BACHELOR'S PROGRAMME WITH BIOTECHNOLOGY AS MAJOR SUBJECT

SEMESTER	COURSE CODE	TYPES OF COURSE	TITLE OF COURSE	CREDITS		
				THEORY 4	PRACTICAL 2	TUTORIAL/ INTERNSHIP
I	BTG 122J	MAJOR	Biomolecules: Structure and Function	4	2	
II	BTG 222J	MAJOR	Microbiology and Immunology	4	2	
III	BTG 322J	MAJOR	Molecular Cell Biology	4	2	
IV	BTG 422J1	COURSE TYPE-1	Biotechniques	3	1	
	BTG 422J2	COURSE TYPE-2	Molecular Biology	4	2	
	BTG 422J3	COURSE TYPE-3	Recombinant DNA Technology	4	2	
V	BTG 522J1	COURSE TYPE-1	Developmental and Systems Biology	3	1	
	BTG 522J2	COURSE TYPE-2	Animal Biotechnology	4	2	
	BTG 522J3	COURSE TYPE-3	Biostatistics and Bioinformatics	4		Internship: 2
VI	BTG 622J1	COURSE TYPE-1	Environmental Biotechnology	3	1	
	BTG 622J2	COURSE TYPE-2	Plant Biotechnology	4	2	
	BTG 622J3	COURSE TYPE-3	OMICS: Genomics, transcriptomics and proteomics	4	2	
VII	BTG 722J1	COURSE TYPE-1	Molecular Genetics and Epigenetics	3	1	
	BTG 722J2	COURSE TYPE-2	Bioprocess Engineering and Technology	4	2	
	BTG 722J3	COURSE TYPE-3	Molecular Diagnosis and Drug Design	4	2	
VIII (Hons with research)	BTG 822J1	COURSE TYPE-1	IPR, Bioethics and Biosafety	3	1	
	BTG 822JP	PROJECT	PROJECT	-	12	-
VIII (Hons)	BTG 822J1	COURSE TYPE-1	IPR, Bioethics and Biosafety	3	1	
	BTG 822J2	COURSE TYPE-1	Food Biotechnology and Nutrigenomics	4	2	
	BTG 822J3	COURSE TYPE-1	Cell Signaling and Cancer Biology	4	2	

Head of the Department / Convenor BOUGS

PROGRAMME LEARNING OUTCOMES OF THE MAJOR DISCIPLINE FROM 1st TO THE LAST SEMESTER:

SEMESTER	COURSE CODE	LEARNING OUTCOMES											
		A	B	C	D	E	F	G	H	I	J	K	L
I	BTG122J	✓	✓			✓		✓					
II	BTG222J	✓	✓	✓		✓			✓	✓			
III	BTG322J	✓	✓	✓		✓	✓	✓					
IV	BTG 422J1		✓	✓	✓	✓	✓	✓	✓	✓			
	BTG422J2	✓	✓	✓	✓	✓	✓	✓	✓	✓			
	BTG422J3	✓	✓	✓	✓	✓	✓	✓	✓	✓			
V	BTG522J1	✓		✓		✓	✓						
	BTG522J2		✓	✓		✓		✓	✓				
	BTG522J3				✓	✓	✓	✓	✓				
VI	BTG622J1	✓	✓			✓			✓				
	BTG622J2		✓	✓		✓		✓	✓				
	BTG622J3		✓	✓	✓	✓	✓		✓	✓			
VII	BTG722J1	✓	✓	✓	✓	✓				✓			
	BTG722J2		✓	✓		✓			✓				
	BTG722J3		✓	✓	✓	✓	✓		✓	✓			
VIII (R)	BTG822J1			✓			✓	✓	✓	✓			
	BTG822JP												
VIII (H)	BTG822J1			✓			✓	✓	✓	✓			
	BTG822J2	✓	✓	✓	✓	✓	✓			✓			
	BTG822J3	✓	✓	✓		✓				✓			

(NOTE: IN THE ABOVE TABLE LEARNING OUTCOMES SHALL BE SPECIFIED IN PLACE OF A, B, C … L etc. AND RELEVANT BOXES IN THE TABLE SHALL BE TICK MARKED)

Head of the Department / Convenor BOUGS

BACHELOR'S PROGRAMME WITH BIOTECHNOLOGY AS MINOR SUBJECT

SEMESTER	COURSE CODE	TYPES OF COURSE	TITLE OF COURSE	CREDITS		
				THEORY 4	PRACTICAL 2 or 0	TUTORIAL 0 or 2
I	BTG122N	MINOR	Biomolecules: Structure and Function	4	2	
II	BTG222N	MINOR	Microbiology and Immunology	4	2	
III	BTG322N	MINOR	Molecular Cell Biology	4	2	
IV	BTG422N	MINOR	Biotechniques	3	1	
V	BTG522N	MINOR	Developmental and Systems Biology	3	1	
VI	BTG622N	MINOR	Environmental Biotechnology	3	1	
VII	BTG722N	MINOR	Molecular Genetics and Epigenetics	3	1	
VIII	BTG822N	MINOR	IPR, Bioethics and Biosafety	3	1	

