Mahakaushal University, Jabalpur (M.P.)

Scheme & Syllabus

For

B.Sc. with Research/honors

Biochemistry

2022-23

Duration of Course: 4 Years
Examination Mode: Semester
Examination System: CBCS

Mahakaushal University
Village-Aithakheda, Mukunwara Road, Post- Tilwara Jabalpur (M.P.) 482003

Biological Science

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UNIT I: INTRODUCTION TO PLANT AND ANIMAL SCIENCES (12 hrs)

What is life? Origin of life: Modern and cell theory. Abiogenesis experimental proof and evidences. Concepts of species and general classification of plants and animals. Overview of kingdom Animalia (Cnidaria, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata and Vertebrates) and Plantae (Bryophytes, Pteridophytes, and Spermatophytes: Gymnosperms and Angiosperms). General characteristics of each group up to class level with an example.

UNIT II: STRUCTURE & FUNCTIONS OF PLANT & ANIMAL TISSUES (10 hrs)

Structure, distribution and functions of parenchyma, collenchyma, sclerenchyma, secretory ducts, laticiferous tubules, meristematic tissue, xylem and phloem. Structure, distribution and functions of epithelial tissue (squamous), connective tissue (fibrous). Cellular basis of connective tissue. Structure and functions of smooth, striated and cardiac muscle tissue, and nervous tissue (neuron).

UNIT III: NUTRITION AND TRANSPORT IN PLANTS (8 hrs)

Grouping of organisms based on energy and carbon sources. Photosynthetic pigments and photosynthesis (light and dark reactions). Plant–water relations: movement of water through a flowering plant, transpiration and stomatal mechanism. Ascent of water in xylem: cohesion, adhesion and root pressure. Mechanism of movement of organic solutes in phloem: Munch's mass flow hypothesis. Significance of nutrients in plants: macronutrients (nitrogen, phosphorus and potassium) and micronutrients (magnesium, manganese, iron, zinc and sulphur).

UNIT IV: NUTRITION, TRANSPORT IN ANIMALS (8 hrs)

Different types of heterotrophic nutrition: holozoic, saprotrophic, parasitic and symbiotic. Feeding mechanisms: filter feeders, detritus feeders, biting and chewing, fluid feeders (sucking and piercing). Types of heart: two-, three- and four-chambered. Types of circulation: open, closed, single and double circulation. General characteristics of blood vessels (arteries, veins, capillaries). Brief introduction to vascular system, lymphatic organs and lymph in humans. Composition of blood and clotting mechanism.

UNIT V: GROWTH IN PLANTS AND ANIMALS (7 hrs)

Definition and types of growth, measurement of growth and patterns of growth. Growth and development in flowering plants. Plant growth regulators: phytohormones biological functions (auxin, gibberellin, cytokinin, abscisic acid and ethylene. Photoperiodism. Growth patterns and evidence of growth in animals. Sexually and asexually produced offspring, Regeneration, metamorphosis and neoteny.

REFERENCE BOOKS:

1. Freeman S, Quillin K, Allison L, Black M, Podgroski G, Taylor E and Carmichael J, *Biological sciences* (7th ed.), San Francisco: Pearson, 2019.
2. Tortora GJ, Derrickson BH, *Principles of Anatomy & Physiology* (12th ed), John Wiley & sons, USA, 2008.

SUGGESTED READINGS:

1. Mader SS and Windelspecht M, *Biology* (13th ed.), New York: McGraw-Hill, 2018.
2. Dickison WC, *Integrative Plant Anatomy* (1st ed.), Harcourt Academic Press, USA, 2000.

Biological Science Lab

1. Study of morphological characteristics of plants
2. Examination of cross sections of stem, root, leaf of dicots and monocots
3. Effect of CO_2 concentration on photosynthesis in *Hydrilla*
4. Observation of stomata in dicot leaf
5. Transpiration index: measurement of transpiration by cobalt chloride method in dry and moist conditions
6. Study of histological slides of various animal tissues: epithelial tissue (columnar and squamous epithelium), connective tissue (adipose and cartilage tissue), muscle (cardiac, skeletal and smooth muscle), and blood vessels (arteries and veins).

REFERENCE BOOKS:

1. Freeman S, Quillin K, Allison L, Black M, Podgroski G, Taylor E and Carmichael J, *Biological sciences* (7th ed.), San Francisco: Pearson, 2019.
2. Tortora GJ, Derrickson BH, *Principles of Anatomy & Physiology* (12th ed), John Wiley & sons, USA, 2008.

Cell Biology and Genetics

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UNIT-I: CELL AS A BASIC UNIT **(12 HRS)**

Discovery of the cells, Structure of plant and animal cell. Development of cell theory: Prokaryotic and Eukaryotic cell organization. Membrane Architecture: Unit membrane model, Fluid mosaic model. Cell Cycle Mitosis and Meiosis.

UNIT-II: ULTRA-STRUCTURE AND FUNCTION OF ORGANELLES (12 HRS)

Nucleus, Mitochondria, Chloroplast, Endoplasmic Reticulum, Golgi, Ribosomes, Lysosomes, Vacuoles, Peroxisomes and Glyoxisomes.

UNIT-III: MENDELIAN GENETICS **(14 HRS)**

Definitions of common terms in genetics- Phenotype, genotype, heterozygous, homozygous, allele, gene, gene locus, pure line, hybrid, Mendel's laws. Monohybrid cross, Dihybrid cross, Test cross, Back cross and Incomplete dominance.

UNIT-IV: INTERACTION OF FACTORS **(10 HRS)**

Complementary, lethal and epistatic. Linkage and crossing over in zea mays. Polygenic inheritance.

UNIT-V: SEX LINKED AND LIMITED INHERITANCE **(12 HRS)**

Sex determination in Drosophila, Genic balance theory of determination. Sex determination in human being. Brief outline of allosomal (Klinefelter syndrome), autosomal (Down syndrome) disorders. Population Genetics - Hardy – Weinberg law.

REFERENCE BOOKS:

1. Cell Biology – Gerald Karp, McGraw-Hill,1979
2. De Robertis, E.D.P and De Robertis E.M.F., 2001, Cell and Molecular Biology, 8th edition, Lippincott Williams and Wilkins, New York.
3. Gardner, E.J. &Snusted, D.P. (1984): Principles of Genetics (4th edition) John Wiley & Sons,N.Y. Lewin, B. (1985): Genes IV Wiley Eastern Ltd.

Cell Biology and Genetics lab

PRACTICAL:

1. Equipment used in laboratory, general practice and maintenances
2. Identification of various stages of cell division (mitosis and meiosis).
3. Mitosis and Meiosis – onion root tip and grasshopper testis squash methods
4. Isolation of genomic DNA from bacterial culture
5. Isolation of genomic DNA from plant tissue.
6. Quantification of DNA using UV spectrophotometer.
7. Agarose gel electrophoresis of genomic DNA.

REFERENCE BOOKS:

1) Molecular Cloning by J. Sambrook and D. W. Russell (2001). Cold Spring Harbour Lab. Press.
2) A short course in Bacterial Genetics by J.H. Miller (1992) Cold Spring Harbor Laboratory.
3) Methods for Genetics and molecular Bacteriology by Ed. RGF Murray, WA. Wood & NB krieg (1994) American society for Microbiology

Biomolecules

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UNIT I: FOUNDATIONS OF LIFE (8 hrs)

Introduction to cellular and chemical foundations of life. Elements found in living organisms. Biological significance of water, weak interactions in aqueous systems, ionization of water, pH, pK_a. Henderson–Hasselbalch equation, biological buffer systems: body fluids and their principal buffers.

