M.G. Science Institute, Autonomous
Affiliated to Gujarat University, Ahmedabad
(Managed by The Ahmedabad Education Society)

Department of Biotechnology

Bachelor of Science (Hons.) in Biotechnology

B.S. (Hons.) Biotechnology
Semester III and IV
Proposed Syllabus

(Effective from Academic Year 2025-26)

Syllabus B.S. Biotechnology Semester III and IV

SEMESTER III BIOTECHNOLOGY

Semester: III	Course Title: GENETICS	Credit: 4
Course Code: BTM231 (T)		4hr/week

COURSE OUTCOMES (COS)

By the end of the course student should be able to:

- CO1: Understand the fundamental concepts of genetics, inheritance patterns.
- CO2: Comprehend the structure and function of genes, chromosomes, and the molecular mechanisms behind gene expression.
- CO3: Interpret the principles of Mendelian inheritance, including dominance, recessiveness, and genetic linkage.
- CO4: Examine the mechanisms of genetic variation and its role in evolution and disease.

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	2		1		2	1	
CO-2	3	3	1	1			1	
CO-3		3			1			1
CO-4		2	2					1

Unit 1: Basics of Mendelian genetics and core concepts Teaching Hours: 15

- Structure & Organization of Gene: Fine Structure of gene (Cistron, Recon, Muton) Structure of eukaryotic gene. Organization of genes,Psuedo genes, Allele, Multiple allele, Pseudo allele, Lethal genes, Pleiotropic gene.
- Mendelian Principles: Laws of Heredity and patterns of inheritance
- Gene Interaction: Allelic Interaction (Dominance, Incomplete Dominance & Co-Dominance), Non allelic interaction (Supplementary, Complementary & Duplicative genes, Epistasis).
- Linkage & Crossing over

Unit 2: Chromosome Biology Teaching Hours: 15

- Structure of chromosome
- Concept of chromosome number
- Extrachromosomal DNA: plasmids, mitochondrial DNA, chloroplast DNA
- Lampbrush and polytene chromosomes

Unit 3: Genomic organization and Replication Teaching Hours: 15

- DNA as genetic material: Experimental evidences (Direct & Indirect Evidences)
- Genomic organization of prokaryotic & eukaryotic cells
  Histones, histone like proteins and nucleosomes
- Experimental evidences of DNA replication
- Process of replication in Prokaryotes & Eukaryotes

Unit - 4 Genetics variability & Evolution Teaching Hours: 15

- Introduction to evolution and genetic variation
- Mechanisms of genetic variation and concepts of: Mutation, genetic drift, gene flow, and natural selection.
- Evolutionary genetics: Speciation, adaptation, and evolutionary clock.
- Population genetics: Gene pool, allele frequencies and its analysis, and Hardy-Weinberg equilibrium.

References

1. Genetics: A Conceptual Approach – Benjamin A. Pierce
2. Molecular Biology of the Gene – James D. Watson et al.
3. Principles of Genetics – D. Peter Snustad and Michael J. Simmons
4. Genetics: From Genes to Genomes – Leland Hartwell, Michael G. Goldberg, Janice A. Rosenthal
5. Genetics: Analysis and Principles – Robert J. Brooker
6. Genomes – T.A. Brown
7. Molecular Genetics of Bacteria – Larry Snyder and Wendy Champness

Semester: III	Course Title: Tissue culture techniques	Credit: 4
Course Code: BTM232 (T)		4hr/week

COURSE OUTCOMES (COs)

By the end of the course, students should be able to:

- CO1: Understand the principles, techniques, and applications of plant and animal tissue culture.
- CO2: Describe the preparation and maintenance of sterile cultures and media of various tissue cultures.
- CO3: Differentiate different types of cell culture systems (monolayer, suspension, organ, etc.) and their applications.
- CO4: Demonstrate knowledge of cellular differentiation, regeneration, and the creation of transgenic organisms using tissue culture techniques.
- CO5: Apply the techniques of plant micropropagation and explain their significance in agriculture and horticulture.

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	3	2	1		2		
CO-2	3	2	1	1	1			1
CO-3		3	2					
CO-4		3			1	1		
CO-5	3				2			1

Unit 1: Introduction to Tissue Culture Techniques Teaching Hours: 15

- History and Discovery and evolution of tissue culture techniques in plants and animals.