Head of the Department
/ Convenor BOUGS

PROGRAMME LEARNING OUTCOMES OF THE MINOR DISCIPLINE FROM 1st TO THE LAST SEMESTER:

SEMESTER	COURSE CODE	LEARNING OUTCOMES											
		A	B	C	D	E	F	G	H	I	J	K	L
I	BTG122J	✓	✓			✓		✓					
II	BTG222J	✓	✓	✓		✓			✓	✓			
III	BTG322J	✓	✓	✓		✓	✓	✓					
IV	BTG422N		✓	✓	✓	✓	✓	✓	✓	✓			
V	BTG522N	✓		✓		✓	✓						
VI	BTG622N	✓	✓			✓			✓				
VII	BTG722N	✓	✓	✓	✓	✓				✓			
VIII	BTG822N			✓			✓	✓	✓	✓			

(NOTE: IN THE ABOVE TABLE LEARNING OUTCOMES SHALL BE SPECIFIED IN PLACE OF A, B, C … L etc. AND RELEVANT BOXES IN THE TABLE SHALL BE TICK MARKED)

Head of the Department / Convenor BOUGS

BACHELOR WITH BIOTECHNOLOGY AS MAJOR

1st SEMESTER

BTG 122J: BIOMOLECULES: STRUCTRURE AND FUNCTION

CREDITS: THEORY - 4, PRACTICAL – 2

MAXIMUMMARKS: 100, MINIMUM MARKS: 36

- Course Learning Objective: understand about the molecules of life like water, carbohydrates, amino acids and proteins etc., their structure, function and coordination.
- **Course outcome: A student will be able to;**
  - to measure pH, make buffers, and distinguish between the different levels of protein structure and types of proteins.
  - predict the effect of [S] and [I] on enzyme action and type of inhibition.
  - draw the different structures of sugars; calculate the energy released during the oxidation different sugar molecules.
  - distinguish between different types of lipids and relate with their biological role, show the steps of oxidation of fatty acids and oxidative phosphorylation, draw the structure of nucleotides and nucleic acids

Unit – 1 15 Hours

Physicochemical properties of water; Concept of pH, pK, pI & buffers; Structure and classification of amino acids; Levels of protein structure- primary, secondary, tertiary and quaternary; Types of proteins – fibrous and globular proteins; Forces stabilizing protein structure.

Unit – 2 15 Hours

Nomenclature and classification of enzymes; Basic principles of enzyme catalysis; Concept of active site; Enzyme activity and its measurement, factors affecting enzyme activity; Michaelis-Menten kinetics; Lineweaver-Burk plot; Enzyme inhibition (competitive, non-competitive and uncompetitive)

Unit – 3 15 Hours

General structure, classification and function of carbohydrates; Stereoisomerism in monosaccharides with special reference to the concepts of configuration and conformation; Breakdown of carbohydrates– glycolysis, TCA cycle, electron transport chain, oxidative phosphorylation.

Unit – 4 15 Hours

Nomenclature and properties of fatty acids; Structure and functions of major types of

lipids - triglycerides, phospholipids, sphingolipids, sterols; Transport of fatty acids across the mitochondrial membrane, β oxidation of saturated and unsaturated fatty acids; Biosynthesis of fatty acids and triglycerides.

Structure and classification of nitrogenous bases, composition and bonding in nucleotides and polynucleotides. Types of DNA (A, B and Z) and their structure, types of RNA (mRNA, tRNA and rRNA) and their structure.

PRACTICALS (2CREDITS: 30 hours) Maximum Marks: 50, Minimum Marks: 18

1. Preparation of molar, molal, normal solution and buffers.
2. Qualitative and quantitative estimation of carbohydrates in a given solution.
3. Qualitative and quantitative estimation of proteins in a given solution.
4. Enzyme activity assay: Acid/Alkaline Phosphatase.
5. Effect of temperature and pH on enzyme activity.

BOOKSRECOMMENDED

1. Lehninger Principles of Biochemistry: Nelson, D. L. and Cox, M. M.-Worth Publishers, New York.
2. Biochemistry Stryer, L.-W.H.Freeman and Company, NewYork.
3. Biochemistry: Voet, D.and Voet, J.G.- John Wiley and Sons Inc. NewYork.
4. Understanding Enzymes: Palmer,T.-Ellis Horwood Limited,UK.
5. Enzymology:Devasena,T.-Oxford University Press.
6. Introductory Practical Biochemistry, S.K. Sawhney, R. Singh, Narosa Publishing House