UNIT II: CARBOHYDRATES (10 hrs)

Classification, chemical and physical properties. Monosaccharide: stereoisomers, enantiomers, epimers, mutarotation. Sugar derivatives: amino sugars, sugar alcohol, sugar acids, deoxy-sugar and glycosides. Disaccharides: sucrose, lactose and maltose.

Polysaccharides: homo and hetero polysaccharides, mucopolysaccharides and glycoproteins.

UNIT III: LIPIDS (10 hrs)

Classification, chemical and physical properties. Fatty acids: saturated, unsaturated and essential fatty acids; rancidity, saponification number, iodine number, acid number and Reichert–Meissel number. Structure and biological functions of triacylglycerol, phospholipids, cholesterol and plant sterols.

UNIT IV: PROTEINS AND AMINO ACIDS (9 hrs)

Classification, chemical and physical properties of amino acids. Peptide bond: planarity and dihedral angles, Ramachandran plot. Structural hierarchy of proteins: primary, secondary, super- secondary, tertiary and quaternary structures. Classification of proteins, properties: isoelectric point, zwitterions, and precipitation reactions. Globular and fibrous proteins:

structure and functions of hemoglobin, collagen, elastin, and keratin.

UNIT V: NUCLEIC ACIDS **(8 Hrs)**

Chemistry of purine and pyrimidine, nucleosides and nucleotides. Types of DNA: structure and properties of A-, B- and Z-DNA. Denaturation, renaturation, T_m and hyperchromicity. Effect of acid and alkali on DNA and RNA. Types and functions of RNA: rRNA, mRNA, tRNA. Primary, secondary, and tertiary structures of tRNA.

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.

2. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.

3. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.

4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001

SUGGESTED READING:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.

Biomolecules Lab

1. Safety measures in the laboratories
2. Determination of pK_a of acetic acid and glycine 3. Qualitative tests for carbohydrates:

   (i) Monosaccharides: hexoses (glucose and fructose)

   (ii) Disaccharides: reducing (maltose/lactose and non-reducing (sucrose)

   (iii) Polysaccharides: starch

1. Qualitative tests for lipids and nucleic acids
2. Qualitative tests for amino acids & proteins

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.

2. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.

3. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.

4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001

Enzymology

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UNIT I: OVERVIEW AND CLASSIFICATION OF ENZYMES (9 hrs)

Historical perspective and definition of enzymes. Nomenclature of enzymes, enzyme classification and characteristics. Co-enzymes and cofactors. Isoenzymes, abzymes and ribozymes. Metalloenzymes and metal-activated enzymes. Units of enzyme activity. Proteolytic enzymes. Multienzyme complexes: pyruvate dehydrogenase and fatty acid synthase.

UNIT II: ENZYME KINETICS (9 hrs)

Factors affecting enzyme activity: pH, temperature and substrate concentration. Derivation of Michaelis–Menten equation. Limitations and transformation of the MM equation: Lineweaver–Burk plot and Hanes–Woolf plot. K_m, V_{max} and K_{cat}. Turnover number, catalytic efficiency and enzyme specificity.

UNIT III: MECHANISM OF ENZYME CATALYSIS (9 hrs)

Enzyme active site and its general characteristics. Mechanism of enzyme action: lock-andkey model, induced- fit hypothesis. Mechanisms of enzyme catalysis: acid–base catalysis, covalent catalysis, substrate strain and entropy effect. Mechanisms of action of chymotrypsin, lysozyme and carboxypeptidase.

UNIT IV: ENZYME REGULATION (9 hrs)

Enzyme inhibition: reversible (competitive, uncompetitive and non-competitive) and irreversible. Enzyme regulation: covalent modification, allosteric, end-product, and feedback regulation.

UNIT V: APPLICATIONS OF ENZYMES

Immobilization techniques: adsorption, covalent binding, cross linking, entrapment, encapsulation, Properties of immobilized enzymes to free enzymes. - Enzyme utilization in Industry: - Application in Food and Drink industries - Application in Artificial kidney machines - Application in other industries (pharmaceutical industry; washing powder manufacturing industries)

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.

2. Rodwell VW, Bender DA, Botham KM, *et al.*, *Harper's illustrated biochemistry* (31st ed.), London: McGraw Hill, 2018.

3. Palmer T and Bonner PL, *Enzymes* (2nd ed.), Cambridge: Woodhead Publishing, 2007.

4. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.

5. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

SUGGESTED READING:

1. Berg JM, Stryer L, Tymoczko J and Gatto G, *Biochemistry* (9th ed.), New York: WH Freeman, 2019.

Devlin TM, Textbook of biochemistry with clinical correlations (7th ed.), New York: John Wiley & Sons, 2010.

Enzymology Lab

1. Isolation and quantification of starch from potatoes
2. Isolation and quantification of casein and lactalbumin from milk
3. Isolation and quantification of ovalbumin from egg
4. Extraction of urease from jack bean
5. Extraction of pectinase
6. Determination of acid number
7. Spectrophotometric estimation of protein by A_{280} method
8. Estimation of enzyme activity by end-point and continuous monitoring assay
9. Effect of pH and temperature on enzyme activity.
10. Determination of enzyme activity in the presence of activators and inhibitors

REFERENCE BOOKS:

1. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
2. Rodwell VW, Bender DA, Botham KM, *et al.*, *Harper's illustrated biochemistry* (31st ed.), London: McGraw Hill, 2018.
3. Palmer T and Bonner PL, *Enzymes* (2nd ed.), Cambridge: Woodhead Publishing, 2007.
4. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.
5. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

Microbiology

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UNIT I: INTRODUCTION AND BACTERIAL CLASSIFICATION **(10 hrs)**

Definition, scope and history of microbiology. Germ theory of disease. Differences between prokaryotic and eukaryotic microorganisms. Classification of Bacteria: based on Gram's staining, temperature and oxygen requirement. Types of bacteria: chlamydia, rickettsia, mycoplasma, actinomycetes, cyanobacteria and eubacteria. Brief overview of Archea.

UNIT II: VIRUSES, FUNGI, ALGAE AND PROTOZOANS **(10 hrs)**

Classification and types of viruses: Baltimore classification. General characteristics of major groups of fungi: Oomycota, Zygomycota, Ascomycota and Basidiomycota. Classification of protozoa: Mastigophora, Sarcodina, Sporozoa and Ciliophora. General characteristics of major groups of algae: Chlorophyta, Phaeophyta, Rhodophyta, Pyrrophyta, Chrysophyta and Euglenophyta.

UNIT III: MICROBIAL GROWTH **(7 hrs)**

Microbial growth, growth rate, doubling time and exponential growth phases. Factors affecting microbial growth: nutrient factors (C, H, N, O, P, S and trace elements) and nonnutrients factors (temperature, hydrostatic pressure, pH, osmotic strength). Types of nutrient media and special nutrient media. Differential media, and examples to distinguish different groups of bacteria using differential media.

UNIT IV: FOOD AND INDUSTRIAL MICROBIOLOGY **(10 hrs)**

Quality control of drinking water: total coliform count. Microorganisms in milk and milk products, and the preservation of milk. Role of microbes in industrial production of fermented foods: alcoholic beverages, dairy products, coffee and chocolate. Preservation of wine. Single-cell proteins, microbial biofuel and biofertilizers.

UNIT V: MICROBIAL DISEASES AND ANTIMICROBIAL AGENTS (8 hrs)

Diseases caused by bacteria, viruses, protozoa and fungi: airborne diseases, water-borne diseases and milk-borne diseases. Prion diseases. Principles and methods of sterilization and disinfection. History, and brief overview of antibiotics, their mechanisms of action, and antibiotic resistance.