- Major applications and industries using tissue culture (e.g., agriculture, pharmaceuticals, and biotechnology).
- Principles of Tissue Culture
    - Definition, importance, and methods of tissue culture.
    - Role of aseptic techniques, culture environment, and sterile conditions.
- Types of plants and animal tissues

Unit 2: Plant Tissue Culture Techniques Teaching Hours: 15

- Explant Selection and Sterilization
    - Methods for sterilizing plant tissues.
    - Types of explants used in plant tissue culture (e.g., meristems, leaves, stems, and roots).
- Micropropagation
    - In vitro regeneration of plants.
    - Applications of micropropagation in agriculture, horticulture, and forestry.
- Somatic Embryogenesis and Organogenesis
    - Induction of somatic embryos and the regeneration of whole plants.
    - Organogenesis: development of organs (roots, shoots) from undifferentiated cells.
- Production of Transgenic Plants
    - Methods of genetic transformation (Agrobacterium-mediated, biolistic).
    - Applications in plant biotechnology (disease resistance, improved yield, GM plants).
- Cryopreservation in Plants
    - Techniques for long-term storage of plant cells and tissues.
    - Importance in conservation and gene bank management.

Unit 3: Animal Tissue Culture Techniques Teaching Hours: 15

- Principles of Animal Cell Culture
    - Media composition for animal cell cultures (e.g., essential nutrients, serum, growth factors).
    - Types of culture systems: monolayer, suspension, organ cultures.
- Primary Cell Culture and Cell Lines
    - Isolation and culture of primary cells.
    - Characteristics and maintenance of cell lines (continuous vs. finite).
- Cell Proliferation and Differentiation
    - Methods for inducing cell growth and differentiation.
    - Use of growth factors and hormones in cell culture.
- Applications of Animal Tissue Culture
    - Production of vaccines, monoclonal antibodies, and recombinant proteins.
    - In vitro toxicology and drug testing.
    - Stem Cells and Tissue Engineering

Unit 4: Ethical and Practical Considerations In Tissue Culture Teaching Hours: 15

- Ethical Issues in Animal Tissue Culture
    - Animal welfare and the 3Rs (Replacement, Reduction, Refinement).
    - Ethical implications of cloning and genetic manipulation.

- Ethical Issues in Plant Tissue Culture
    - Concerns regarding genetically modified organisms (GM plants).
    - Environmental and biodiversity concerns.
- Contamination and Quality Control
    - Types of contamination in tissue culture (bacterial, fungal, viral).
    - Strategies for contamination control and maintaining culture purity.
- Biosafty rules and policy

References

1 Plant Tissue Culture: Theory and Practice, S. S. Bhojwani and M. K. Razdan
2 Animal Cell Culture and Technology, R. Ian Freshney
3 Plant Biotechnologies: The Genetic Manipulation of Plants M. R. Ahuja
4 Introductions to Plant Tissue Culture M. K. Razdan
5 Cultures of Animal Cells: A Manual of Basic Technique R. Ian Freshney
6 Animal and Plant Cell Culture: A Practical Approach, R. L. M. S. Colvin and J. A. W. Nicol
7 Fundamentals of Tissue Culture, A. R. G. Pearson and J. S. Croft
8 Plant Biotechnology and In Vitro Biology, P. A. L. Drews and S. M. L. Guo

Semester: III	Course Title: Biotechnology Practicals	Credit: 4
Course Code: BTM233 (P)		8hr/week

COURSE OUTCOMES (COs)

By the end of the course, students should be able to:

- **CO1**: Demonstrate the ability to organize and maintain a tissue culture laboratory, ensuring optimal facilities for successful cultures.
- **CO2**: Prepare different types of tissue culture media and understand their principle
- **CO3**: Understand the importance of nutrients and growth regulators media.
- **CO4**: Knowledge of isolation of bacterial and plant DNA and will analyse the comparative step.
- CO5: Apply Mendelian principles to solve genetic problems and Hardy-Weinberg Law of Equilibrium principle to solve population genetics problems

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	2	3	1		2		
CO-2	3	3	1	1			1	1
CO-3	2		3		1			
CO-4		3				3		2
CO-5	3	3	2		1		2	

1. Plant tissue culture: laboratory organization facilities and aseptic techniques
2. Preparation of Plant tissue culture media: MS, Nitsch & Whites medium.

