-032153910-6.

## Core Course: Microbiology

CC-I: Introduction to Microbiology and Microbial Diversity

Paper code: MICG1101

(Credits: Theory-4, Practicals-2)

### THEORY

#### Unit 1 History of Development of Microbiology

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff and Edward Jenner.

#### Unit 2 Diversity of Microbial World

##### A. Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

**B. General characteristics** of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

##### • Algae

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

##### • Fungi

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

##### • Protozoa

General characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia.

#### Unit 3 An overview of Scope of Microbiology

## **PRACTICALS**

### **Introduction to Microbiology and Microbial Diversity (Lab)**

**Paper code: MICG1102**

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Sterilization of medium using Autoclave and assessment for sterility.
4. Sterilization of glassware using Hot Air Oven and assessment for sterility.
5. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
6. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
7. Study of Rhizopus, Penicillium, Aspergillus, Saccharomyces using temporary mounts.
8. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium.

### **Suggested Readings**

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14<sup>th</sup> edition. Pearson International Edition .
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9<sup>th</sup> Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGrawHill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5<sup>th</sup> edition. McMillan.



## Core Course: Microbiology

CC-II: Bacteriology and Virology

Paper code: MICG1103

(Credits: Theory-4, Practicals-2)

### THEORY

#### Unit 1 Bacterial Cell Organization

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.  
Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaeobacterial cell wall, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms.  
Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.  
Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids  
Endospore: Structure, formation, stages of sporulation.

#### Unit 2 Bacteriological techniques and Microscopy

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; Bright Field Microscope: Principle and functions

#### Unit 3 Nutrition, Growth and Reproduction

Nutritional requirements in bacteria and nutritional categories.  
Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.  
Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.  
Physical and Chemical methods of microbial control: Types and mode of action.

#### Unit 4 Important archaeal and eubacterial groups

**Archaeobacteria:** General characteristics, phylogenetic overview, genera belonging to thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)

**Eubacteria:** Morphology, metabolism, ecological significance and economic importance

**Gram Negative:** Non proteobacteria, Alpha proteobacteria, Beta proteobacteria, Gamma proteobacteria, Delta proteobacteria, Epsilon proteobacteria, Zeta proteobacteria.

**Gram Positive:** General characteristics with reference to *Lactobacillus*, *Bacillus*, *Clostridium*, *Mycoplasma*, *Staphylococcus*, *Streptococcus* and *Heliobacterium*.

**Cyanobacteria:** General characteristics.

#### Unit 5 Nature and Properties of Viruses

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin.

Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses. Salient features of viral Nucleic acid.

Viral taxonomy: Classification and nomenclature of different groups of viruses.

#### Unit 6 Bacteriophages and Retrovirus

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage), concept of early and late proteins, regulation of transcription in lambda phage, terminal cohesive ends, HIV (retrovirus)

### **Unit 7 Prevention & control of viral diseases**

Antiviral compounds and their mode of action, Interferon and their mode of action. General principles of viral vaccination.

### **Unit 8 Applications of Virology**

Use of viral vectors in cloning and expression, Gene therapy, Phage display and phage therapy.

## **PRACTICALS**

### **Bacteriology and Virology (Lab)**

**Paper code: MICG1104**

1. Preparation of different media: Synthetic Media, Complex media (Nutrient Agar, McConkey agar).
2. Simple staining, Gram's staining, Negative staining, Acid fast staining (permanent slide only), Capsule staining and Spore staining.
3. Isolation of pure cultures of bacteria by streaking method.
4. Estimation of CFU count by spread plate method/pour plate method.
5. Demonstration of Motility by hanging drop method.
6. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo, hepatitis B and retroviruses) using electron micrographs.
7. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.
8. Study of the structure of important bacterial viruses ( $\phi$ X 174, T4,  $\lambda$ ) using electron micrograph.
9. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
10. Studying isolation and propagation of animal viruses by chick embryo technique by photographs.
11. Study of cytopathic effects of viruses using photographs.
12. Performing local lesion technique for assaying plant viruses.

### **Suggested Readings**

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14<sup>th</sup> edition. Pearson International Edition .
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9<sup>th</sup> Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGrawHill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5<sup>th</sup> edition. McMillan.
8. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall.
9. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd
10. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
11. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
12. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
13. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

## Core Course: Microbiology

CC–III: Microbial Genetics, Physiology and Metabolism

Paper code: MICG2105

(Credits: Theory-4, Practicals-2)

### THEORY

#### Unit 1 Genome Organization and Mutations

Genome organization: *E. coli*, *Saccharomyces*.

Organelle genome: Chloroplast and Mitochondria.

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations.

Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes.

#### Unit 2 Plasmids and Mechanism of Genetic Exchange

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2  $\mu$  plasmid. Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.

Transformation - Discovery, mechanism of natural competence.

Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping.

Transduction - Generalized transduction, specialized transduction.

#### Unit 3 Phage Genetics and Transposable elements

Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda.

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons,

Replicative and Non-replicative transposition, Mu transposon.

Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements).

Uses of transposons and transposition.

#### Unit 4 Microbial Growth and Effect of Environment on Microbial Growth

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate

Effect of temperature, pH, solute, oxygen concentration and water activity on microbial growth.

Nutritional categories of microorganisms.

#### Unit 5 Nutrient uptake and Transport

Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport

Group translocation.

#### Unit 6 Chemoheterotrophic Metabolism- - Aerobic Respiration, Anaerobic respiration and fermentation

Concept of aerobic respiration, anaerobic respiration and fermentation.

Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle.

Electron transport chain: components of respiratory chain, electron transport phosphorylation.

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration).

Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

### **Unit 7 Chemolithotrophic and Phototrophic Metabolism**

Introduction to aerobic and anaerobic chemolithotrophy with an example each.

Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria.

## **PRACTICALS**

**Microbial Genetics, Physiology and Metabolism (Lab)      Paper code: MICG2106**

1. Preparation of Master and Replica Plates.
2. Study the effect of chemical (HNO<sub>2</sub>) and physical (UV) mutagens on bacterial cells.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
4. Isolation of Plasmid DNA from *E. coli*.
5. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
6. Demonstration of Bacterial Conjugation.
7. Demonstration of Ames test.
8. Study and plot the growth curve of *E. coli* by turbidometric method.
9. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
10. Studying Effect of pH and temperature on growth of *E. coli*.
11. Demonstration of alcoholic fermentation.

### **Suggested Readings**

1. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14<sup>th</sup> edition. Pearson International Edition.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
3. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
4. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.
5. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9<sup>th</sup> Edition. McGraw Hill International.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5<sup>th</sup> edition. McMillan.
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
8. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
9. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
10. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings.
11. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning.
12. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings.
13. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
14. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers.

## Core Course: Microbiology

CC-IV: Industrial and Medical Microbiology

Paper code: MICG2107

(Credits: Theory-4, Practicals-2)

### THEORY

#### Unit 1 Introduction to industrial microbiology and fermentation processes

Brief history and developments in industrial microbiology.

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations.

Components of a typical bio-reactor, Types of Bioreactors-Laboratory, pilot- scale and production fermenters.

Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

#### Unit 2 Isolation of industrially important microbial strains and production of industrial products

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement.

Citric acid, ethanol, glutamic acid, Vitamin B12. Enzymes (amylase, protease, lipase).