REFERENCE BOOKS:

1. Willey JM, Sherwood LM and Woolverton CJ, *Prescott, Harley, and Klein's Microbiology* (7th ed.), Boston: McGraw Hill, 2007.Leboffe MJ and Pierce BE, *A photographic atlas for the microbiology laboratory* (4th ed.), Englewood: Morton Publishing, 2011.

2. Ananathanarayanan and Panikar, *Text book of microbiology* (10^{th} ed.), New Delhi: The Orient Blackswan, 2017.

3. Sherman N and Cappuccino JG (2004) *Microbiology A Laboratory Manual*, Benjamin- Cummings Publishing Company, San Francisco, 2004.

Microbiology Lab

1. Sterilization techniques
2. Identification of bacterial cells and the determination of antibacterial activity
3. Pure culture techniques: streak plate, pour plate, spread plate and serial dilution
4. Methylene blue reductase test (MBRT)
5. Simple staining & Gram staining
6. Microbial growth curve

REFERENCE BOOKS:

1. Willey JM, Sherwood LM and Woolverton CJ, *Prescott, Harley, and Klein's Microbiology* (7th ed.), Boston: McGraw Hill, 2007.Leboffe MJ and Pierce BE, *A photographic atlas for the microbiology laboratory* (4th ed.), Englewood: Morton Publishing, 2011.

2. Ananathanarayanan and Panikar, *Text book of microbiology* (10th ed.), New Delhi: The Orient Blackswan, 2017.

3. Sherman N and Cappuccino JG (2004) *Microbiology A Laboratory Manual*, Benjamin-Cummings Publishing Company, San Francisco, 2004.

Immunology

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UNIT I: OVERVIEW AND HISTORICAL PERSPECTIVE **(8 hrs)**

Immunity and types of immunity: innate and adaptive, active and passive, natural and acquired immunity. Overview of immune system, cells of the immune system and their functions. Organs of the immune systems and their functions: primary and secondary lymphoid organs

UNIT II: ANTIGEN AND ANTIBODY **(10 hrs)**

Nature and types of antigens, specificity, epitope, haptens, adjuvants. Immunogenicity and factors affecting immunogenicity. Immunoglobulins: structure, classes and functions. Antigen– antibody reactions: agglutination, precipitation, flocculation, complement fixation, neutralization.

UNIT III: HUMORAL AND CELL-MEDIATED IMMUNITY **(9 hrs)**

Functions of T_H, T_C, T_S and B lymphocytes. Primary and secondary immune responses and the role of memory cells. Polyclonal and monoclonal antibody generation and their applications.

UNIT IV: IMMUNODIAGNOSTIC TECHNIQUES **(10 hrs)**

Single immunodiffusion: one dimension and radial, double immunodiffusion: one dimension and radial. Immunoelectrophoresis, immunofluorescence, rocket electrophoresis, haemagglutination assay, CFT, ELISA, RIA.

UNIT V: HYPERSENSITIVITY REACTIONS **(8 hrs)**

Types of hypersensitive reactions: type I, II, III and IV. Fundamentals of autoimmune disorders, immunodeficiency diseases, brief account on immune suppression. Transplantation immunology: graft acceptance and rejection (in brief).

REFERENCE BOOKS:

1. Punt J, Stranford S, Jones P and Owen J, *Kuby immunology* (8th ed.), New York: W.H. Freeman, 2018.
2. Murphy K, Mowat A, Weaver CT, *Janeway's Immunobiology* (8th ed), Garland Science, London & New York, 2012.
3. Gordon JR, *A practical guide to cellular and molecular research methods in immunology* (4th ed.), Saskatoon: University of Saskatchewan, 2002.
4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

SUGGESTED READING:

1. Delves PJ, Martin, SJ, Burton RD and Roitt IM, *Roitt's essential immunology* (13th ed.), London: Wiley-Blackwell, 2017.

BBCH601P: Immunology Lab

1. Blood grouping
2. Identification of immune cells in blood smears
3. Single and double immunodiffusion
4. Radial immunoassay
5. Dot ELISA
6. Widal's test
7. Complement Fixation Test

REFERENCE BOOKS:

1. Punt J, Stranford S, Jones P and Owen J, *Kuby immunology* (8th ed.), New York: W.H. Freeman, 2018.
2. Murphy K, Mowat A, Weaver CT, *Janeway's Immunobiology* (8th ed), Garland Science, London & New York, 2012.
3. Gordon JR, *A practical guide to cellular and molecular research methods in immunology* (4th ed.), Saskatoon: University of Saskatchewan, 2002.
4. Plummer DT, *Introduction to practical Biochemistry*. Tata McGraw-Hill, New Delhi Education, 2001.

Molecular Biology

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UNIT I: INTRODUCTION OF MOLECULAR BIOLOGY **(9 hrs)**

Discovery of DNA as genetic material: experiments of Griffith, Avery, McLeod and McCarty, Hershey and Chase experiment, Lederberg and Tatum's conjugation experiment and Friedrich Miescher's experiment. Types of DNA and RNA. Chromosomal organization in prokaryotes and eukaryotes. Chemical nature of the gene. Gene and gene concept: cistron, muton, replicon and recon. Central dogma of molecular biology.

UNIT II: DNA REPLICATION **(9 hrs)**

Messelson–Stahl experiment of semiconservative DNA replication. DNA replication in prokaryotes: enzymes and proteins involved in replication. DNA mutation and repair: types of mutation (mismatch, base-excision, nucleotide excision and direct repair). Replication of plasmids and mitochondrial DNA.

UNIT III: TRANSCRIPTION **(9 hrs)**

Transcription in prokaryotes: types of RNA polymerases. DNA elements in transcription: promoters, enhancers, silencers, transcription factors and inhibitors of transcription. Structure of mRNA in prokaryotes and eukaryotes. Post-transcriptional processing in eukaryotes: splicing, capping and polyadenylation. Codon, characteristics of genetic code and wobble hypothesis. Reverse transcription, transposons and retrotransposons.

UNIT IV: TRANSLATION **(9 hrs)**

Mechanism of translation in prokaryotes: amino acid activation, initiation, elongation, and termination. Posttranslational modification in eukaryotes. Inhibition of protein synthesis by antibiotics.

UNIT V: REGULATION OF GENE EXPRESSION **(9 hrs)**

Positive and negative control: *lac* and *trp* operon. Gene regulation in eukaryotes, Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- and eukaryotes – Helix turn helix, zinc fingers, leucine zippers/ b zip, helix loop helix motifs. Regulation of Gene Expression in Development- Development in Drosophila. Maternal genes –bicoid and nanos and hunchback. Gap genes, pair rule genes segmentation genes, homeotic genes Gene silencing – of chromatin in regulating gene expression and gene silencing-RNAi, MicroRNAs riboswitches-regulation of gene expression in bacteriophage-gene dosage- gene amplification.

REFERENCE BOOKS:

1. Watson JD, Baker TA, Stephen PB, *et al.*, *Molecular biology of the gene* (7th ed.), San Francisco: Pearson Education, 2017.
2. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
3. Green MR and Sambrook J, *Molecular cloning: a laboratory manual* (4th ed.), Cold Spring Harbor: Cold Spring Harbor Laboratory Press, 2012.