3. Production of callus culture & study of characteristics
4. Preparation of synthetic seeds: Encapsulation Techniques
5. Isolation of Protoplast
6. Study of media for animal cells & tissues.
7. Study of animal cell lines (demonstration)
8. Isolation of DNA from plants
9. Isolation genomic DNA from bacteria
10. Quantization of DNA by spectrophotometry
11. Problem solving on Mendelian Principles
12. Problem solving on Hardy Weinberg Law of equilibrium

References

1. Plant Tissue Culture: A Laboratory Manual by M. K. Razdan
2. Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith
3. Plant DNA Isolation: Methods and Applications by T. L. V. S. R. B. Pratap
4. Animal Cell Culture and Technology by N. N. R. B. I. S. Johr
5. Cell and Tissue Culture: Laboratory Procedures by L. E. W. Denny
6. Molecular Cloning: A Laboratory Manual by Joseph Sambrook and David Russell
7. Mendelian Genetics: Principles of Heredity by S. M. Longo
8. Principles of Population Genetics by Daniel L. Hartl

Semester: III	Course Title: Analytical Techniques I	Credit: 2 (T+P)
Course Code: BTSEC236A		(1+2)hrs/week

Course Outcomes:
By the end of the course, students should be able to:

CO1: Understand the definition, principles and general principles of chromatography
CO2: Compare and contrast various types of chromatography.
CO3: Understand the fundamental principles and definitions of spectroscopy, along with its diverse applications in the analysis of molecular structure and concentration.
CO4: Differentiate between various types of spectroscopy (UV-Visible, Fluorescence, Infrared (IR), Nuclear Magnetic Resonance (NMR), Atomic Absorption Spectroscopy).

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	2	3	2		2		
CO-2	3	2	1	1			1	1
CO-3			3		1			
CO-4	3	3	3			3		

Unit 1: Chromatography and Spectroscopy Teaching Hours: 15

- Overview of Chromatography
  - Definition, history and general principles of chromatography
  - Applications of Chromatography in Biotechnology
- Types of Chromatography:
  - Paper Chromatography
  - Thin Layer Chromatography (TLC)
  - Column Chromatography

    - Gas Chromatography (GC)
    - High Performance Liquid Chromatography (HPLC)
    - Ion-exchange Chromatography
- Over view of spectroscopy
    - Definitions, principles and applications
- Types of spectroscopy: UV-Visible Spectroscopy,

Unit 2: Applicative approach of chromatography and spectroscopy Teaching Hours: 30

1. Preparative measures and principles of solvent systems, phases and matrix
2. Study of Paper chromatography (ascending) for separation of amino acids
3. Study of TLC as a separation technique
4. determination of lamda max for given solution

Reference Books

- Basic Chromatography Techniques (2nd ed.) by, Robert L. S., Wiley
- Chromatography: A Practical Approach (3rd ed.)by E. Heftmann, Springer
- Laboratory Methods in Biochemistry and Molecular Biology by K. Wilson & J. Walker Cambridge University Press
- Introduction to Spectroscopy" by Donald L. Pavia, Gary M. Lampman, and George S. Kriz
- Chromatographic Techniques" by K. S. P. Rao

Semester: III	Course Title: Basics of Soil analysis	Credit: 2 (T+P)
Course Code: BTSEC236B		(1+2)hrs/week

Course Outcomes:

- CO1: Understand the concept of edaphic factors and explain the importance of soil in influencing plant growth.
- CO2: Describe the processes of soil formation, including weathering and organic matter
- CO3: Understand how soil texture, structure, and holding capacity affect soil fertility and agricultural productivity.
- CO4: Conduct the experiments for various parameters determination of soil

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	2			1	2		
CO-2	2		1	1			1	1
CO-3	3	1	2			1		
CO-4	2		3		1		3	