Wine, beer. Antibiotics – Penicillin, Streptomycin.

#### Unit 3 Enzyme immobilization and Downstream processing

Methods of immobilization, advantages and applications of immobilization, large scale applications of

immobilized enzymes (glucose isomerase and penicillin acylase).

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.

#### Unit 4 Normal microflora of the human body and host pathogen interaction

Normal microflora of skin, throat, gastrointestinal tract, urogenital tract.

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxicogenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS.

#### Unit 5 Sample collection, transport and diagnosis

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

#### Unit 6 Microbial Diseases

**Bacterial diseases:** Study symptoms, mode of transmission, prophylaxis and control of

Respiratory Diseases: *Streptococcus pyogenes*, *Mycobacterium tuberculosis*

Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori*.

Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*, *Treponema pallidum*, *Clostridium difficile*.

**Viral diseases:** Study symptoms, mode of transmission, prophylaxis and control of Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis.

**Protozoan diseases:** Study symptoms, mode of transmission, prophylaxis and control of Malaria and Kala-azar.

**Fungal diseases:** Brief description of each of the following types of mycoses:

Cutaneous mycoses: Tinea pedis (Athlete's foot).

Systemic mycoses: Histoplasmosis.

Opportunistic mycoses: Candidiasis.

### **Unit 7 Antimicrobial agents: General characteristics and mode of action**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism.

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin.

Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine

Antibiotic resistance, MDR, XDR, MRSA, NDM-1

## **PRACTICALS**

### **Industrial and Medical Microbiology (Lab) Paper code: MICG2108**

1. Study different parts of fermenter.
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
  - (a) Enzymes: Amylase and Protease.
  - (b) Amino acid: Glutamic acid.
  - (c) Organic acid: lactic acid/ Acetic Acid
  - (d) Alcohol: Ethanol.
3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.
4. Identify bacteria, *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus* (any three) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
5. Study of composition and use of important differential media for identification of bacteria: EMB Agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
6. Study of bacterial flora of skin by swab method.
7. Perform antibacterial sensitivity by Kirby-Bauer method.
8. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms).
9. Study of various stages of Malarial parasite in RBCs using permanent mounts/Photomicrographs.

### **Suggested Readings**

1. Madigan Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA.
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition, Wiley – Blackwell.
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company.
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

6. Crueger W and Crueger A. (2000). *Biotechnology: A textbook of Industrial Microbiology*. 2<sup>nd</sup> edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). *Principles of Fermentation Technology*. 2<sup>nd</sup> edition, Elsevier Science Ltd.
6. Ananthanarayan R. and Paniker C.K.J. (2009) *Textbook of Microbiology*. 8<sup>th</sup> edition, University Press Publication.
7. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) *Jawetz, Melnick and Adelberg's Medical Microbiology*. 26<sup>th</sup> edition. McGraw Hill Publication.
8. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) *Mims' Medical Microbiology*. 4<sup>th</sup> edition. Elsevier.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013) *Prescott, Harley and Klein's Microbiology*. 9<sup>th</sup> edition. McGraw Hill Higher Education.
10. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). *Brock Biology of Microorganisms*. 14<sup>th</sup> edition. Pearson International Edition.

## **Discipline Specific Elective: Microbiology**

**DSE-I: Environmental Microbiology**

**Paper code: MICG3209**

**(Credits: Theory-4, Practicals-2)**

### **THEORY**

#### **Unit 1 Microorganisms and their Habitats**

Structure and function of ecosystems.

Terrestrial Environment: Soil profile and soil microflora.

Aquatic Environment: Microflora of fresh water and marine habitats.

Atmosphere: Aeromicroflora and dispersal of microbes.

Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.

Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Microbial succession in decomposition of plant organic matter.

#### **Unit 2 Microbial Interactions**

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation.

Microbe-Plant interaction: Symbiotic and non-symbiotic interactions.

Microbe-animal interaction: termite gut microflora, nematophagus fungi and symbiotic luminescent bacteria.

#### **Unit 3 Biogeochemical Cycling**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin.

Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction.

Phosphorus cycle: Phosphate immobilization and solubilisation.

Sulphur cycle: Microbes involved in sulphur cycle.

Other elemental cycles: Iron and manganese.

#### **Unit 4 Waste Management**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill).

Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

#### **Unit 5 Microbial Bioremediation**

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.

#### **Unit 6 Water Potability**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.



## **PRACTICALS**

### **Environmental Microbiology (Lab)**

**Paper code: MICG3210**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of Rhizobium from root nodules.

### **Suggested Readings**

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings.
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York.
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg.
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
10. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. NewYork & London.
11. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
12. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
13. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

**Discipline Specific Elective: Microbiology**  
**DSE–II: Advances in Microbiology**                      **Paper code: MICG3211**  
**(Credits: Theory-4, Practicals-2)**

**THEORY**

**Unit 1 Evolution of Microbial Genomes**

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence – Genomic islands, Pathogenicity islands (PAI) and their characteristics, CRISPR/CAS system.

**Unit 2 Metagenomic**

Brief history and development of metagenomics, understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics. Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

**Unit 3 Molecular Basis of Host-Microbe Interactions**

Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens,

Biofilms: types of microorganisms, molecular aspects and significance in environment, health care,

virulence and antimicrobial resistance.

**Unit 4 Systems and Synthetic Biology**

Networking in biological systems, Quorum sensing and quenching in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses.

## **PRACTICALS**

**Advances in Microbiology (Lab)**

**Paper code: MICG3212**

1. Extraction of metagenomic DNA from soil.
2. Understand the impediments in extracting metagenomic DNA from soil.
3. PCR amplification of metagenomic DNA using universal 16S ribosomal gene primers.
4. Case study to understand how the poliovirus genome was synthesized in the laboratory.
5. Case study to understand how networking of metabolic pathways in bacteria takes place.

### **Suggested Readings**

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press.
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press.
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press.
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press.
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag.
6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons.
7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brock's Biology of Microorganisms, 14<sup>th</sup> edition, Pearson-Benjamin Cummings.
8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011) Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press.
9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International.
10. Voit EO (2012) A First Course in Systems Biology, 1st edition, Garland Science.

**Discipline Specific Elective: Microbiology**  
**DSE–III: Microbial Biotechnology      Paper code: MICG3211**  
**(Credits: Theory-4, Practicals-2)**

**THEORY**

**Unit 1 Microbial Biotechnology and its Applications**

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology.

Use of prokaryotic and eukaryotic microorganisms in biotechnological applications.

Genetically engineered microbes for industrial application: Bacteria and yeast.

**Unit 2 Therapeutic and Industrial Biotechnology**

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine).

Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics

Microbial biosensors.

**Unit 3 Applications of Microbes in Biotransformations**

Microbial based transformation of steroids and sterols.

Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute.

**Unit 4 Microbial Products and their Recovery**

Microbial product purification: filtration, ion exchange & affinity chromatography techniques  
Immobilization methods and their application: Whole cell immobilization.

**Unit 5 Microbes for Bio-energy and Environment**

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture.

Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents.

**Unit 6 RNAi**

RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions.

**Unit 7 Intellectual Property Rights**

Patents, Copyrights, Trademarks.