BACHELOR WITH BIOTECHNOLOGY AS MINOR

1st SEMESTER

BTG 122N: BIOMOLECULES: STRUCTRURE AND FUNCTION

CREDITS: THEORY - 4, PRACTICAL – 2

MAXIMUMMARKS: 100, MINIMUM MARKS: 36

- Course Learning Objective: understand about the molecules of life like water, carbohydrates, amino acids and proteins etc., their structure, function and coordination.
- Course outcome: A student will be able to;
  - to measure pH, make buffers, and distinguish between the different levels of protein structure and types of proteins.
  - predict the effect of [S] and [I] on enzyme action and type of inhibition.
  - draw the different structures of sugars; calculate the energy released during the oxidation different sugar molecules.
  - distinguish between different types of lipids and relate with their biological role, show the steps of oxidation of fatty acids and oxidative phosphorylation, draw the structure of nucleotides and nucleic acids

Unit – 1 15 Hours

Physicochemical properties of water; Concept of pH, pK, pI & buffers; Structure and classification of amino acids; Levels of protein structure- primary, secondary, tertiary and quaternary; Types of proteins – fibrous and globular proteins; Forces stabilizing protein structure.

Unit – 2 15 Hours

Nomenclature and classification of enzymes; Basic principles of enzyme catalysis; Concept of active site; Enzyme activity and its measurement, factors affecting enzyme activity; Michaelis-Menten kinetics; Lineweaver-Burk plot; Enzyme inhibition (competitive, non-competitive and uncompetitive)

Unit – 3 15 Hours

General structure, classification and function of carbohydrates; Stereoisomerism in monosaccharides with special reference to the concepts of configuration and conformation; Breakdown of carbohydrates– glycolysis, TCA cycle, electron transport chain, oxidative phosphorylation.

Unit – 4 15 Hours

Nomenclature and properties of fatty acids; Structure and functions of major types of

lipids - triglycerides, phospholipids, sphingolipids, sterols; Transport of fatty acids across the mitochondrial membrane, β oxidation of saturated and unsaturated fatty acids; Biosynthesis of fatty acids and triglycerides.

Structure and classification of nitrogenous bases, composition and bonding in nucleotides and polynucleotides. Types of DNA (A, B and Z) and their structure, types of RNA (mRNA, tRNA and rRNA) and their structure.

PRACTICALS (2CREDITS: 30 hours) Maximum Marks: 50, Minimum Marks: 18

1. Preparation of molar, molal, normal solution and buffers.
2. Qualitative and quantitative estimation of carbohydrates in a given solution.
3. Qualitative and quantitative estimation of proteins in a given solution.
4. Enzyme activity assay: Acid/Alkaline Phosphatase.
5. Effect of temperature and pH on enzyme activity.

BOOKS RECOMMENDED:

1. Lehninger Principles of Biochemistry: Nelson, D. L. and Cox, M. M.-Worth Publishers, New York.
2. Biochemistry Stryer, L.-W.H.Freeman and Company, NewYork.
3. Biochemistry: Voet, D.and Voet, J.G.- John Wiley and Sons Inc. NewYork.
4. Understanding Enzymes: Palmer,T.-Ellis Horwood Limited,UK.
5. Enzymology: Devasena, T.-Oxford University Press.
6. Introductory Practical Biochemistry, S.K. Sawhney, R. Singh, Narosa Publishing House

BACHELOR WITH BIOTECHNOLOGY AS MAJOR

2nd SEMESTER

BTG 222J: MICROBIOLOGY AND IMMUNOLOGY

CREDITS: THEORY - 4, PRACTICAL – 2

MAXIMUMMARKS: 100, MINIMUM MARKS: 36

- **Objective:** Students will learn basics of microbiology like structure, bacterial genetics and general account of viruses. Students will learn about immune system – types of immune response, cells and different organs of the system. They would also learn responses generated by Lymphocytes, Antigen-Antibody interactions.
- **Expected Learning Outcomes:**
  - A student will be able to use microscopes, differentiate bacteria on basis of Gram staining and differentiate between different types of gene transfers in bacteria and classify viruses.
  - A student will be able to grow bacteria, measure their growth, determine the effect of different factors on growth and be able to control the growth of microbes.
  - Will be able to differentiate between different immune responses, cells involved and organs of immune system.
  - Able to classify antigen, adjuvants and haptens. Carry out different antigen-antibody interactions.

Unit –1 15 Hours

General structure of Bacterial cell (cell wall – Gram +*ve* and Gram –*ve*, flagella, bacterial chromosome, plasmid, cell inclusions).

Gene transfer in bacteria (Transformation, conjugation, transduction).

General structure of viruses (Capsid symmetry, enveloped and non-enveloped viruses) viral classification (RNA & DNA, positive & negative stranded viruses). Bacteriophages - lambda phage life cycle).

Unit –2 15 Hours

Nutritional requirements, Bacterial nutritional types (photolitho-autotrophy, chemolithio-autotrophy, photoorgano-heterotrophy and chemoorgano-heterotrophy). Growth curve - its phases, Growth kinetics. Factors affecting growth (solute and water activity, pH, temperature, oxygen concentration, pressure), Measurement of bacterial growth. Control of microbial growth (physical, chemical and antibiotics).