Unit 1 Understanding Soil as a Factor Teaching hours 15

- Edaphic factor: Importance of soil, Effect of soil on plants
- Origin and Development of soil, soil profile
- Soil composition, Soil texture, soil holding capacity
- Soil pollution- causes and effects and remedies
- Electrical conductivity of soils

- Soil erosion
- Soil conservation

Unit 2: Basics of soil analysis Teaching hours 30

1. Chart of types of soil
2. Chart of Soil profile
3. Determination of soil water holding capacity
4. Determination of Acidity of soil sample.
5. Determination of Alkalinity of soil sample.
6. Determination of Electrical conductivity of soil sample.
7. Determination of carbonates and bicarbonate of soil sample.
8. Determination of pH of soil sample

Reference Books

- "Principles and Practices of Soil Science" by R.K. Sharma and S.K. Gupta; Kalyani Publishers, 2008, ISBN: 9788127221803
- "Soil and Plant Analysis" by P.K. Gupta; Agrobios (India), 2007, ISBN: 9788177541148
- "Soil Science: An Introduction" by D.K. Das; Kalyani Publishers, 2015, ISBN: 9789327236774
- 'Soil Science and Management', Edward J. Plaster, Cengage Learning, 6th Edition, Year: 2013, ISBN-13: 9780840024329, ISBN-10: 0840024320
- "Fundamentals of Soil Science" by Henry D. Foth: ; John Wiley & Sons, 8th Edition, 1990, ISBN-13: 9780471522799, ISBN-10: 0471522791

SEMESTER IV: BIOTECHNOLOGY

Semester: IV	Course Title:	Credit: 4
Course Code: BTM241 (T)	Fundamentals of Metabolism	4hr/week

COURSE OUTCOMES (COS)

By the end of the course student should be able to:

- CO1: Understand and describe the key pathways in metabolism regarding carbohydrates, proteins, lipid and nucleic acids.
- CO2: Illustrate the biochemical steps involved in photosynthesis and its relevance to cellular metabolism.
- CO3: Comprehend the urea cycle and its importance in nitrogen metabolism.
- CO4: Understand the concept of hormones and their functions.
- CO5: Explain the structure and function of biological membranes and its role in signal transduction.

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	2	1	1		2		
CO-2	2	3	1	1			1	1
CO-3						3	2	2
CO-4	3				1	2		2

CO-5	3		2				2	

Unit 1: Metabolism - 1 Teaching hours 15

- Carbohydrate Metabolism: Glycolysis, Gluconeogenesis
- Tri carboxylic acid cycle
- Photosynthesis- C3 cycle
- Lipid Metabolism: β-oxidation of fatty acids

Unit 2: Metabolism - 2 Teaching hours 15

- Protein Metabolism-introduction
- Details of Transamination, Decarboxylation and Deamination
- Urea Cycle and its significance
- Biosynthesis of Nucleotide- introduction to de-novo and salvage pathway

Unit 3: Hormones Teaching hours 15

- Introduction to Hormones: Endocrine and Exocrine
- Animal Hormones and its functions
- Disorders due to hormonal imbalance in humans Addisons disease, Diabetes Mellitus, Diabetes Insipidus, Congenital hypothyroidism
- Plant Hormones and its functions

Unit 4: Molecular Transportation and Signaling Teaching hours 15

- Composition and architecture of membrane
- Solute transport across membrane- active and passive transport
- Concept of Signal transduction
- Regulation of cell cycle by protein kinase

References

1. General Microbiology By Stanier R.Y.: 5th Ed.
2. The physiology and Biochemistry of prokaryotes, 2nd edition by Devid
3. Lenhinger. Principles of Biochemistry, Nelson & Cox, 4th Edition.
4. Voet & Voet Donald. 3rd Edition. Fundamentals of Biochemistry, J/W.
5. Mathews, Van Holde, Biochemistry, 3rd Edition Pearson Education.
6. Garret and Grisham, Biochemistry, Thomsan Edition, 3rd Edn.
7. U Satyanarayan, Biochemistry, 3rd Edn, Books and Allied Pvt. Ltd.
8. Salisburry and Rose, Plant Physiology, 4th Edn, Wadsworth Pub.
9. Arthur M. Lask, Introduction to Protein Science, Oxford publication.
10. Price & Steven, Fundamentals of Enzymology,3rd Edition
11. Cohn and Stumph. Outline of Biochemistry. Wiley eastern.
12. Creigntion, proteins: Structure & Molecular Properties, Freeman Pub.
13. Switzer and Garrity. Experimental Biochemistry WH Freeman.2nd Edition