## **PRACTICALS**

**Advances in Microbiology (Lab)**

**Paper code: MICG3212**

1. Study yeast cell immobilization in calcium alginate gels.
2. Study enzyme immobilization by calcium alginate method.
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*).
4. Isolation of xylanase or lipase producing bacteria.
5. Study of algal Single Cell Proteins.
6. Hydrolysis of Starch/Polysaccharide/Lignocellulosic residue.
7. Biotransformation of steroid and its detection by a suitable method (TLC).
8. Demonstration of production of a recombinant product.

### **Suggested Readings**

1. Fraser Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2<sup>nd</sup> Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in *Escherichia coli* production of therapeutic proteins. *Current Opinion in Biotechnology*, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications.
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press.
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science.
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc..

**Core Course Chemistry: 1**  
**Conceptual Organic Chemistry**  
**(Credits: Theory-4, Practicals-2)**

**THEORY**  
**Lectures: 60**

**Unit 1: Stereochemistry** **(18 Lectures)**

Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae.  
Interconversion of one type of structural representation into another type.

**Conformations:** Restricted rotation about single bonds, Various conformations of ethane, butane, ethane-1,2-diol and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds.

**Geometrical Isomerism:** Requirements for a molecule to show geometrical isomerism, Cis-Trans and E/ Z notation along with CIP rules for geometrical isomers.

**Optical Isomerism:** Optical activity, specific and molar rotation, chirality, enantiomerism, diastereoisomerism, racemic mixtures and their resolution by salt formation method.

**Relative and absolute configuration:** D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. R- and S- configuration (upto two chiral centres).

**Unit 2: Addition Reactions** **(10 Lectures)**

**Alkenes and Alkynes:** Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercuration-demercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes.

**Aldehydes and ketones:** (formaldehyde, acetaldehyde, benzaldehyde, acetone)  
Addition of sodium bisulphite, hydrogen cyanide and alcohols.  
Addition- elimination reactions with ammonia and its derivatives

**Name reactions:** Aldol, cross Aldol, Claisen, Knoevengel, Cannizzaro, cross Cannizzaro

**Unit 3: Substitution Reactions** **(15 Lectures)**

**Free radical substitution reactions:** Halogenation of alkanes, allylic compounds and alkyl benzenes.

**Nucleophilic substitution reactions:** Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group)

**Benzene diazonium chloride:** Replacement of diazo group

**Alcohols, amines and phenols:** Substitution of active hydrogen, replacement of hydroxyl group in alcohols (using PCl<sub>5</sub>, SOCl<sub>2</sub> and HI)

**Carboxylic acid derivatives:** Hydrolysis

**Ethers:** Cleavage by HI

**Electrophilic Substitution Reactions** (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents.

#### **Unit 4: Elimination Reactions**

**(6 Lectures)**

Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination). Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution

#### **Unit 5: Oxidation**

**(6 Lectures)**

**Aromatic side chain:** Oxidation with potassium permanganate, potassium dichromate

**Alcohols:** Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenation and Oppenauer oxidation. Oxidation of 1,2-diols with periodic acid and lead tetraacetate.

**Aldehydes:** Oxidation with potassium permanganate, chromic acid and Tollen's reagent

**Ketones:** Oxidation with potassium permanganate, sodium hypiodite (iodoform reaction) and Baeyer–Villiger oxidation

#### **Unit 6: Reductions**

**(5 Lectures)**

**Aldehydes and Ketones:** Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner

**Carboxylic acids and their derivatives:** Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction.

**Nitro compounds:** Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

**Recommended Texts:**

1. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
2. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Pearson Education.
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.
5. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*; Wiley: London, 1994.
6. T. W. Graham Solomon's *Organic Chemistry*, John Wiley and Sons.
7. P.S. Kalsi, *Stereochemistry, Conformation and Mechanism*, John Wiley and Sons.
8. D. Nasipuri, *Stereochemistry of Organic Compounds*, New Age International Publishers.



## PRACTICAL-1

1. Purification of organic compounds by crystallization using the following solvents:
  - a. Water
  - b. Alcohol
2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).
3. Determination of optical activity by using polarimeter

**Organic preparations:** Carry out the following preparations using 0.5 - 1 g of starting compound. Recrystallize the product and determine the melting point of the recrystallized sample.

4. To prepare acetanilide by the acetylation of aniline.
5. To prepare p-bromoacetanilide.
6. Benzoylation of aniline or  $\beta$ -naphthol by Schotten-Baumann reaction
7. Hydrolysis of benzamide or ethyl benzoate.
8. Semicarbazone derivative of one the following compounds: acetone, ethyl methyl ketone, diethylketone, cyclohexanone, benzaldehyde.
9. Nitration of nitrobenzene.
10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

### Recommended Texts:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry*, 5<sup>th</sup> Ed., Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Longman, London & New York.
3. Ahluwalia, V.K.; Dhingra, S. & Gulati, A. *College Practical Chemistry*, Universities Press.

**Core Course Chemistry-II**  
**Molecules of Life**  
**(Credits: Theory-4, Practicals-2)**

**THEORY**  
**Lectures: 60**

**Unit 1: Carbohydrates** **(10 Lectures)**

Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof).

Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose.

Linkage between monosachharides, structure of disachharides (sucrose, maltose, lactose) and polysachharides (starch and cellulose) excluding their structure elucidation.

**Unit 2: Amino Acids, Peptides and Proteins** **(12 Lectures)**

Classification of Amino Acids, Zwitterion structure and Isoelectric point.

Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C-terminal amino acid (by 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: Enzymes and correlation with drug action** **(12 Lectures)**

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and non-competitive inhibition including allosteric inhibition). Drug action - receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, -NH<sub>2</sub> group, double bond and aromatic ring.

**Unit 4: Nucleic Acids** **(10 Lectures)**

Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

**Unit 5: Lipids** **(8 Lectures)**

Introduction to lipids, classification.

Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.  
Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

## Unit 6: Concept of Energy in Biosystems

(8 Lectures)

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats.

Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change.

Conversion of food into energy. Outline of catabolic pathways of Carbohydrates - Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of fats and proteins. Interrelationships in the metabolic pathways of proteins, fats and carbohydrates.

### Recommended Texts:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry (Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7<sup>th</sup> Ed.*, W. H. Freeman.
5. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7<sup>th</sup> Ed.*, W. H. Freeman.

### PRACTICAL-2

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/nonreducing sugar.
9. Extraction of DNA from onion/ cauliflower
10. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

### Recommended Texts:

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
2. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press.

**Core Course Chemistry: III**  
**CHEMICAL BONDING, TRANSITION METAL & COORDINATION CHEMISTRY**  
**(Credits: Theory-4, Practicals-2)**

**THEORY**  
**Lectures: 60**

**Unit 1: The covalent bond and the structure of molecules (10 Lectures)**

Valence bond approach, Concept of resonance in various organic and inorganic compounds, Hybridization and structure, equivalent and non-equivalent hybrid orbitals, Bent's rule and its applications, VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

**Unit 2: Molecular Orbital Approach (10 Lectures)**

LCAO method, symmetry and overlap for s-s, s-p and p-p combinations, MO treatment of homonuclear diatomic molecules of 2<sup>nd</sup> period (B<sub>2</sub>, C<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, F<sub>2</sub>) and heteronuclear diatomic molecules (CO, NO) and their ions.

**Unit 3: Intermolecular forces: (8 Lectures)**

van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility.