SUGGESTED READING:

1. Voet D, Voet JG and Pratt CW, Principles of biochemistry (4th ed.) Singapore: John Wiley & Sons, Inc., 2012.

LAB IN MOLECULAR BIOLOGY **(30 Hrs)**

- Hydrolysis of DNA and separation of nucleotide bases by paper chromatography
- Ultraviolet absorption spectrum of DNA and estimation of concentration by A_{260} method
- Colorimetric estimation by DNA by diphenylamine (DPA) method
- Isolation of microbial DNA
- Isolation of plant and animal DNA
- Agarose gel electrophoresis
- Estimation of RNA by Orcinol method

REFERENCE BOOKS:

1. Watson JD, Baker TA, Stephen PB, *et al.*, *Molecular biology of the gene* (7th ed.), San Francisco: Pearson Education, 2017.
2. Lehninger AL, Nelson DL and Cox MM, *Lehninger principles of biochemistry* (7th ed.), New York: W.H. Freeman, 2017.
3. Green MR and Sambrook J, *Molecular cloning: a laboratory manual* (4th ed.), Cold Spring Harbor: Cold Spring Harbor Laboratory Press, 2012.

Endocrinology

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UNIT I: INTRODUCTION TO ENDOCRINOLOGY **(12 hrs)**

Historical perspective, comparative endocrinology and its roles in homeostasis. Definition of hormones. Major endocrine glands: Anatomy, structure and functions. Concept of secondary messenger system- Sutherland experiment. Chemical nature and types of hormones. Hormones regulations and feedback mechanisms.

UNIT II: BRAIN AND PITUITARY GLAND HORMONES **(12 hrs)**

Hormones of the hypothalamus: Structure and functions. Control of hypothalamic–hypophyseal hormone secretion. Pituitary gland: anatomy, hormones, their biological roles and associated disorders.

UNIT III: THE THYROID AND PARATHYROID GLANDS HORMONE (10 hrs)

Structure and functions of the thyroid gland. Thyroid hormones: biosynthesis and biological functions. Diseases associated with the thyroid gland: hypo- and hyperthyroidism. Structure and functions of the parathyroid gland. Parathyroid hormone: biological functions. Hypo- and hyperparathyroidism. Regulation of calcium and phosphorus metabolism by calcitriol.

UNIT IV: THE PANCREAS **(8 hrs)**

Endocrine regions of the pancreas. Synthesis, regulation, secretion, biological actions and disorders associated with the pancreatic hormones: glucagon, insulin and somatostatin.

UNIT V: ADRENAL GLAND HORMONES **(8 hrs)**

Hormones of the adrenal gland: adrenal cortex (glucocorticoids and mineralocorticoids) and adrenal medulla (epinephrine and norepinephrine).

UNIT VI: THE REPRODUCTIVE AND ADIPOSE HORMONES **(10 hrs)**

Structure and cell types of the testis. Spermatogenesis, steroidogenensis and endocrine control of testicular function. Biological actions of androgens and associated disorders. Structure and cell types of the ovaries. The ovarian cycle, ovarian steroid hormones, their physiological roles and associated disorders. Hormones of the adipose tissue, their biological functions, and roles in diseases.

REFERENCE BOOKS:

1. Hall JE, *Guyton and Hall textbook of medical physiology* (13th ed.), Philadelphia: Saunders, 2016.
2. Rodwell VW, Bender DA, Botham KM, Kennelly PJ and Weil PA, *Harper's illustrated biochemistry* (31st ed.), Blacklick: McGraw-Hill Education, 2018.

SUGGESTED READING:

1. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

Endocrinology Lab

1. Determination of cation exchange method

2. Determination of total difference of solids.

3. Synthesis of hydrogel by co-precipitation method.

4. Synthesis of silver and gold metal nanoparticles.

REFERENCE BOOKS:

1. Hall JE, *Guyton and Hall textbook of medical physiology* (13th ed.), Philadelphia: Saunders, 2016.
2. Rodwell VW, Bender DA, Botham KM, Kennelly PJ and Weil PA, *Harper's illustrated biochemistry* (31st ed.), Blacklick: McGraw-Hill Education, 2018.

: Plant and Animal Physiology

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UNIT I: HOMEOSTASIS **(8 hrs)**

Homeostasis concept. Control systems in biology: types and components of control system (block diagram of input unit, processing unit and responding unit), threshold level and steady state level. Temperature regulation in ectothermic and endothermic animals. Osmoregulation and water conservation: nitrogen and urea excretion in ammonotelic, ureotelic and uricotelic animals, blood pH regulation.

UNIT II: REPRODUCTION IN PLANTS AND ANIMALS **(10 hrs)**

Reproduction types in plants. Types of asexual reproduction in plants: cutting, grafting and layering. Roles of plants part involved in asexual reproduction: bulb, corn, rhizomes, tuber and stolen. Artificial propagation of plants, and tissue culture. Sexual reproduction: pollination and fertilization. Reproduction in animals: outline of asexual reproduction in animals. Sexual reproduction in animals: Humans male and female reproductive system.

UNIT III: BASIC CONCEPTS OF DEVELOPMENTAL BIOLOGY **(10 hrs)**

History, basic concepts and landmark experiments in developmental biology. Outline of organizers, gametogenesis, fertilization, cleavage, blastulation, gastrulation. Types of morphogenetic movements: epiboly, emboly, involution, ingression, invagination, intercalation and convergent extension. Cell fate and commitment. Differentiation and pattern formation.

Fates of the ecto- (epidermis, neural crest and neural tube), endo- and mesoderm. Somitogenesis: paraxial, caudal, lateral and intermediate.

UNIT IV: CONTROL AND CO-ORDINATION IN PLANTS AND ANIMALS (7 hrs)

Plant movements: tropism, taxes, nastic and kinesis in brief. Types of stimuli and their applications. Types of plant movements with examples. Phloem calcium channels in plant co- ordination. Control and coordination in animals: stimuli, means of coordination: receptors and effectors. Parts of the nervous system: central, peripheral (sensory, motor and somatic) and autonomic. Reflex action and its importance.

UNIT V: EVOLUTION **(10 Hrs)**

Theories of the origin of life. Evolution, and evidences for evolution: fossils, comparative anatomy, comparative embryology, biochemical and biogeographic evidence. Human evolution. Selection: definition, types (artificial and natural), and mechanisms. Concept of inbreeding and outbreeding: advantages and disadvantages. The peppered moth experiment (directional, stabilizing and disruptive selection). Definition of species, and types of speciation: inter- and intraspecific (allopatric and sympatric) speciation.

REFERENCE BOOKS:

1. Freeman S, Quillin K, Allison L, Black M, Podgroski G, Taylor E and Carmichael J, *Biological sciences* (7th ed.), San Francisco: Pearson, 2019.
2. Barresi MJF and Gilbert SF, *Developmental biology* (12th ed.), New York: Sinauer, 2019.
3. Taiz L, Zeiger E, Møller IM and Murphy A, *Plant physiology and development* (6th ed.), New York: Sinauer, 2015.
4. Lea PJ and Leegood RC, *Plant biochemistry and molecular biology* (2nd ed.), New York: John Wiley & Sons, 2001.
5. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

SUGGESTED READING:

1. Mader SS and Windelspecht M, *Biology* (13th ed.), New York: McGraw-Hill, 2018.

[illegible] : Analytical Biochemistry

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UNIT I: CENTRIFUGATION **(9 hrs)**

Principle of centrifugation and Svedberg unit, analytical and preparative. Centrifugation rotors: vertical, fixed angle, swinging bucket. Subcellular fractionation by differential centrifugation, density gradient (Rate zonal, isopycnic) and principle of analytical ultracentrifuge.

UNIT II: CHROMATOGRAPHY **(9 hrs)**

Partition and adsorption chromatography. Types of chromatography: Paper, TLC, ion exchange, gel filtration and affinity chromatography. Principles and instrumentation of gas– liquid chromatography (GLC) and high-performance liquid chromatography (HPLC).