Unit – 3 15 Hours

Innate Immune system, (Anatomical and physiological barriers). Hematopoiesis, Cells of

myeloid and lymphoid system (Basophils, Neutrophils, Eosinophils, monocytes, T cells, B cells, NK cells, dendritic cells, mast cells). Phagocytosis and respiratory burst, Inflammation (clinical signs, initiators and mediators), Organs of immune system – primary (bone marrow, thymus) secondary (lymph node, spleen, MALT). Lymph and lymphatic system. Host-pathogen interaction, Toll like Receptors, Basic concept of cytokines. Complement system – pathways.

Unit – 4 15 Hours

Nature and properties of antigen, Structure and types of antibodies, Primary and secondary immune response. Antigen processing and presentation. Mechanism of humoral immune response, Significance of Co-Stimulation. Mechanism of cell mediated immune response. Monoclonal antibodies – uses. Basic concept of vaccines.

PRACTICALS (2CREDITS: 30 hours) Maximum Marks: 50, Minimum Marks: 18

1. Preparation and sterilization of culture media for bacterial cultivation.
2. Culture Techniques: Streaking, Spreading etc.
3. Gram staining
4. Blood smear preparation and staining.
5. Introduction to different types of media, selective, differential media etc.,
6. Total and differential Leukocyte count, Total RBCcount and Blood grouping.
7. Field trip/subject tour (visit to food/dairy/industry/institute/lab/university)

BOOKS RECOMMENDED

1. General Microbiology: Stanier, R. Y., Ingraham, J. L., Wheelis, M. L. and Painter, P. R. – Macmillan Press Ltd., UK.
2. Microbiology: Prescott, L.M.,Harley, J.P.and Klein, D.A.-McGraw-Hill.
3. Microbiology: Pelczar,M.J., Chan, E. C.S. and Krieg, N.R.-McGraw-Hill.
4. Kuby Immunology: Goldsby, R. A., Kindt, T. J., Osborne, B. A. and Kuby, J. - W.H. Freeman and Company, New York.
5. The Immune System: Parham, P.-Garland Publishers.
6. Text Book of Immunology, Seemi Farhat Basir, PHI.

BACHELOR WITH BIOTECHNOLOGY AS MINOR

2nd SEMESTER

BTG 222N: MICROBIOLOGY AND IMMUNOLOGY

CREDITS: THEORY - 4, PRACTICAL – 2

MAXIMUMMARKS: 100, MINIMUM MARKS: 36

- **Objective:** Students will learn basics of microbiology like structure, bacterial genetics and general account of viruses. Students will learn about immune system – types of immune response, cells and different organs of the system. They would also learn responses generated by Lymphocytes, Antigen-Antibody interactions.
- **Expected Learning Outcomes:**
  - A student will be able to use microscopes, differentiate bacteria on basis of Gram staining and differentiate between different types of gene transfers in bacteria and classify viruses.
  - A student will be able to grow bacteria, measure their growth, determine the effect of different factors on growth and be able to control the growth of microbes.
  - Will be able to differentiate between different immune responses, cells involved and organs of immune system.
  - Able to classify antigen, adjuvants and haptens. Carry out different antigen-antibody interactions.

Unit –1 15 Hours

General structure of Bacterial cell (cell wall – Gram +*ve* and Gram –*ve*, flagella, bacterial chromosome, plasmid, cell inclusions).

Gene transfer in bacteria (Transformation, conjugation, transduction).

General structure of viruses (Capsid symmetry, enveloped and non-enveloped viruses) viral classification (RNA & DNA, positive & negative stranded viruses). Bacteriophages - lambda phage life cycle).

Unit –2 15 Hours

Nutritional requirements, Bacterial nutritional types (photolitho-autotrophy, chemolithio-autotrophy, photoorgano-heterotrophy and chemoorgano-heterotrophy). Growth curve - its phases, Growth kinetics. Factors affecting growth (solute and water activity, pH, temperature, oxygen concentration, pressure), Measurement of bacterial growth. Control of microbial growth (physical, chemical and antibiotics).

Unit – 3 15 Hours

Innate Immune system, (Anatomical and physiological barriers). Hematopoiesis, Cells of

myeloid and lymphoid system (Basophils, Neutrophils, Eosinophils, monocytes, T cells, B cells, NK cells, dendritic cells, mast cells). Phagocytosis and respiratory burst, Inflammation (clinical signs, initiators and mediators), Organs of immune system – primary (bone marrow, thymus) secondary (lymph node, spleen, MALT). Lymph and lymphatic system. Host-pathogen interaction, Toll like Receptors, Basic concept of cytokines. Complement system – pathways.

Unit – 4 15 Hours

Nature and properties of antigen, Structure and types of antibodies, Primary and secondary immune response. Antigen processing and presentation. Mechanism of humoral immune response, Significance of Co-Stimulation. Mechanism of cell mediated immune response. Monoclonal antibodies – uses. Basic concept of vaccines.