**Unit 4: Transition Elements (3d series) (12 Lectures)**

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.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

**Unit 5: Coordination Chemistry (10 Lectures)**

Valence 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.

Coordination compounds in biological systems: Fe, Cu, Co, Mn, Ni, Zn and heavy metal ions.

**Unit 6: Crystal Field Theory (10 Lectures)**

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry.

Jahn-Teller distortion, Square planar coordination.

**Suggested Texts:**

1. James E. Huheey, "*Inorganic Chemistry: Principles of structure and reactivity*", Prentice Hall, IV Edition.
2. D. S. Shriver and P.A. Atkins, "*Inorganic Chemistry*", Oxford University Press, IV Edition.
3. Alan G. Sharpe, "*Inorganic Chemistry*", University of Cambridge, III Edition.
4. J. D. Lee, "*A New Concise Inorganic Chemistry*", ELBS IV Edition
5. Grey L. Miessler and Donald A. Tarr, "*Inorganic Chemistry*", Prentice Hall, III Edition.
6. B. Douglas, D. H. McDaniel and J. J. Alexander, "*Concepts and Models of Inorganic Chemistry*", John Wiley and Sons, III Edition.
7. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.

## PRACTICAL-3

### Titrimetric Analysis:

Preparations of standard solutions (concept of primary and secondary standards), Different units of concentration (molarity, molality, normality and formality)

#### (A) Titrations involving Acids-Bases:

Principles of acid-base titrations, Principle behind selection of an appropriate indicator.

1. Standardization of NaOH solution (standard solution of oxalic acid to be prepared)
2. Determination of concentration of carbonate and hydroxide present in a mixture.
3. Determination of concentration of carbonate and bicarbonate present in a mixture.
4. Determination of concentration of free alkali present in soaps/detergents/shampoos.

#### (B) Titrations involving redox reactions:

Concept of electrode potential, principle behind selection of an appropriate indicator.

5. Standardization of  $\text{KMnO}_4$  solution (standard solution of Mohr's salt to be prepared).
6. Determination of concentration of Fe(II) in Mohr's salt and/or  $\text{K}_2\text{Cr}_2\text{O}_7$  using diphenylamine/ N-phenylanthranilic acid as internal indicator (standard solution of  $\text{K}_2\text{Cr}_2\text{O}_7$  and /or Mohr's salt to be prepared).
7. Determination of iron content in ores / alloys using appropriate redox titration.

#### (C) Complexometric Titrations

Principles of complexometric titrations

8. Determination of concentration of Mg (II) & Zn (II) by titrimetric method using EDTA.
9. Determination of concentration of Ca/Mg in drugs or in food samples.
10. Determination of concentration of total hardness of a given sample of water by complexometric titration.

(At least 2 experiments from each set.)

#### Recommended Texts:

1. Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS.
2. Harris, D.C. & Freeman, W.H. & Co. *Quantitative Chemical Analysis* 7<sup>th</sup> Ed., New York.

**Core Course Chemistry: IV**  
**Physical Chemistry for the Biosciences**

**(Credits: Theory-4, Practicals-2)**

**THEORY**  
**Lectures: 60**

**Unit 1: Chemical Energetics** **(10 Lectures)**

Review of the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, 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 – Kirchoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

**Unit 2: Chemical Equilibrium** **(8 Lectures)**

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

**Unit 3: Ionic Equilibria** **(12 Lectures)**

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.

**Unit 4: Chemical Kinetics** **(8 Lectures)**

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 and first order reactions. Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Enzyme kinetics.

**Unit 5: Spectroscopy** **(16 Lectures)**

Introduction to spectroscopy: Electromagnetic radiation, fundamental definitions, electromagnetic spectrum, introduction to concepts of absorption and emission spectroscopy, Beer-Lambert law.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations, IR spectrum, fingerprint and group frequency regions and their significance, Hooke's law and vibrational frequency. Factors affecting vibrational frequency.

Characterization of functional groups: alkanes, alkenes, alkynes (only alicyclic systems), aldehydes, ketones, carboxylic acids and their derivatives, hydroxy compounds and amines. Study of hydrogen bonding.

Electronic Spectroscopy: Electronic transitions, singlet and triplet states, dissociation and predissociation.

UV spectroscopy: Types of electronic transitions, UV spectrum,  $\lambda_{\max}$ ,  $\epsilon_{\max}$ , chromophores, auxochromes, bathochromic shift, hypsochromic shift (definitions and elementary examples) and solvent effect. Characteristic UV transitions in common functional groups.

General applications of UV spectroscopy including distinction between cis-trans isomers.

Woodward rules for calculating  $\lambda_{\max}$  in the following systems:

- Conjugated dienes: alicyclic, homoannular, heteroannular.
- $\alpha,\beta$ -Unsaturated aldehydes and ketones.
- Extended conjugated systems: dienes, aldehydes and ketones.

PMR spectroscopy: Basic principles of NMR spectroscopy, PMR scale, chemical shifts (concept of shielding and deshielding), factors influencing chemical shifts, simple spin-spin couplings, coupling constant, chemical shift equivalence, anisotropic effects in alkenes, alkynes, aldehydes and aromatics. Interpretation of PMR spectra of simple compounds.

Application of UV, IR and PMR in solving structures of simple molecules.

## Unit 6: Photochemistry

(6 Lectures)

Laws of photochemistry. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions.

### Recommended Texts:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 9th Ed., Oxford University Press (2011).
2. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
4. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).
5. Chang, R. *Physical Chemistry for the Biosciences*. University Science Books (2005).

## PRACTICAL-4

### (I) Thermochemistry

1. Determination of heat capacity of a calorimeter for different volumes.
2. Determination of the enthalpy of neutralization of hydrochloric acid with sodium hydroxide.



3. Determination of integral enthalpy of solution of salts (endothermic and exothermic).

### **(III) pH-metric and potentiometric measurements**

4. Preparation of sodium acetate-acetic acid buffer solutions and measurement of their pH.
5. Potentiometric titrations of (i) strong acid vs strong base (ii) weak acid vs strong base
6. Determination of dissociation constant of a weak acid.

### **(IV) Study the kinetics of the following reactions:**

7. Initial rate method: Iodide-persulphate reaction
8. Integrated rate method:
  - a. Acid hydrolysis of methyl acetate with hydrochloric acid.
  - b. Saponification of ethyl acetate

### **(V) Colourimetry**

9. Verification of Lambert-Beer's Law for potassium dichromate/ potassium permanganate solution.
10. Determination of pK (indicator) for phenolphthalein.
11. Study the kinetics of interaction of crystal violet with sodium hydroxide colourimetrically.

### **Recommended Texts:**

1. Khosla, B.D.; Garg, V.C.; Gulati, A. & Chand, R. *Senior Practical Physical Chemistry*, New Delhi.

## Discipline Specific Electives

Select two papers

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### CHEMISTRY-DSE (ELECTIVES)

#### **CHEMISTRY-DSE: ANALYTICAL METHODS IN CHEMISTRY**

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

#### **Qualitative and quantitative aspects of analysis:**

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

(5 Lectures)

#### **Optical methods of analysis:**

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

*UV-Visible Spectrometry:* Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

*Basic principles of quantitative analysis:* estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

*Infrared Spectrometry:* Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

*Flame Atomic Absorption and Emission Spectrometry:* Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

(25 Lectures)

#### **Thermal methods of analysis:**

Theory of thermogravimetry (TG), basic principle of instrumentation.