UNIT III: ELECTROPHORESIS **(9 hrs)**

Principle and applications of agarose and native polyacrylamide gel electrophoresis. Denaturing SDS–PAGE: principle, reagents, instrumentation, protocol and applications.

UNIT IV: SPECTROSCOPIC TECHNIQUES **(9 hrs)**

Beer–Lambert's law, transmittance, absorbance, optical density and colorimetry. Types of spectroscopy, UV–Visible spectroscopy: principle, instrumentation and applications.

UNIT V: RADIOACTIVE TECHNIQUES **(9 hrs)**

Types of radiation, units of radioactivity and half-life. Measurement of radioactivity: GM and scintillation counters. Applications of radioactivity: autoradiography. Hazards of radioactivity and safety measures.

REFERENCE BOOKS:

1. Hofman A and Clokie S, *Wilson and Walker's principles and techniques of biochemistry and molecular biology* (8th ed.), London: Cambridge University Press, 2018.
2. Campbell I, *Biophysical techniques*, London: Oxford University Press, 2012.

SUGGESTED READING:

1. Upadhyay A, Upadhyay K and Nath N, *Biophysical techniques: principles and techniques* (4th ed.), Mumbai: Himalaya Publishing House, 2016.

Human Physiology

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UNIT I: THE DIGESTIVE SYSTEM **(8 hrs)**

The anatomy of the human alimentary canal. Accessory glands of the digestive system. The biochemistry of digestion of carbohydrates, protein and fats in various regions of the alimentary canal in humans. Absorption, and fates of ingested carbohydrates, protein and dietary lipids. Storage and detoxification.

UNIT II: THE CARDIOVASCULAR AND CIRCULATORY SYSTEM (10 hrs)

Structure and functions of heart, conductive system of heart, origin and conduction of the heartbeat. Cardiac cycle, and electrocardiogram (ECG). Structure of the endothelium. Anatomy of the human vascular and lymphatic systems. Composition of blood and its functions. Common diseases of the blood, blood vessels and heart.

UNIT III: THE RESPIRATORY AND MUSCULAR SYSTEMS **(10 hrs)**

Structure and functions of lung. Mechanism of pulmonary ventilation: exchange of gases between lung and blood, and transport of gases between blood and tissues. Disorders associated with the lungs: occupational and habitual diseases. Ultra-structure and chemical composition of skeletal muscle, sliding filament theory, physico-chemical changes during muscle contraction and muscular dystrophy.

UNIT IV: THE NERVOUS SYSTEM **(9 hrs)**

Concept of nerve and nerve cells. Transmission of nerve impulse. Action potential, neurotransmitters. Synaptic conduction: neuromuscular synapse, adrenergic and cholinergic neurotransmission. The anatomy of the human brain. Functions of different parts of the human brain. The blood–brain barrier. Structure and functions of the spinal cord. Parts of the nervous system: central, peripheral and autonomic. Reflex action: importance of reflexes, sympathetic and parasympathetic nervous systems. CSF and its composition. Neurodegenerative diseases.

UNIT V: THE EXCRETORY SYSTEM **(8 hrs)**

Structure and functions of kidney and nephron. Composition and formation of urine. Principle of ultrafiltration. Fluid and electrolyte balance, acid–base dynamics. Role of the lungs in excretion. Metabolic and respiratory acidosis and alkalosis.

REFERENCE BOOKS:

1. Hall JE, *Guyton and Hall textbook of medical physiology* (13th ed.), Philadelphia: Saunders, 2015.

2. Waugh A and Grant A, *Ross and Wilson anatomy and physiology in health and illness*

(13th ed.), New York: Churchill Livingstone, 2018.

3. Bell GH, Emslie-Smith D and Paterson CR, *Textbook of physiology and biochemistry* (9th ed.), London: Churchill Livingstone, 1976.

SUGGESTED READING:

1. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, *Ganong's review of medical physiology* (26th ed.), New York: McGraw-Hill Education, 2019.

: Clinical Biochemistry

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UNIT I: APPROACHES TO CLINICAL BIOCHEMISTRY (7 hrs)

Concepts of accuracy, precision, sensitivity and reproducibility. Quality control and determination of normal range. Collection and processing of blood and urine samples, anticoagulants, preservatives for blood and urine, and transport of biological samples.

UNIT II: DISORDERS OF CARBOHYDRATE METABOLISM (8 hrs)

Introduction: normal fasting and post-prandial blood glucose level, mechanism of blood glucose homeostasis: hypo- and hyperglycemia, renal threshold value. Diabetes mellitus: types, diagnosis, clinical features, metabolic defects and complications. GTT, galactosemia, fructosuria and glycogen storage diseases.

UNIT III: DISORDERS OF PROTEIN METABOLISM (10 hrs)

Introduction: clinical significance and variation of plasma and serum proteins. Clinical features of phenylketonuria, alkaptonuria, albinism and tyrosinosis. Disorders of the urea cycle. Clinical significance of non-protein nitrogen: BUN and creatinine (normal and abnormal levels). Clinical importance of clearance determination. Abnormal constituents of urine and their significances.

UNIT IV: DISORDER OF LIPID AND NUCLEIC ACID METABOLISM (8 hrs)

Introduction, hypertriglyceridemia, hypo- and hyperlipoproteinemia. Atherosclerosis: clinical features and complications. Lipid storage diseases and fatty liver. Gout: types, aetiology and clinical features. Brief overview of lysosomal storage diseases.

UNIT V: LIVER AND GASTRIC FUNCTION TESTS (12 hrs)

Functions of the liver and classification of LFTs. Abnormalities in bile pigment metabolism: differential diagnosis of jaundice (hemolytic, hepatic and obstructive). Changes in plasma proteins, clotting factors and prothrombin time. Serum enzymes in liver diseases: ALP,

SGOT, SGPT and γ-GTP. Bile pigment levels in urine and faeces. Gastric function tests: collection and examination of gastric contents after stimulation. Errors in collection of samples. Fractional test meal analysis and its interpretation, and tubeless gastric analysis.

REFERENCE BOOKS:

1. Murphy MJ, Srivastava R and Deans K, *Clinical biochemistry: an illustrated color text* (6th ed.), Edinburgh: Elsevier, 2019.
2. Devlin TM, *Textbook of biochemistry with clinical correlations* (7th ed.), New York: John Wiley & Sons, 2010.
3. Bisswanger H, *Practical enzymology* (3rd ed.), Weinheim: John Wiley & Sons, 2019.

SUGGESTED READING:

1. Chatterjea MN, Rana Shinde, *Textbook of Medical Biochemistry,* JPB; eigth edition (1 January 2012).
2. Vasudevan DM, Sreekumari S, Kannan Vaidyanathan, *Textbook Of Biochemistry For Medical Students*, Jaypee Brothers Medical Publishers; Ninth edition, 2019.

Cell Culture Technology

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UNIT I: ANIMAL CELL CULTURE **(10 Hrs)**

History, biology of cultured cells, culture media-composition, preparation and development, cell isolation, establishment and evaluation of cell culture, sterilization techniques for ATC lab. Animal cell lines: Establishment, properties and use of cell lines, cultures of tumor cells; Cryopreservation of animal cells. Culture and scale up: Monolayer culture-surface requirements, gas phase requirements, capillary culture units, suspension culture scale up. Somatic cell fusion: Methods of somatic cell fusion, selection, properties of cell hybrids and their applications.