PRACTICALS (2CREDITS: 30 hours) Maximum Marks: 50, Minimum Marks: 18

1. Preparation and sterilization of culture media for bacterial cultivation.
2. Culture Techniques: Streaking, Spreading etc.
3. Gram staining
4. Blood smear preparation and staining.
5. Introduction to different types of media, selective, differential media etc.,
6. Total and differential Leukocyte count, Total RBCcount and Blood grouping.
7. Field trip/subject tour (visit to food/dairy/industry/institute/lab/university)

BOOKS RECOMMENDED

1. General Microbiology: Stanier, R. Y., Ingraham, J. L., Wheelis, M. L. and Painter, P. R. – Macmillan Press Ltd., UK.
2. Microbiology: Prescott, L.M.,Harley, J.P.and Klein, D.A.-McGraw-Hill.
3. Microbiology: Pelczar,M.J., Chan, E. C.S. and Krieg, N.R.-McGraw-Hill.
4. Kuby Immunology: Goldsby, R. A., Kindt, T. J., Osborne, B. A. and Kuby, J. - W.H. Freeman and Company, New York.
5. The Immune System: Parham, P.-Garland Publishers.
6. Text Book of Immunology, Seemi Farhat Basir, PHI.

BACHELOR WITH BIOTECHNOLOGY AS MAJOR

3rd SEMESTER

BTG 322J: MOLECULAR CELL BIOLOGY

CREDITS: THEORY - 4, PRACTICAL – 2

MAXIMUMMARKS: 100, MINIMUM MARKS: 36

- **Objectives:** Cell being the basic unit of life, this course is aimed to provide students an insight about basic cellular structure, functioning of cell organelles and cell cycle.
- **Expected Learning Outcomes**: Students will be able to;
  - Draw the organization of cell membrane and distinguish between different types of transport across it.
  - Analyze the functioning of Endoplasmic reticulum, Golgi complex and associated vesicle transport.
  - Describe the structure and functioning of nucleus and other organelles.
  - Gain an understanding of the functions performed by the cytoskeleton and the significance of cell-cell interactions and distinguish between different phases of the cell cycle.

UNIT I 15 hours

Introduction to cell (animal and plant cell). Cell Membrane – structure and function. Membrane organization (Fluid Mosaic Model). Transport across membrane – Active and Passive transport (Ca^{++}-ATPase, Na^{+}/K^{+}ATPase, Na^{+} linked, Na^{+}-linked Antiporter, $Ca^{++}$from cardiac muscle, symporters, diffusion and facilitated diffusion).

UNIT II 15 hours

Endoplasmic reticulum, Golgi complex and Lysosomes: Structure and function.
Role in Protein sorting and transport. Mechanism of vesicular transport (COP I, COP II and Clathrin coated vesicles). Endocytosis, Pinocytosis and Phagocytosis.

Unit III 15 hours

Mitochondria, chloroplast, ribosomes, vacuoles and peroxisomes: Structure and function. Structure and organization of nucleus, organization of nuclear pore. Structure and functions of microtubules, microfilaments and intermediate filaments.

UNIT IV 15 hours

Extra cellular matrix and cell-matrix interactions. Cell-cell interactions: Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. Cell cycle (mitosis and meiosis), regulation of cell cycle. Apoptosis - brief idea.

PRACTICALS (2CREDITS: 30 hours) Maximum Marks: 50, Minimum Marks: 18

1. Studying of different cellular organelles with animations and micrographs.

2. Studying the different stages of mitosis by preparing slides of onion root tip.
3. Staining of cells.
4. Karyotyping.
5. Observations on the permeability of Plasma membrane- effect of Isotonic, Hypotonic and Hypertonic solutions on Mammalian R.B.Cs or any other cell.
6. Field trip/subject tour/report.

Books:

1. Molecular Biology of the Cell by Alberts, B Taylor and Francis, New York. USA.
2. Cell and Molecular Biology: Concepts and Experiments by G. Karp, John Wiley & Sons.
3. Cell and Molecular Biology by De Robertis and De Robertis Lippincott Williams and Wilkins, Philadelphia.
4. The Cell: A Molecular Approach by Cooper, G.M. and Hausman, ASM Press.
5. The World of the Cell by Becker, Kleinsmith, Hardin. J. and Berton, Pearson Benjamin Cummings Publishing,

BACHELOR WITH BIOTECHNOLOGY AS MINOR

3rd SEMESTER

BTG 322N: MOLECULAR CELL BIOLOGY

CREDITS: THEORY - 4, PRACTICAL – 2

MAXIMUMMARKS: 100, MINIMUM MARKS: 36

- **Objectives:** Cell being the basic unit of life, this course is aimed to provide students an insight about basic cellular structure, functioning of cell organelles and cell cycle.
- **Expected Learning Outcomes**: Students will be able to;
  - Draw the organization of cell membrane and distinguish between different types of transport across it.
  - Analyze the functioning of Endoplasmic reticulum, Golgi complex and associated vesicle transport.
  - Describe the structure and functioning of nucleus and other organelles.
  - Gain an understanding of the functions performed by the cytoskeleton and the significance of cell-cell interactions and distinguish between different phases of the cell cycle.