Semester: IV	Course Title:	Credit: 4
Course Code: BTM242 (T)	Immunology	4hr/week

COURSE OUTCOMES (COS)

By the end of the course student should be able to:

- CO1: Understand the fundamentals of immunology, immune system of humans and haematopoiesis in detail
- CO2: Learn about antigen and antibody structure, properties, types and interactions
- CO3: Analyse and explain antigen processing and presentation, MHC types and properties.
- CO4: Illustrate complement system, cytokines, interferon's and elaborate tumour immunology

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	2	2	1		2		
CO-2	2	3	1	1			1	1
CO-3					1		2	3
CO-4					1	3	3	

Unit 1: Immunity and immune system Teaching hours 15

- Historical Perspective, Innate Immune response and its role in protection
- Adaptive Immune response - Humoral and cellular component of the Immune response, Comparison between Innate and adaptive immunity.
- Hematopoiesis and Cells of the Immune System.
- Organs of the Immune System : Primary and Secondary Lymphoid Organs

Unit 2: Antigen and Antibody Teaching hours 15

- Antigen: Characteristics of antigens, Factors that influence immunogenicity, Cross reactivity, Epitopes, Haptens, Adjuvants.
- Immunoglobulins: Structure, Classification & Functions.
- Class switching and clonal selection theory
- Antigen and Antibody Interactions concept of Agglutination and Precipitation
- Monoclonal Antibodies: Production by Hybridoma Technology & Applications

Unit - 3 MHC, T cell and B cell and hypersensitivity Teaching hours 15

- MHC: MHC molecules, Structure and function
- T- Cell Receptor – structure
- Antigen Processing and Presentation
- Hypersensitivity and its types

Unit - 4 Specific Immuno-molecules and their functions Teaching hours 15

- Cytokines: Introduction and Function of Cytokines
- Complement System
- Interferon- introduction and applications
- Tumor immunology-types of tumor

Reference

1. Janis Kuby, Immunology, 5th Edition
2. Ivan Roitt, Essential Immunology, 9th Edn.
3. Ananthnarayan, Medical microbiology
4. Mary S. Leffell,& Noel R. Rose, Handbook of Human Immunology, CR
5. Tizzard, Immunology
6. Elgert Immunology
7. Lidyard, Instant notes in Immunology, 2nd Edition.
8. Darla J wise, Immunology-A comprehensive review: A Blackwell science Pub.
9. Todd & Spickett, Immunology
10. Delves & Roitte Encyclopedia of Immunology- Vol-1 to Vol.-4, 2nd Edition

Semester: IV	Course Title: Biotechnology Practicals	Credit: 4
Course Code: BTM243 (P)		8hr/week

COURSE OUTCOMES (COS)

By the end of the course student should be able to:

- CO1:Explain process of DNA, RNA, carbohydrate and protein estimation techniques
- CO2: Perform total count of blood cells using haemocytometer
- CO3: differentiate various blood cells
- CO4: Analyse and conclude Blood group, widal test, SRID and ODD test.

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	2	1	1		2		
CO-2	3	3	1	1			1	1
CO-3					1	3		3
CO-4		2		2			2	

1. Estimation of Protein by folin lowry's method.
2. Estimation of Reducing Sugar by DNSA method
3. Estimation of DNA by diphenyl amine method
4. Estimation of RNA by orcinol method)
5. Estimation of Carbohydrate by cole's method
6. Total count of blood cells using haemocytometer
7. Differential Count of blood cells
8. Practical understanding of Agglutination & Precipitation
    a. Blood Grouping
    b. Widal Test (Slide /Tube)
    c. Oucterlouny Double diffusion (ODD)
    d. SRID (Single Radial Immunodiffusion)Test

Reference

1. A handbook of practical and clinical immunology. Talwar GP and Gupta SK (1992) CBS Publications
2. Using Antibodies: A Laboratory Manual. Harlow & Lane (1998) Cold Spring Harbor Lab Press.