UNIT II: ANIMAL CLONING AND EMBRYO TRANSFER **(8 Hrs)**

Superovulation, in vitro fertilization, embryo transfer technology in animals; Concepts and techniques of cloning. Applications: Industrial applications of animal cell culture; Stem cell culture and its applications.

UNIT III: PLANT TISSUE CULTURE **(9 Hrs)**

History of plant cell culture, culture media-composition, preparation and development, cellular totipotency, cryopreservation. Callus and cell culture: Isolation of cells, growth of single isolated cells. Suspension culture: Regeneration and maintenance of callus, organogenesis and embryogenesis.

UNIT IV: PLANT ORGANOTYPIC CULTURE **(9 Hrs)**

Meristem culture, embryo culture and embryo rescue, another culture, virus free plant production and haploid plant production, production of synthetic seed, micropropagation. Protoplast culture and fusion: Isolation of protoplasts, culture and regeneration; fusion of protoplasts, selection of fusion products of protoplasts; Cybrids. Somaclonal variation, plant transformation-Agrobacterium mediated and particle gun mediated, secondary plant metabolites and application of plant biotechnology in crop improvement.

UNIT V: APPLICATIONS & ASSAYS **(9 Hrs)**

Cell-Based Assays- Proliferation assays, Apoptosis assays Reporter gene assays. Clinical Applications- Stem cell culture and regenerative medicine. Cell therapy and personalized medicine. Current Trends and Emerging Technologies- 3D cell culture, Organoids and microfluidics, Ethical and Regulatory Considerations- Ethical guidelines in cell culture research, Regulatory requirements for cell-based products

REFERENCE BOOKS:

1. Freshney RI, *Culture of animal cells:* A manual of Basic Technique, 5th edition (2005), Willey Liss Publisher.
2. Minuth WW, Strehl R, Schumacher K, *Tissue Engineering*: Essential for Daily Laboratory Works, Willey Publisher (2005).
3. Chawla HS, *Plant Biotechnology*, Oxford and IBH, 2009.
4. Chrispeels MJ. and Sadava DE, *Plants, Genes and Crop Biotechnology,* 2nd Edition, American Society of Plant Biologists, Jones and Bartlett Publishers, USA (2003).

SUGGESTED READINGS:

1. Singh BD, *Plant Biotechnology*. Kalyani publisher, 2003.
2. Arie Altman, Marcel Dekker, *Agricultural Biotechnology*, Inc. (2001).
3. Buchanan BB, Gruissem W, and Jones RL *Biochemistry and Molecular Biology of Plants*, (2000).

: Cell Signaling

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UNIT I: INTRODUCTION TO CELL SIGNALING (10 Hrs)

Overview of cellular communication, Types of signaling: autocrine, paracrine, endocrine, Local and long-distance communication. Components of signaling pathways: ligands, receptors, effectors, Historical milestones in cell signaling research

UNIT II: RECEPTOR-LIGAND INTERACTIONS (12 Hrs)

Receptor classification: cell surface receptors, intracellular receptors, Ligand binding and conformational changes, Downstream events triggered by receptor activation, Signal amplification and termination, Mechanisms for terminating signals. Signal Termination- Role of phosphatases and desensitization.

UNIT III INTRACELLULAR SIGNALING PATHWAYS (12 Hrs)

Second messengers: cAMP, cGMP, calcium ions, Protein kinases and phosphorylation cascades: Examples of key signaling pathways: MAPK, JAK-STAT, NF-κB. G-protein coupled receptors (GPCRs), Enzyme-linked receptors and receptor tyrosine kinases (RTKs)

UNIT IV REGULATION OF CELL SIGNALING (14 Hrs)

Negative feedback loops in signaling pathways, Examples of negative feedback in different signaling pathways. Crosstalk between signaling pathways, Cell communication in development and tissue homeostasis- Signaling in embryonic development.

Role of signaling in tissue regeneration and repair. Role of signaling in immune responses- Inflammatory signaling pathways. Immunomodulation and therapeutic implications

UNIT V: DISEASES AND ABERRATIONS IN CELL SIGNALING (12 Hrs)

Genetic mutations and signaling pathway dysregulation- Diseases associated with genetic alterations in signaling pathways, Cancer and abnormal cell signaling- Hallmarks of cancer and their connection to signaling pathways.

Oncogenes and tumor suppressor genes. Signaling in neurodegenerative diseases- Therapeutic targeting of signaling pathways- Overview of drug development targeting signaling pathways.

REFERENCE BOOKS:

1. "Cell Signaling" Wendell Lim, Bruce Mayer, Tony Pawson (2014), Garland Science Publications, 3rd edition
2. "Molecular Biology of the Cell", Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2014), Garland Science Publications, 6th edition
3. "Signal Transduction", Bastien D. Gomperts, Ijsbrand M. Kramer, Peter E.R. Tatham
(2009), Academic Press Publications, 3 rd edition
4. "Cell Signaling in Health and Disease" Martin Beckerman, (2018), CRC Press, 1st edition

SUGGESTED READING:

1. "Principles of Cell Signaling" Authors: C. David Sherris, Robert E. Sherris, (2010), Garland Science Publication, 1st edition
2. "Cell Signaling: Principles and Mechanisms" Tony Pawson, Anthony J. Hunter (1998), Oxford University Press, 1st edition
3. "Cell Signaling and Growth Factors in Development: From Molecules to Organogenesis" Daniel R. Marshak, Michael T. Coughlin, Jeffrey L. Smith, (2006), Cold Spring Harbor Laboratory Press, 1st edition

Introduction to Stem Cell Technology

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UNIT I: INTRODUCTION TO STEM CELLS (10 Hrs)

Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.

UNIT II: TYPES OF STEM CELLS (12 Hrs)

Stem Cell biology and therapy, types embryonic stem cell, Pluripotent, Multipotent and Totipotent Stem cells; Primordial germ cells, adult stem cell, Stem Cell Biology and Therapy, Embryonic Stem Cells, culture and the potential benefits of stem cell technology

UNIT III: THERAPEUTIC APPLICATIONS OF STEM CELLS (12 Hrs)

Gene Therapy: Introduction, History and evolution of Gene therapy, optimal disease targets, Failures and successes with gene therapy and future prospects, Genetic Perspectives for Gene Therapy, Gene Delivery methods: Viral vectors and Non-viral Vectors

UNIT IV: ETHICAL ISSUES (12 Hrs)

Ethical issues associated with stem cell-based regenerative medicine field: Regulatory and Ethical Considerations of stem cell and Gene Therapy, Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies.

UNIT- V: TISSUE AND ORGAN DEVELOPMENT (14 Hrs)

Differentiation in early development, Potency, Commitment, specification, induction, competence determination and differentiation, morphogenetic gradients, cell fate. Cellular differentiation of the nervous system.

REFERENCE BOOKS:

1. Lanza, R. and Atala, A. (2013) Essentials of Stem Cell Biology, Academic Press, California.
2. Huang, N.F., L'Heureux, N., Song, L. (2018) Engineering Stem Cells for Tissue Regeneration. World Scientific Publishing Company
3. Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. Wiley, 1998

SUGGESTED READING:

1. Scott, C.T. (2006) Stem Cell Now, Pearson Education, New Jersey.
2. Marshak, D.R., Gardner, R.L., Gottlieb, D. Lanza, R., Atala, A (ED.) (2001) Stem Cell Biology.Cold Spring Harbor Press, New York.
3. Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003

[illegible]: Genomics and Proteomics

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UNIT I: CONCEPT OF GENOMICS **(9 Hrs)**

Mutagenesis, Regulated vectors for controlled expression of multiple genes to study gene function in different hosts. Recombinant DNA strategies to study protein interactions. (Yeast 2-hybrid system, Phage display, Protein fragment complementation). Determining the Function of Individua l genes (Gene deletion, over-expression and complementation, Genomewide insertional mutagenesis).