UNIT I 15 hours

Introduction to cell (animal and plant cell). Cell Membrane – structure and function. Membrane organization (Fluid Mosaic Model). Transport across membrane – Active and Passive transport (Ca^{++}-ATPase, Na^{+}/K^{+}ATPase, Na^{+} linked, Na^{+}-linked Antiporter, $Ca^{++}$from cardiac muscle, symporters, diffusion and facilitated diffusion).

UNIT II 15 hours

Endoplasmic reticulum, Golgi complex and Lysosomes: Structure and function.
Role in Protein sorting and transport. Mechanism of vesicular transport (COP I, COP II and Clathrin coated vesicles). Endocytosis, Pinocytosis and Phagocytosis.

Unit III 15 hours

Mitochondria, chloroplast, ribosomes, vacuoles and peroxisomes: Structure and function. Structure and organization of nucleus, organization of nuclear pore. Structure and functions of microtubules, microfilaments and intermediate filaments.

UNIT IV 15 hours

Extra cellular matrix and cell-matrix interactions. Cell-cell interactions: Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. Cell cycle (mitosis and meiosis), regulation of cell cycle. Apoptosis - brief idea.

PRACTICALS (2CREDITS: 30 hours) Maximum Marks: 50, Minimum Marks: 18

1. Studying of different cellular organelles with animations and micrographs.
2. Studying the different stages of mitosis by preparing slides of onion root tip.

3. Staining of cells.
4. Karyotyping.
5. Observations on the permeability of Plasma membrane- effect of Isotonic, Hypotonic and Hypertonic solutions on Mammalian R.B.Cs or any other cell.
6. Field trip/subject tour/report.

Books:

1. Molecular Biology of the Cell by Alberts, B Taylor and Francis, New York. USA.
2. Cell and Molecular Biology: Concepts and Experiments by G. Karp, John Wiley & Sons.
3. Cell and Molecular Biology by De Robertis and De Robertis Lippincott Williams and Wilkins, Philadelphia.
4. The Cell: A Molecular Approach by Cooper, G.M. and Hausman, ASM Press.
5. The World of the Cell by Becker, Kleinsmith, Hardin. J. and Berton, Pearson Benjamin Cummings Publishing,

BACHELOR WITH BIOTECHNOLOGY AS MAJOR

4th SEMESTER

BTG 422J1: BIOTECHNIQUES

CREDITS: THEORY – 3, PRACTICAL – 1

MAXIMUMMARKS: 75, MINIMUM MARKS: 27

- Course Learning Objective: This course is designed to expose student to different techniques, handling instruments understand their working and applications for research and analysis.
- **Course outcome:** A student will be able to;
  - separate, purify and characterize different bio molecules using centrifugation and chromatographic techniques.
  - analyze, separate and identify nucleic acids and proteins by different electrophoretic and blotting techniques.
  - prepare specimens and use different types of microscopes for observation and use of UV-Vis spectroscopy for different applications.

Unit -1 15 hours

Centrifugation: General principle of centrifugation, sedimentation coefficient, preparative and analytical centrifugation, differential centrifugation & density-gradient centrifugation, ultracentrifugation and its applications.

Chromatography: Principle, working and applications of thin-layer chromatography, ion-exchange chromatography, gel filtration and affinity chromatography. HPLC.

Unit -2 15 hours

Electrophoresis: General principle and types; Principle, procedure and applications of native poly acrylamide gel electrophoresis, sodium dodecyl sulphate polyacrylamide gel electrophoresis, isoelectric focusing, two-dimensional gel electrophoresis and agarose gel electrophoresis, pulse field gel electrophoresis.

Blotting techniques: Southern, northern & western blotting; **PCR**: principle, methodology and applications.

Unit -3 15 hours

Microscopy: Principle, working and applications of light microscopy - bright-field, dark-field, phase-contrast, fluorescence & confocal microscopy, electron microscopy- TEM and SEM; Staining-principle and procedure of simple staining, negative staining & differential staining.

Spectroscopy: Beer-Lambert's law. Principle, working and applications of ultraviolet/visible light spectroscopy (UV/Vis spectroscopy).

PRACTICALS (1 CREDITS: 15 hours) Maximum Marks: 25, Minimum Marks: 9

1. Use of microscope – simple attaining and differential staining
2. Separating cells from broth/plasma separation from blood.
3. Paper chromatography/TLC
4. SDS-PAGE.
5. Amplification of a gene by PCR/demonstration.
6. Agarose gel electrophoresis.

BOOKS RECOMMENDED

1. Principles and Techniques of Biochemistry and Molecular Biology: Wilson, K. and Walker, J, Cambridge University Press.
2. Physical Biochemistry - Applications to Biochemistry and Molecular Biology: Freifelder, D., W. H. Freeman and Company.
3. Molecular Cloning - A Laboratory Manual: Sambrook, J. and Russell, D. W., Cold Spring Harbor Laboratory Press.