3. Immunological Techniques Made Easy. Cochet, et al. (1998) Wiley Publishers, Canada.
4. Clinical Immunology Principles and Laboratory Diagnosis. Sheehan (1990)

Semester: IV	Course Title: Analytical Techniques II	Credit: 2 (T+P)
Course Code: BTSEC246A		(1+2)hrs/week

Course Outcomes:

By the end of the course student should be able to:

- CO1: Skill enhancement in electrophoresis and centrifugation techniques.
- CO2: Knowledge about the fundamental principles, applications, types, and methods of electrophoresis and centrifugation techniques
- CO3: Perform and understand AGE and PAGE
- CO4: Analyze process of protein extraction and purification

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1	3	3	1	1		2		
CO-2	3	3	1	1	2		1	1
CO-3	2	3	1	3	1			2
CO-4	2	3	1	2		2	1	

Unit 1: Fundamentals of electrophoresis and centrifugation Teaching Hours: 15

- Electrophoresis:- Basic Principles and applications
- Agarose gel electrophoresis, SDS PAGE, native gel
- Centrifugation: Introduction, Basic Principle of Sedimentation, The basic components of centrifuge{Electric rotar, Drive Shaft, Rotars to hold Tubes etc}
- Preparative and analytical Centrifuges; Density gradient Centrifugation {Zonal and Isopycnic}, Differential Centrifugation

Unit 2: Applicative approach of analytical techniques Teaching Hours: 30

- Study of preparation of agarose gel and buffers for separation of DNA
- Separation of DNA by gel electrophoresis
- Study of preparation of poly acrylamide gel and buffers for separation of Protein
- Separation of protein by gel electrophoresis (demonstration)

Reference Books

- Basic Chromatography Techniques (2nd ed.) by, Robert L. S., Wiley
- Chromatography: A Practical Approach (3rd ed.)by E. Heftmann, Springer
- Laboratory Methods in Biochemistry and Molecular Biology by K. Wilson & J. Walker Cambridge University Press
- Introduction to Spectroscopy" by Donald L. Pavia, Gary M. Lampman, and George S. Kriz
- Chromatographic Techniques" by K. S. P. Rao

Semester: IV	Course Title: Fundamentals of blood banking	Credit: 2 (T+P)
Course Code: BTSEC246B		(1+2)hrs/week

Course Outcomes:

By the end of the course student should be able to:

- CO1: Understand functioning of blood bank
- CO2: explain preparatory measures of blood transfusion, collection and donor competence.
- CO3: analyse various blood groups and conduct blood grouping
- CO4: Perform haemoglobin estimation.

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8
CO-1		2	3	1		2		
CO-2	3	3	1		1		1	1
CO-3			2			1		
CO-4	2			1		2		1

Unit 1 Introduction to blood Bank Teaching Hours: 15

- Blood collection: Preparation of donor, Criteria for blood donation
- Procedure of blood bank, Screening and collection of blood, Various methods of blood collection
- Difference of serum and plasma
- Preservation of blood : Anticoagulants used in blood bank
- Various anticoagulants used in hematology tests, Components of blood, Component separation and its storage, preservation and shelf life

Unit 2 Blood Bank Techniques Teaching hours: 30

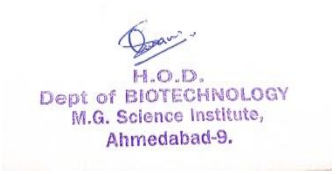
- Principals involved in Blood grouping, ABO system and Rh system
- Factors influencing the results of blood grouping,
- Other blood grouping systems, Cross matching, Compatibility test
- Knowledge about types of blood transfusion reactions
- Different methods of Haemoglobin estimation: Specific gravity method (Copper sulphate), Sahli's (Cyanmethhemoglobin) method.

References:

1. Baker and Silverton's Introduction to Medical Laboratory Technology, Baker F J,

Silverton R E, Pallister C J, 7th edition (1998), Butterworths-Heinemann, Oxford, UK

2. Medical Laboratory Technology, Mukherjee 4th edition (2022), McGraw-Hill Education.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