UNIT II: FUNDAMENTALS OF WHOLE-GENOME SEQUENCING (9 Hrs)

Sequencing of Phage, Viral and Bacterial Genomes, Human Genome sequencing, and comparative genomics. High throughput genome-wide cloning and protein expression strategies and applications. Antibody gene cloning and engineering, humanization and Human antibodies.

UNIT III: INTRODUCTION TO PROTEOME **(9 Hrs)**

Proteomics technology, types and kinds of proteomics investigation, importance of proteomics. Principles and applications of the separation technology (Electrophoresis, Centrifugation, Chromatography) in proteomics. Mass spectrometry (Ionizers, analyzers and detectors) technology and its application in proteomics. General workflow for the 2-D Gel Electrophoreses, sample preparation, evolution of 2D PAGE, experimental details for the 2D gel and high throughput 2-D PAGE. Application of two-dimension gel electrophoreses in proteomics and biomarker discovery. Importance of 2-D fluorescence difference gel electrophoresis for comparative proteomics.

UNIT IV: PROTEOMIC PROFILING FOR HOST-PATHOGEN INTERACTION (9 hrs)

Sample treatment for labeling, 2D LC-MS/MS analysis, database search and relative quantification, analysis and interpretation, quantitative proteomics. Protein-Protein Interaction (PPI) and its application in proteomics. Methods to study PPI. Application of proteomics for drug discovery. Biomarkers and drug targets identification.

UNIT V: VALIDATION OF DRUG TARGETS AND ASSESSMENT OF ITS TOXICOLOGY **(9 Hrs)**

Case Studies:

(i) Strategies for large-scale expression of recombinant proteins in heterogonous hosts. Purification and downstream processing to produce Therapeutic grade recombinant proteins and regulatory aspects.

(ii) Microarray techniques for DNA, Proteins and Antibodies. Global expression profiling (iii) Cellular Engineering.

REFERENCE BOOKS:

1. Glick BR, Pasternak JJ and Patten CL, *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (2010) 4th ed., ASM Press (Washington DC).
2. Erica G and Peter DA, *Protein-Protein Interactions: A Molecular Cloning Manual* (2005) Cold Spring Harbor Laboratory Press,
3. Green MR and Sambrook J, *Molecular cloning,* A Laboratory Manual Vol. I-III. (Fourth edition), (2012) Cold Spring Harbor Laboratory Press.
4. Ausubel FM, et al., Current Protocols in Molecular Biology, (2015) John Wiley and Sons, Inc.

SUGGESTED READING:

1. James D. Watson, Richard M. Myers, Amy A. Caudy and Jan Witkowski, *Recombinant DNA, Genes and Genomes – A Short Course* (3rd edition), (2007). Cold Spring Harbor Laboratory Press.

Primrose SB and Twyman RM, Principles of Genome Analysis and Genomics. (7th edition), (2006) Blackwell Publishing.

Biochemistry Laboratory Skills - I

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UNIT I: BASIC LABORATORY PRINCIPLES (12 hrs)

Organization of clinical laboratory and role of Medical Lab Technologist, Code of conduct of medical laboratory personnel, ethics, responsibility, safety measure and hazards in clinical biochemistry lab and first aid in laboratory accidents. Waste disposal in the labs.

UNIT II: PRINCIPLES AND CALIBRATION (12 hrs)

Laboratory instruments, Glassware's & plastic wares used in lab, Cleaning, care and maintenance of glasswares. calibration of volumetric apparatus. Principle, working, care & maintenance and calibration of Weighing balance, autoclave, Centrifuges, Incubator, Hot air oven, Colorimeter, Spectrophotometer, Water distillation plant, pH meter.

UNIT III: PREPARATION OF SOLUTION AND REAGENTS (12 hrs)

Preparation of Normal saline. Preparation of Normal solution, molar solutions, percent solution, buffer solution, dilutions, w/v, v/v, standard solution.

UNIT IV: COLLECTION, TRANSPORT AND DISPOSAL (12 hrs)

General approach to specimen collection, transport and disposal: Specimen collection and processing of blood, urine & CSF, separation of serum and plasma, Handling of specimens for testing, preservation of specimen, transport of specimen, effect of storage on sample. Anticoagulants- E.D.T.A, Dipotassium salts of EDTA Double oxalate, single oxalate, sodium citrate. Sodium Fluoride.

UNIT V: ANALYZERS IN CLINICAL LABORATORY (12 hrs)

Types of analyzers - Semi-auto analyzer - Batch analyzer - Random Access autoanalyzers. Steps in the automated systems - Responsibilities of a technician in the maintenance of the analyzers.

Clinical laboratory records. Quality control in clinical laboratories: - Quality control: Accuracy, Precision, and Reference values.

REFERENCE BOOKS:

1. Teitz, *Clinical Chemistry*, W.B. Saunders Company Harcourt (India) Private Limited New Delhi.

2. Singh & Sahni, *Introductory Practical Biochemistry*,2nd edition, Alpha science, 2008.

3. Godkar PB, Godkar DB, *Text book of Medical Laboratory Technology*. Bhalani Publishing House, 2014.

SUGGESTED READING:

1. Vasudevan DM, (2011), *Text book of Medical Biochemistry*, 6th edition Jaypee Publishers.
2. Baker EJ, Silverton RE, Butterworth-Heinemann. *Introduction to Medical Laboratory Technology*, Butterworth- Heinemann, 2014.
3. Chatterjea MN & Rana Shinde, (2012), *Text book of Medical Biochemistry*, 8th edition, Jayppe Publications.

Phytochemistry of Medicinal Plants

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UNIT I: INTRODUCTION TO MEDICINALLY IMPORTANT PLANT PARTS (4 hrs)

Fruits, Leaves, Stem and its modifications (underground and aerial), Roots.

UNIT II: PLANT IDENTIFICATION **(12 hrs)**

Elementary knowledge of Binomial nomenclature – Outline of Bentham and Hooker classification – Herbarium techniques.

UNIT- III: INTRODUCTION TO HERBAL MEDICINE **(16 hrs)**

Herbal medicine - History of herbal medicine - different types of herbal medicine - Ayurveda, Siddha and Unani - Pharmacological action- Traditional uses of Indian medicinal plants - *Eclipta alba, Gymnema sylvestre, Ocimum sanctum, Curcuma longa.* Medicinal Plants – past and present status in world and India. Important medicinal plants of India with their systematics, geographical distribution and uses. *Acorus calamus, Adhatoda vasica, Abrus precatorius Aloe vera, Phyllanthus amarus, Stevia rebaudiana, Belladona and Cinchona*

UNIT IV: ORGANOLEPTIC STUDY **(16 hrs)**

Organoleptic study of the following medicinal plants: Fruit – Amla, Bulb – Garlic, Rhizome – Ginger, seed – castor, Bark – Cinchona, Leaves – Neem and Flower – Clove

UNIT-V: HEALTH BENEFITS OF PHYTOPHARMACEUTICALS **(12 hrs)**

Introduction of Phytopharmaceuticals. Health benefits of phytopharmaceuticals - anthocyanins, carotenoids, lycopene, isoflavones, polyphenols, omega 3 - fatty acids, biological effects of resveratrol.

REFERENCE BOOKS:

1. Godte VM, *Ayurvedic pharmacology and therapeutic uses of medicinal plants*. Bharathiya Vidya Bhavan, Mumbai. 2000.
2. Grewal RC, *Medicinal Plants,* Campus Books International, New Delhi. 2000.