Techniques for quantitative estimation of Ca and Mg from their mixture.

(5 Lectures)

#### **Electroanalytical methods:**

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

(10 Lectures)

### **Separation techniques:**

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.

Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange.

Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).

Role of computers in instrumental methods of analysis.

(15 Lectures)

### **Reference Books:**

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
  - Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7<sup>th</sup> Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
  - Christian, G.D; *Analytical Chemistry*, 6<sup>th</sup> Ed. John Wiley & Sons, New York, 2004.
  - Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
  - Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
  - Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
  - Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
  - Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.
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## **PRACTICALS- DSE LAB: ANALYTICAL METHODS IN CHEMISTRY**

### **60 Lectures**

#### **I. Separation Techniques**

##### 1. Chromatography:

###### (a) Separation of mixtures

(i) Paper chromatographic separation of  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ , and  $\text{Cr}^{3+}$ .

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the  $R_f$  values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their  $R_f$  values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

#### **II. Solvent Extractions:**

(i) To separate a mixture of  $\text{Ni}^{2+}$  &  $\text{Fe}^{2+}$  by complexation with DMG and extracting the  $\text{Ni}^{2+}$ - DMG complex in chloroform, and determine its concentration by spectrophotometry.

(ii) Solvent extraction of zirconium with amberliti LA-1, separation from a mixture of irons and gallium.

3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

##### 5. Analysis of soil:

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

##### 6. Ion exchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.

(iii) Separation of amino acids from organic acids by ion exchange chromatography.

#### **III Spectrophotometry**

1. Determination of pK<sub>a</sub> values of indicator using spectrophotometry.
- 2 Structural characterization of compounds by infrared spectroscopy.
- 3 Determination of dissolved oxygen in water.
- 4 Determination of chemical oxygen demand (COD).
- 5 Determination of Biological oxygen demand (BOD).
- 6 Determine the composition of the ferric-salicylate/ ferric-thiocyanate complex by Job's method.

#### Reference Books:

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7<sup>th</sup> Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
- Christian, Gary D; *Analytical Chemistry*, 6<sup>th</sup> Ed. John Wiley & Sons, New York, 2004.
- Harris, Daniel C: *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
- Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

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## CHEMISTRY-DSE: MOLECULAR MODELLING & DRUG DESIGN

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

### Introduction to Molecular Modelling:

Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

(10 Lectures)

### Force Fields:

Fields. Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

(14 Lectures)

### Energy Minimization and Computer Simulation:

Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple

thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

(12 Lectures)

### **Molecular Dynamics & Monte Carlo Simulation:**

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

(12 Lectures)

### **Structure Prediction and Drug Design:**

Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design,

Drug Discovery – Chemoinformatics – QSAR.

(12 Lectures)

### **Reference Books:**

- Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
- Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
- Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

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## **PRACTICAL- DSE LAB: MOLECULAR MODELLING & DRUG DESIGN**

### **60 Lectures**

- Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane  $\sigma$  bonds and ethene, ethyne, benzene and pyridine  $\pi$  bonds.
- (a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of *cis* and *trans* 2-butene.
- Visualize the electron density and electrostatic potential maps for LiH, HF, N<sub>2</sub>, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.
- (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
- (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 °C, 100 °C, 108 °C, 82 °C, respectively).
- Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b)

- aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.
- vii. (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
- viii. Arrange 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
- ix. (a) Compare the optimized bond angles H<sub>2</sub>O, H<sub>2</sub>S, H<sub>2</sub>Se. (b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.

*Note:* Software: ChemSketch, ArgusLab ([www.planaria-software.com](http://www.planaria-software.com)), TINKER 6.2 ([dasher.wustl.edu/ffe](mailto:dasher.wustl.edu/ffe)), WebLab Viewer, Hyperchem, or any similar software.

#### Reference Books:

- Leach, A.R. *Molecular Modelling Principles and Application*, Longman, 2001.
  - Haile, J.M. *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.
  - Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.
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## CHEMISTRY-DSE: RESEARCH METHODOLOGY FOR CHEMISTRY (Credits: Theory-05, Tutorials-01)

Theory: 75 Lectures

### Literature Survey:

**Print:** Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

**Digital:** Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

**Information Technology and Library Resources:** The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

(20 Lectures)

### Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

(20 Lectures)

### **Chemical Safety and Ethical Handling of Chemicals:**

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

(12 Lectures)

### **Data Analysis**

*The Investigative Approach: Making and Recording Measurements.* SI Units and their use. Scientific method and design of experiments.

*Analysis and Presentation of Data:* Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit,  $r$  and its abuse. Basic aspects of multiple linear regression analysis.

(13 Lectures)

### **Electronics**

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

(10 Lectures)

### **Reference Books**

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry*. 2<sup>nd</sup> Ed. Prentice-Hall, Harlow.
  - Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
  - Topping, J. (1984) *Errors of observation and their treatment*. Fourth Ed., Chapman Hall, London.
  - Harris, D. C. *Quantitative chemical analysis*. 6<sup>th</sup> Ed., Freeman (2007) Chapters 3-5.
  - Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*. Cambridge Univ. Press (2001) 487 pages.
  - Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
  - OSU safety manual 1.01.
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## **CHEMISTRY-DSE: GREEN CHEMISTRY**

**(Credits: Theory-04, Practicals-02)**

**Theory: 60 Lectures**

### **Introduction to Green Chemistry**

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

**(4 Lectures)**

### **Principles of Green Chemistry and Designing a Chemical synthesis**

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/ toxic products reducing toxicity.

risk = (function) hazard × exposure; waste or pollution prevention hierarchy.

- Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluoros biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents.
- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
- Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.
- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
- Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD “What you don’t have cannot harm you”, greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
- Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

**(30 Lectures)**

### **Examples of Green Synthesis/ Reactions and some real world cases**

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-

Alder reaction and Decarboxylation reaction

3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
- 4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO<sub>2</sub> for precision cleaning and dry cleaning of garments.
- 5 Designing of Environmentally safe marine antifoulant.
- 6 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
- 7 An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
- 8 Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils
- 9 Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

**(16 Lectures)**

### **Future Trends in Green Chemistry**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C<sup>2</sup>S<sup>3</sup>); Green chemistry in sustainable development.

**(10 Lectures)**

### **Reference Books:**

- Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
- Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
- Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
- Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
- Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
- Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2<sup>nd</sup> Edition, 2010.

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## **CHEMISTRY PRACTICAL - DSE LAB: GREEN**

### **CHEMISTRY 60 Lectures**

#### **1. Safer starting materials**

- Preparation and characterization of nanoparticles of gold using tea leaves.

#### **2. Using renewable resources**

- Preparation of biodiesel from vegetable/ waste cooking oil.

### 3. Avoiding waste

Principle of atom economy.

- Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.
- Preparation of propene by two methods can be studied
  - (I) Triethylamine ion + OH<sup>-</sup> → propene + trimethylpropene + water
  - (II) 1-propanol  $\xrightarrow{\text{H}_2\text{SO}_4/\square}$  propene + water
- Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

### 4. Use of enzymes as catalysts

- Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

### 5. Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO<sub>2</sub> prepared from dry ice.

Mechanochemical solvent free synthesis of azomethines

### 6. Alternative sources of energy

- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
- Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

### Reference Books:

- Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
- Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
- Ryan, M.A. *Introduction to Green Chemistry*, Tinnensand; (Ed), American Chemical Society, Washington DC (2002).
- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
- Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
- Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
- Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2<sup>nd</sup> Edition, 2010.
- Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach*, W.B.Saunders, 1995.