BACHELOR WITH BIOTECHNOLOGY AS MINOR

4th SEMESTER

BTG 422N: BIOTECHNIQUES

CREDITS: THEORY – 3, PRACTICAL – 1

MAXIMUMMARKS: 75, MINIMUM MARKS: 27

- Course Learning Objective: This course is designed to expose student to different techniques, handling instruments understand their working and applications for research and analysis.
- **Course outcome:** A student will be able to;
  - separate, purify and characterize different bio molecules using centrifugation and chromatographic techniques.
  - analyze, separate and identify nucleic acids and proteins by different electrophoretic and blotting techniques.
  - prepare specimens and use different types of microscopes for observation and use of UV-Vis spectroscopy for different applications.

Unit -1 15 hours

Centrifugation: General principle of centrifugation, sedimentation coefficient, preparative and analytical centrifugation, differential centrifugation & density-gradient centrifugation, ultracentrifugation and its applications.

Chromatography: Principle, working and applications of thin-layer chromatography, ion-exchange chromatography, gel filtration and affinity chromatography. HPLC.

Unit -2 15 hours

Electrophoresis: General principle and types; Principle, procedure and applications of native poly acrylamide gel electrophoresis, sodium dodecyl sulphate polyacrylamide gel electrophoresis, isoelectric focusing, two-dimensional gel electrophoresis and agarose gel electrophoresis, pulse field gel electrophoresis.

Blotting techniques: Southern, northern & western blotting; **PCR**: principle, methodology and applications.

Unit -3 15 hours

Microscopy: Principle, working and applications of light microscopy - bright-field, dark-field, phase-contrast, fluorescence & confocal microscopy, electron microscopy- TEM and SEM; Staining-principle and procedure of simple staining, negative staining & differential staining.

Spectroscopy: Beer-Lambert's law. Principle, working and applications of ultraviolet/visible light spectroscopy (UV/Vis spectroscopy).

PRACTICALS (1 CREDITS: 15 hours) Maximum Marks: 25, Minimum Marks: 9

1. Use of microscope – simple attaining and differential staining
2. Separating cells from broth/plasma separation from blood.
3. Paper chromatography/TLC
4. SDS-PAGE.
5. Amplification of a gene by PCR/demonstration.
6. Agarose gel electrophoresis.

BOOKS RECOMMENDED

1. Principles and Techniques of Biochemistry and Molecular Biology: Wilson, K. and Walker, J, Cambridge University Press.
2. Physical Biochemistry - Applications to Biochemistry and Molecular Biology: Freifelder, D., W. H. Freeman and Company.
3. Molecular Cloning - A Laboratory Manual: Sambrook, J. and Russell, D. W., Cold Spring Harbor Laboratory Press.

BACHELOR WITH BIOTECHNOLOGY AS MAJOR

4th SEMESTER

BTG 422J2: Molecular Biology

CREDITS: THEORY – 4, PRACTICAL – 2

MAXIMUM MARKS: 100, MINIMUM MARKS: 34

- Course Learning Objective: aim of this course is to understand information flow at molecular level, appreciate the functions of DNA, RNA and protein and how these regulate different biological processes.
- **Course outcome:** A student will be able to;
  - analyze the different properties of nucleic acids and genomes.
  - interpret and predict the role of different enzymes and proteins involved in replication of DNA, mutation and repair.
  - illustrate the process of gene expression, factors involved, processing and regulation of expression.
  - describe how the language of the nucleic acids is translated into proteins and its regulation.

UNIT – I 15 hours

DNA as genetic material (Griffith, Avery-MacLeod-McCarty and Hershey and Chase experiments), RNA as genetic material (Fraenkel Conrat experiment). DNA structure - features of double helix, forms of DNA (A, B, Z, H). Forces stabilizing DNA. DNA topology, Genome and C-value paradox, Genome complexity (Cot curve, repetitive, non-repetitive sequences). Organization of prokaryotic and eukaryotic genomes.

UNIT – II 15 hours

DNA Relication in prokaryotes, modes of replication (semi-conservative, conservative, dispersive, continuous, discontinuous and bi-directional replication), origin of replication (prokaryotic and eukaryotic), Enzymes and proteins involved: DNA polymerases, helicases, topoisomerase and ligase, proof reading, leading and lagging strand synthesis. Rolling circle replication (λ and M13). End replication of linear DNA (telomerase). DNA Mutations: Base substitution, missense, non sense, deletion, insertion, frame shift, silent). DNA damage: radiation, alkylation and oxidative. DNA repair: photo-reactivation, base excision, nucleotide excision, mismatch and recombination repair.

UNIT – III 15 hours

Transcription in prokaryotes: RNA polymerase, role of σ factor, promoter, initiation, elongation and termination. Operon concept, positive and negative regulation with reference

to *lac* and *trp* operons. Eukaryotic transcription: RNA polymerases, promoters, promoter clearance, enhancers, silencers, transcription factors/domains (zinc finger domains, leucine zippers, basic domains). Post-transcriptional processing - 5' cap formation, splicing, polyadenylation. Brief outline of rRNA and tRNA processing. Inhibitors of transcription.