SUGGESTED READINGS:

1. Kumar NC, *An Introduction to Medicinal Botany and Pharmacognosy* –Emkay
2. Acharya Vipul Rao, *Herbs that Heal,* Diamond Pocket Books, New Delhi.
3. Samant SS and Dhar U, *Medicinal Plants of Indian Himalava*.

Biochemistry Laboratory Skills II

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UNIT I: INTRODUCTION TO CLINICAL BIOCHEMISTRY (8 hrs)
Definition of biochemistry, use of biochemical tests-the application of biochemistry in hospital setting. Introduction and definition of photometry. Colorimetry - Lambert Beer's Law - Parts of photo colorimeter.

UNIT II: BIOCHEMICAL ESTIMATIONS IN BLOOD (12 hrs) Determination of proteins in serum and plasma. Determination of glucose, glycated hemoglobin, triglycerides, cholesterol, lipoproteins.

UNIT III: EVALUATION OF ORGAN FUNCTION TESTS (16 hrs)
LFT, RFT, pancreatic, gastric function test, thyroid function tests (important test). Diagnostic enzymes of pancreas and heart.

UNIT IV: BODY FLUIDS (12 hrs)
Body Fluids: Characteristics of Cerebrospinal Fluid. - Synovial fluid – Pleural fluid - Pericardial fluids - Peritoneal fluids.

UNIT V: GENERAL EXAMINATION OF URINE (12 hrs)
Physical, chemical and microscopic examination of urine, Bence Jones Proteinuria and its clinical significance, qualitative test of urine for reducing sugars, protein, ketone bodies, bile Salt, bile pigments, urobilinogen, occult blood, uric acid, urea and Creatinine, quantitative estimation of 24 hrs urine for protein and their clinical significance.

REFERENCE BOOKS:

1. Mayne, *Clinical Chemistry in Diagnosis and Treatment*, ELBS. 6th ed. 1994.
2. Todd & Stanford, *Clinical Diagnosis and Management by Laboratory Methods*, 16th ed. 2016.

SUGGESTED READING:

1. Vasudevan DM, (2011), *Text book of Medical Biochemistry*, 6th edition Jaypee Publishers.
2. Chatterjee MN & Rana Shinde, (2012), *Text book of Medical Biochemistry*, 8th edition,
Jayppe Publications
3. Teitz, *Clinical Chemistry*. W.B. Saunders Company Harcourt (India) Private Limited New Delhi
4. Harold Varley. *Practical clinical biochemistry*. CBS Publisher. 6th ed. 2002

Herbal Technology

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UNIT-1: EXTRACTION AND PURIFICATION METHODS **(12 hrs)**

Extraction – purification of bio-active compounds from plants - cold & hot extract extraction. Soxhlet extraction - crude extracts purification by various solvents.

UNIT-II: CHROMATOGRAPHIC TECHNIQUES **(12 hrs)**

Isolation of bioactive compounds- chromatographic techniques - thin layer chromatography, HPLC and UPLC.

UNIT-III: STRUCTURAL ANALYSIS TECHNIQUES **(12 hrs)**

Structural analysis of bioactive compounds - IR spectroscopy - Mass spectroscopy- GC–MS, LC–MS, NMR spectroscopy and their applications in natural products.

UNIT IV: INTRODUCTION TO HERBAL INDUSTRY **(12 hrs)**

General Introduction to Herbal Industry Herbal drugs industry: Present scope and future prospects. Schedule T – Good Manufacturing Practice of Indian systems of medicine Components of GMP (Schedule – T) and its objectives Infrastructural requirements, working space, storage area, machinery and equipment, standard operating procedures, health and hygiene, documentation and records.

WHO & ICH guidelines for the assessment of herbal drugs. Stability testing of herbal drugs (in brief).

UNIT-V: ANALYTICAL PHARMACOGNOSY **(12 hrs)**

Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs – Preliminary phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

REFERENCE BOOKS:

1. .Harbone JB, *Phytochemical Methods*: A guide to modern techniques of plant analysis, Springer (India) Private Limited, 3rd ed. New Delhi. 1998.
2. Silverstein RM, Wester FX, *Spectroscopic identification of organic compounds*, John Wiley. 1998.
3. Willard HH, Merrit LL, Dean JA, *Instrumental Methods of Analysis*, 1987.

SUGGESTED READING:

1. Gokhale, S.S., C.K.Kokate and A.P. Purohit (1994) Pharmacognosy. Nirali Prakashan. Pune.
2. Tyagi, Dinesh Kumar (2005) Pharma Forestry. Field Guide to Medicinal Plants. Atlantic Publishers and Distributors, New Delhi.
3. Mukherjee, P.W. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals. Business Horizons Publishers, New Delhi, India, 2002.

Microbiological Laboratory Skills

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UNIT I: INTRODUCTION TO MICROBIOLOGY **(12 hrs)**

History and mile stones in microbiology. Contributions of Anton von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Ivanowsky. Classification of microorganisms (in brief). Importance and applications of microbiology. Principles of microscopy

UNIT II: METHODS OF STERILIZATION **(12 hrs)**

Physical methods, Chemical methods and their application. Microbial cultures: Concept of pure culture, Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Protection of microbial cultures: subculturing, overlaying cultures with mineral oils, lyophilization, and cultures, storage at low temperature.

UNIT III: STAINING TECHNIQUES **(12 hrs)**

Simple and Differential staining techniques. Gram positive cell wall, Gram negative cell wall, Cell wall of fungi and yeasts.

UNIT IV: MICROBIAL GROWTH - DIRECT METHODS **(12 hrs)**

Principles of growth, Kinetics of growth, Methods of measuring growth, Direct methods: viable plate counts, membrane filtration.

UNIT V: MICROBIAL GROWTH - INDIRECT METHODS **(12 hrs)**

Indirect methods: Metabolic activity –measurements of DNA, Protein, Microscopic counts, electronic counters, most probable number; Batch and continuous growth, Synchronous culture, Diauxic growth, Types of cultures-stock, batch, continuous and synchronous cultures.

EXCERCISES:

1. Microbiology Good Laboratory Practices and Biosafety.
2. Preparation of culture media for cultivation of bacteria
3. Preparation of culture media for cultivation of fungi
4. Sterilization of medium using Autoclave
5. Sterilization of glassware using Hot Air Oven
6. Light compound microscope and its handling
7. Microscopic observation of bacteria (Gram +ve bacilli and cocci, Gram –ve bacilli), Cyanobacteria, Algae and Fungi.
8. Simple staining
9. Gram's staining
10. Hanging-drop method.
11. Isolation of pure cultures of bacteria by streaking method.
12. Preservation of bacterial cultures by various techniques.

REFERENCE BOOKS:

1. Prescott LM, Harley JP and Klein DA *Microbiology* (7th edition) McGraw Hill, New York, 2006.
2. Pelczar MJ, Chan ECS and Kreig NR, *Microbiology*, 5th Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 1993.
3. Dube RC and Maheswari DK, *General Microbiology*, S Chand, New Delhi, Edition, Himalaya Publishing House, Mumbai, 2000.
4. Power CB and Daginawala HF, *General Microbiology Vol I & II,* (1986).

SUGGESTED READING:

1. Reddy SM, and Reddy SR, *Microbiology*, Practical Manual, 3 rd Edition, Sri Padmavathi Publications, Hyderabad. (1998).
2. Jaya Babu, *Practical Manual on Microbial Metabolisms and General Microbiology*. Kalyani Publishers, New Delhi, (2006).
3. Gopal Reddy et al., Laboratory Experiments.