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## **CHEMISTRY-DSE: BIOINORGANIC & ENVIRONMENTAL CHEMISTRY**

**(Credits: Theory-04, Practicals-02)**

**Theory: 60 Lectures**

### **Bio-Inorganic Chemistry**

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

**(12 Lectures)**

### **Environment and its segments**

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by  $\text{SO}_2$ ,  $\text{CO}_2$ ,  $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{H}_2\text{S}$  and other foul smelling gases. Methods of estimation of  $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{SO}_x$  and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

*Water Pollution:* Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

**(30 Lectures)**

### **Energy & Environment**

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

(10 Lectures)

### Biocatalysis

Introduction to biocatalysis: Importance in “Green Chemistry” and Chemical Industry.

(8 Lectures)

### Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
  - R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
  - J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
  - S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
  - K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
  - S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
  - S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
  - G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
  - A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).
- 

## CHEMISTRY PRACTICAL - DSE LAB: BIO-INORGANIC & ENVIRONMENTAL CHEMISTRY

### 60 Lectures

1. Determination of dissolved oxygen in water.
  2. Determination of Chemical Oxygen Demand (COD)
  3. Determination of Biological Oxygen Demand (BOD)
  4. Percentage of available chlorine in bleaching powder.
  5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO<sub>3</sub> and potassium chromate).
  6. Estimation of total alkalinity of water samples (CO<sub>3</sub><sup>2-</sup>, HCO<sub>3</sub><sup>-</sup>) using double titration method.
  7. Measurement of dissolved CO<sub>2</sub>.
  8. Study of some of the common bio-indicators of pollution.
  9. Estimation of SPM in air samples.
  10. Preparation of borax/ boric acid.
- Separation of mixtures by chromatography: Measure the *R<sub>f</sub>* value in each case. (Combination of two ions to be given)

11. Paper chromatographic separation of Fe<sup>3+</sup>, Al<sup>3+</sup> and Cr<sup>3+</sup> or paper chromatographic separation of Ni<sup>2+</sup>, Co<sup>2+</sup>, Mn<sup>2+</sup> and Zn<sup>2+</sup>

### Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.

- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
  - S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
  - K. De, *Environmental Chemistry*: New Age International Pvt. Ltd, New Delhi.
  - S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
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## **CHEMISTRY-DSE: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS**

**(Credits: Theory-04, Practicals-02)**

**Theory: 60 Lectures**

### **Introduction to spectroscopic methods of analysis:**

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

**(4 Lectures)**

### **Molecular spectroscopy:**

#### *Infrared spectroscopy:*

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

*UV-Visible/ Near IR* – emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags).

**(16 Lectures)**

### **Separation techniques**

*Chromatography*: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

#### *Immunoassays and DNA techniques*

*Mass spectroscopy*: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser

desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

**(16 Lectures)**

### **Elemental analysis:**

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence.

Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

**(8 Lectures)**

**NMR spectroscopy:** Principle, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications.

**(4 Lectures)**

**Electroanalytical Methods:** Potentiometry & Voltammetry

**(4 Lectures)**

**Radiochemical Methods**

**(4 Lectures)**

**X-ray analysis and electron spectroscopy (surface analysis)**

**(4 Lectures)**

### **Reference books:**

- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7<sup>th</sup> Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
- P.W. Atkins: *Physical Chemistry*.
- G.W. Castellan: *Physical Chemistry*.
- C.N. Banwell: *Fundamentals of Molecular Spectroscopy*.
- Brian Smith: *Infrared Spectral Interpretations: A Systematic Approach*.
- W.J. Moore: *Physical Chemistry*.

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## **CHEMISTRY PRACTICAL - DSE LAB: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS**

**60 Lectures**

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.

4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10. Separation of Carbohydrates by HPLC
11. Determination of Caffeine in Beverages by HPLC
12. Potentiometric Titration of a Chloride-Iodide Mixture
13. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
14. Nuclear Magnetic Resonance
15. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
16. Use of “presumptive tests” for anthrax or cocaine
17. Collection, preservation, and control of blood evidence being used for DNA testing
18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)
19. Use of sequencing for the analysis of mitochondrial DNA
20. Laboratory analysis to confirm anthrax or cocaine
21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
22. Detection of illegal drugs or steroids in athletes
23. Detection of pollutants or illegal dumping
24. Fibre analysis

*At least 10 experiments to be performed.*

#### **Reference Books:**

- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7<sup>th</sup> Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

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#### **Reference Books:**

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
  - Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
-



## Skill Enhancement Courses

### Botany

#### Biofertilizers

(Credits 2)

#### Lectures: 30

**Unit 1:** General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

(4 Lectures)

**Unit 2:** *Azospirillum*: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication. (8 Lectures)

**Unit 3:** Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

(4 Lectures)

**Unit 4:** Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

(8 Lectures)

**Unit 5:** Organic farming – Green manuring and organic fertilizers, Recycling of bio- degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. (6 Lectures)

### Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.

5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

## Skill Enhancement Course

### Botany Herbal

#### Technology

(Credits 2)

#### Lectures: 30

**Unit 1:** Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants. **(6 Lectures)**

**Unit 2:** Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. **(6 Lectures)**

**Unit 3:** Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster). **(6 Lectures)**

**Unit 4:** Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds) **(8 Lectures)**

**Unit 5:** Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy) **(4 Lectures)**

#### Suggested Readings

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.

6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.

7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

**Skill Enhancement Course**  
**Botany**  
**Nursery and Gardening**

**(Credits 2)**

**Lectures: 30**

**Unit 1:** Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. **(4 Lectures)**

**Unit 2:** Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification. **(6 Lectures)**

**Unit 3:**Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house. **(6Lecture**

**s)**

**Unit 4:** Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting. **(8 Lectures)**

**Unit 5:** Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures. **(6 Lectures)**

**Suggested Readings**

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.

5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and

- Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

**Skill Enhancement  
Course Botany**

**Floriculture**

**(Credits 2)**

**Lectures: 30**

**Unit 1:** Introduction: History of gardening; Importance and scope of floriculture and landscape gardening. **(2**

**Lectures)**

**Unit 2:** Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

**(8 Lectures)**

**Unit 3:** Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

**(4 Lectures)**

**Unit 4:** Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. **(4**

**Lectures)**

**Unit 5:** Landscaping Places of Public Importance: Landscaping highways and Educational institutions. **(4 Lectures)**

**Unit 6:** Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Liliium, Orchids). **(6 Lectures)**

**Unit 7:** Diseases and Pests of Ornamental Plants. **(2 Lectures)**

**Suggested Readings**

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.







## Skill Enhancement Course

### Botany

#### Medicinal Botany

(Credits 2)

#### Lectures: 30

**Unit 1:** History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations. **(10**

**Lectures)**

**Unit 2:** Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding. **(10**

**Lectures)**

**Unit 3:** Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. **(10 Lectures)**

#### Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2<sup>nd</sup> edn. Agrobios, India.