UNIT – IV 15 hours

Protein translation machinery: ribosomes, mRNA, tRNA, charging of tRNA, aminoacyl tRNA synthetases, translation initiation (prokaryotes and eukaryotes). Genetic code – its salient features, Wobble hypothesis, reading frames, mechanism of elongation and termination in prokaryotes and eukaryotes. Inhibitors of translation. Post-translational modifications of proteins. Translation regulation.

PRACTICALS (2 CREDITS: 30 hours) Maximum Marks: 50, Minimum Marks: 18

1. Isolation of genomic DNA from bacterial cells.
2. Qualitative analysis of DNA by agarose gel electrophoresis.
3. Isolation of RNA from cells.
4. Quantitative estimation of RNA and DNA by spectrophotometry.
5. DNA denaturation and renaturation curves and calculation of Tm.
6. Lab visits/ Field trip/ subject tour etc.

BOOKS RECOMMENDED

1. Cell and Molecular Biology: Concepts and Experiments, Karp, G. John Wiley & Sons. Inc.
2. The Cell: A Molecular Approach. Cooper, G.M. and Hausman, R.E ASM Press
3. The World of the Cell, Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. Benjamin-Cummings Pub
4. Molecular Biology of the Gene, J Watson, T Baker, S Bell, A Gann, M Levine, R Losick, Pearson
5. Lewins Genes XI J E. Krebs, S T. Kilpatrick, E S. Goldstein Jones & Bartlett Learning
6. Molecular Cell Biology Harvey Lodish, Arnold Berk, Chris A. Kaiser Monty Krieger, Anthony Bretscher, W H Freeman & Co
7. Molecular Biology, David Freifelder, Narosa Publishers.

BACHELOR WITH BIOTECHNOLOGY AS MAJOR

4th Semester

BTG 422J3: RECOMBINANT DNA TECHNOLOGY

CREDITS: THEORY – 4, PRACTICAL – 2

MAXIMUM MARKS: 100, MINIMUM MARKS: 36

- **Objective:** Through this course, students will learn about the different tools used in recombinant DNA technology and its applications.
- **Expected Learning Outcomes:** At the end of the course students should be able to;

- use different enzymes for cloning, modification and amplification of DNA.
- select and use the suitable vector for cloning and screening of transformants.
- express recombinant proteins and purify them.
- make cDNA library, edit and target different genes.

THEORY (4 CREDITS: 60 HOURS)

UNIT I 15 Hours

Introduction to Recombinant DNA technology, tools of recombinant DNA technology: Restriction endonucleases (types, nomenclature, cleavage pattern-blunt and cohesive end cutters), DNA polymerases (pol I, Klenow fragment, Taq), DNA ligases, kinases, phosphatases, nucleotidyl transferase, exonucleases, reverse transcriptase. Use of linker and adapters, homopolymer tailing.

Unit II 15 Hours

Plasmid vectors- general features. Features of pBR322 and pUC. Bacteriophage vectors: insertion and replacement, M13, cosmids, phagemids, YAC and BAC. Basic cloning methodology in plasmid vectors: Vector and insert preparation, ligation, competent cells, transformation (heat-shock and electroporation) screening of recombinants (antibiotic resistance and blue-white screening). Preparation of probe – radioactive and non radioactive labeling. Sequence based screening (colony, hybridization, PCR)

UNIT III 15 Hours

Recombinant protein expression in heterologous systems: expression in E.coli (inducible promoter system), yeast, insect and mammalian systems. Recombinant protein purification using tags (His, GST, Flag, HA). Reporter genes (luciferase, CAT, GFP, GUS) and their applications. In vitro transcription and translation and its applications.

Unit IV 15 Hours

Genomic and cDNA library construction, screening of libraries. Gene knock downs: antisense RNA technology and RNA interference. Gene knock out by Cre-LoxP system. Gene editing by CRISPR-CAS system. Gene targeting: Site directed mutagenesis (single primer extension, double primer extension, PCR based mutagenesis). Protein engineering for increased thermal stability, activity, shelf life.

PRACTICALS (2 CREDIT: 60 HOURS) Maximum Marks: 50, Minimum Marks: 18

1. DNA/plasmid isolation from bacterial/plant/any other cell.
2. Preparation of competent cells.
3. Restriction digestion of DNA.
4. Transformation of competent cells by heat shock.
5. Easy (TA) Cloning.
6. Blue-white screening
7. Agarose gel electrophoresis.
8. Educational tour to different labs/institutes.

BOOKS RECOMMENDED

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard R. Glick, Cheryl L. Pattern, ASM Press.
2. Gene Cloning and DNA Analysis: An Introduction by Brown TA Wiley-Blackwell
3. Principles of Gene Manipulation and Genomics by Primrose SB, Twyman R and Old B Wiley- Blackwell.
4. Gene Cloning and Manipulation by Christopher Howe, Cambridge University Press
5. Analysis of Genes and Genomes by Reece J Richard, Wiley-Blackwell