**Skill Enhancement Course**  
**Plant Diversity and Human**  
**Welfare**

(Credits 2)

**Lectures: 30**

**Unit 1:** Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes. **(8 Lectures)**

**Unit 2: Loss of Biodiversity:** Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, **Management of Plant Biodiversity:** Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication. **(8 Lectures)**

**Unit 3: Conservation of Biodiversity:** Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. **(8 Lectures)**

**Unit 4: Role of plants in relation to Human Welfare;** a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses. **(6 Lectures)**

**Suggested Readings**

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

## Skill Enhancement Course

### Botany

#### Ethnobotany

(Credits 2)

Lectures: 30

#### Unit 1: Ethnobotany

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. (6 Lectures)

#### Unit 2: Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. (6 Lectures)

#### Unit 3: Role of ethnobotany in modern Medicine

Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). (10 Lectures)

#### Unit 4: Ethnobotany and legal aspects

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge. (8 Lectures)

#### Suggested Readings

- 1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- 2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
- 3) Lone et al., Palaeoethnobotany
- 4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
- 5) S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
- 6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
- 7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra

Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996 9)

## Skill Enhancement Course

### Botany

### Mushroom Culture

### Technology (Credits 2)

#### Lectures: 30

**Unit 1:** Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*,

*Pleurotus citrinopileatus*, *Agaricus bisporus*. (5 Lectures)

**Unit 2:** Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation

- Low cost technology, Composting technology in mushroom production. (12 Lectures)

**Unit 3:** Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

(8 Lectures)

**Unit 4:** Food Preparation : Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value. (5 Lectures)

#### Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

**Skill Enhancement Course**

**Botany**

**Intellectual Property Rights**

**(Credits 2)**

**Lectures: 30**

**Unit 1: Introduction to intellectual property right (IPR) (2 lectures)**

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

**Unit 2 : Patents (3 Lectures)**

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

**Unit 3: Copyrights (3 Lectures)**

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

**Unit4: Trademarks (3 Lectures)**

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

**Unit 5: Geographical Indications (3 Lectures)**

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

**Unit 6: Protection of Traditional Knowledge (4 Lectures)**

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

**Unit 7: Industrial Designs (2 Lectures)**

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

**Unit 8: Protection of Plant Varieties (2 Lectures)**

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties

protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

**Unit 9: Information Technology Related Intellectual Property Rights (4 Lectures)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

**Unit 10: Biotechnology and Intellectual Property Rights. (4 Lectures)**

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

**Suggested Readings**

1. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxwell.
3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L. Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.



**Skill Enhancement Course (any four) (Credit: 02 each)- SEC1 to SEC4**

**Chemistry**  
**IT SKILLS FOR CHEMISTS**  
**(Credits: 02)**  
**30 Lectures**

**Mathematics**

Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.

Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities.

Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).

Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms). Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary-bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

**Computer programming:**

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

**HANDS ON**

**Introductory writing activities:** Introduction to word processor and structure drawing (ChemSketch) software. Incorporating chemical structures, chemical equations, expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg's law, van der Waals equation, etc.) into word processing documents.

**Handling numeric data:** Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure- volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.

**Numeric modelling:** Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentration-time data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pKa of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data).

**Statistical analysis:** Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The  $t$  test. The  $F$  test.

**Presentation:** Presentation graphics

**Reference Books:**

- McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
- Mortimer, R. Mathematics for Physical Chemistry. 3<sup>rd</sup>Ed. Elsevier (2005).
- Steiner, E. The Chemical Maths Book Oxford University Press (1996).
- Yates, P. Chemical calculations. 2<sup>nd</sup>Ed. CRC Press (2007).
- Harris, D. C. *Quantitative Chemical Analysis*. 6<sup>th</sup> Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
- Noggle, J. H. *Physical chemistry on a Microcomputer*. Little Brown & Co. (1985).
- Venit, S.M. *Programming in BASIC: Problem solving with structure and style*. Jaico Publishing House: Delhi (1996).

## BASIC ANALYTICAL CHEMISTRY

(Credits: 02)

30 Lectures

**Introduction:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

**Analysis of soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

- Determination of pH of soil samples.
- Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

- Determination of pH, acidity and alkalinity of a water sample.
- Determination of dissolved oxygen (DO) of a water sample.

**Analysis of food products:** Nutritional value of foods, idea about food processing and food preservations and adulteration.

- Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
- Analysis of preservatives and colouring matter.

**Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

- Paper chromatographic separation of mixture of metal ion ( $\text{Fe}^{3+}$  and  $\text{Al}^{3+}$ ).
- To compare paint samples by TLC method. **Ion-exchange:** Column, ion-exchange chromatography etc.  
Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

**Analysis of cosmetics:** Major and minor constituents and their function

- Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
- Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

**Suggested Applications (Any one):**

- To study the use of phenolphthalein in trap cases.
- To analyze arson accelerants.
- To carry out analysis of gasoline.

### **Suggested Instrumental demonstrations:**

- a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
- b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
- c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

### **Reference Books:**

- Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*. 7<sup>th</sup> Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry* 6<sup>th</sup> Ed., Saunders College Publishing, Fort Worth (1992).
- Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
- Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
- Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
- Freifelder, D. *Physical Biochemistry* 2<sup>nd</sup> Ed., W.H. Freeman and Co., N.Y. USA (1982).
- Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
- Vogel, A. I. *Vogel's Qualitative Inorganic Analysis* 7<sup>th</sup> Ed., Prentice Hall.
- Vogel, A. I. *Vogel's Quantitative Chemical Analysis* 6<sup>th</sup> Ed., Prentice Hall.
- Robinson, J.W. *Undergraduate Instrumental Analysis* 5<sup>th</sup> Ed., Marcel Dekker, Inc., New York (1995).

## **CHEMICAL TECHNOLOGY & SOCIETY**

**(Credits: 02)**

**Theory: 30 Lectures**

### **Chemical Technology**

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

### **Society**

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

### **Reference Book:**

John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13<sup>th</sup> Ed.

## CHEMOINFORMATICS

(Credits: 02)

Theory: 30 Lectures

**Introduction to Chemoinformatics:** History and evolution of chemoinformatics, Use of chemoinformatics, Prospects of chemoinformatics, Molecular Modelling and Structure elucidation.

**Representation of molecules and chemical reactions:** Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

**Searching chemical structures:** Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

**Applications:** Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of Chemoinformatics in Drug Design.

**Hands-on**

**Exercises**

**Reference Books:**

- Andrew R. Leach & Valerie, J. Gillet (2007) *An introduction to Chemoinformatics*. Springer: The Netherlands.
- Gasteiger, J. & Engel, T. (2003) *Chemoinformatics: A text-book*. Wiley-VCH.
- Gupta, S. P. (2011) *QSAR & Molecular Modeling*. Anamaya Pub.: New Delhi.

## **BUSINESS SKILLS FOR CHEMISTS**

**(Credits: 02)**

**Theory: 30 Lectures**

### **Business Basics**

Key business concepts: Business plans, market need, project management and routes to market.

### **Chemistry in Industry**

Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies.

### **Making money**

Financial aspects of business with case studies

### **Intellectual property**

Concept of intellectual property, patents.

### **Reference**

[www.rsc.org](http://www.rsc.org)

## ANALYTICAL CLINICAL BIOCHEMISTRY

(Credits: 02)

THEORY: 30 Lectures

**Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:**

Review of concepts studied in the core course:

*Carbohydrates:* Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.

Isolation and characterization of polysaccharides.

*Proteins:* Classification, biological importance; Primary and secondary and tertiary structures of proteins:  $\alpha$ -helix and  $\beta$ -pleated sheets, Isolation, characterization, denaturation of proteins.

*Enzymes:* Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

*Lipids:* Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.

Lipoproteins.

Properties, functions and biochemical functions of steroid

hormones. Biochemistry of peptide hormones.

*Structure of DNA* (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

*Enzymes:* Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

**Biochemistry of disease: A diagnostic approach by blood/ urine analysis.**

*Blood:* Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

*Urine:* Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

### Practicals

Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.



2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

**Reference Books:**

- T.G. Cooper: Tool of Biochemistry.
- Keith Wilson and John Walker: Practical Biochemistry.
- Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
- Thomas M. Devlin: Textbook of Biochemistry.
- Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3<sup>rd</sup> Ed. PHI Learning.
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry* 7<sup>th</sup> Ed., W. H. Freeman.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

## GREEN METHODS IN CHEMISTRY

(Credits: 02)

Theory: 30 Lectures

### *Theory and Hand-on Experiments*

Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, green solvents, Green Chemistry and catalysis and alternative sources of energy, Green energy and sustainability

### **The following Real world Cases in Green Chemistry should be discussed:**

- Surfactants for carbon dioxide – Replacing smog producing and ozone depleting solvents with CO<sub>2</sub> for precision cleaning and dry cleaning of garments.
- Designing of environmentally safe marine antifoulant.
- Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments.
- An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

### **Practicals**

- Preparation and characterization of biodiesel from vegetable oil.
- Extraction of D-limonene from orange peel using liquid CO<sub>2</sub> prepared from dry ice.
- Mechano chemical solvent free synthesis of azomethine.
- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II).

### **Reference Books:**

- Anastas, P.T. & Warner, J.K. *Green Chemistry- Theory and Practical*, Oxford University Press (1998).
- Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
- Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
- Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. *Green Chemistry Experiments: A monograph* I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore.
- Lancaster, M. *Green Chemistry: An introductory text* RSC publishing, 2nd Edition.
- Sidhwani, I.T., Saini, G., Chowdhury, S., Garg, D., Malovika, Garg, N. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated "A Social Awareness

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## PHARMACEUTICAL CHEMISTRY

(Credits: 02)

Theory: 30 Lectures

### Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

### Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

### Practicals

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

### Reference Books:

- G.L. Patrick: Introduction to *Medicinal Chemistry*, Oxford University Press, UK.
- Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.
- William O. Foye, Thomas L., Lemke, David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

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## ---- CHEMISTRY OF COSMETICS &

PERFUMES (Credits: 02)

30 Lectures

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

### Practicals

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.

5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

**Reference Books:**

- E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
- Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

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**PESTICIDE CHEMISTRY**

**(Credits: 02)**

**30 Lectures**

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion ); Carbamates (Carbofuran and carbaryl); Quinones ( Chloranil), Anilides (Alachlor and Butachlor).

**Practicals**

- 1 To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
- 2 Preparation of simple organophosphates, phosphonates and thiophosphates

**Reference Book:**

- Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, New York, 1978.

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**---- FUEL CHEMISTRY**

**(Credits: 02)**

**30 Lectures**

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

*Coal:* Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

*Petroleum and Petrochemical Industry:* Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking),

Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived

from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

*Lubricants:* Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pour point) and their determination.

**Reference Books:**

- Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
  - Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
  - Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).
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**Skill Enhancement**

**Course Zoology**

**Apiculture**

**(CREDITS 2)**

**Unit 1: Biology of Bees (4)**

History, Classification and Biology of Honey  
Bees Social Organization of Bee Colony

**Unit 2: Rearing of Bees (10)**

Artificial Bee rearing (Apiary), Beehives – Newton and  
Langstroth Bee Pasturage  
Selection of Bee Species for  
Apiculture Bee Keeping Equipment  
Methods of Extraction of Honey (Indigenous and Modern)

**Unit 3: Diseases and Enemies (5)**

Bee Diseases and Enemies  
Control and Preventive  
measures

**Unit 4: Bee Economy (2)**

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis),  
Pollen etc

**Unit 5: Entrepreneurship in Apiculture (4)**

Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

#### **SUGGESTED READINGS**

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
- Bisht D.S., *Apiculture*, ICAR Publication.
- Singh S., *Beekeeping in India*, Indian council of Agricultural Research, NewDelhi.

**Skill Enhancement Course**

**Zoology**

**AQUARIUM FISH  
KEEPING**

**(CREDITS 2)**

**Unit1: Introduction to Aquarium Fish Keeping**

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

**Unit 2: Biology of Aquarium Fishes**

Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

**Unit 3: Food and feeding of Aquarium fishes**

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

**Unit 4: Fish Transportation**

Live fish transport - Fish handling, packing and forwarding techniques.

**Unit 5: Maintenance of Aquarium**

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry



## Skill Enhancement

### Course Zoology

#### MEDICAL DIAGNOSTICS

#### **THEORY** (Credits 2)

- Unit 1: Introduction to Medical Diagnostics and its Importance** 2
- Unit 2: Diagnostics Methods Used for Analysis of Blood** 10  
Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)
- Unit 3: Diagnostic Methods Used for Urine Analysis** 6  
Urine Analysis: Physical characteristics; Abnormal constituents
- Unit 4: Non-infectious Diseases** 6  
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit
- Unit 5: Infectious Diseases** 3  
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis
- Unit 6: Tumours** 3  
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

#### **SUGGESTED READINGS**

- Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
- Guyton A.C. and Hall J.E. *Textbook of Medical Physiology*, Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

## Skill Enhancement Course

### Zoology

#### RESEARCH METHODOLOGY

CREDITS 2

**Unit 1: Foundations of Research** **5**

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

**Unit 2: Research Design** **8**

Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

**Unit 3: Data Collection, Analysis and Report Writing** **12**

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

**Unit 4: Ethical Issues** **5**

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

#### SUGGESTED READINGS

- Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
- Walliman, N. 2011. Research Methods- The Basics. Taylor and Francis, London, New York.
- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
- C.R.Kothari: Research Methodology, New Age International, 2009
- Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing". Stage Publications

## Skill Enhancement Course

### Zoology SERICULTURE

(CREDITS 2)

#### **Unit 1: Introduction** (3)

Sericulture: Definition, history and present status; Silk route  
Types of silkworms, Distribution and Races  
Exotic and indigenous races  
Mulberry and non-mulberry Sericulture

#### **Unit 2: Biology of Silkworm** (3)

Life cycle of *Bombyx mori*  
Structure of silk gland and secretion of silk

#### **Unit 3: Rearing of Silkworms** (13)

Selection of mulberry variety and establishment of mulberry garden  
Rearing house and rearing appliances  
Disinfectants: Formalin, bleaching powder, RKO  
Silkworm rearing technology: Early age and Late age rearing  
Types of mountages  
Spinning, harvesting and storage of cocoons

#### **Unit 4: Pests and Diseases** (4)

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates  
Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial  
Control and prevention of pests and diseases

#### **Unit 5: Entrepreneurship in Sericulture** (2)

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.

### SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna  
CSB, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi  
Pub. Co. Ltd., Tokyo, Japan 1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore  
1989. Improved Method of Rearing Young age silkworm; S. Krishnaswamy,  
reprinted CSB, Bangalore, 1986

