Raja N.L. Khan Women's College
(Autonomous)

Syllabus

Department Of Biotechnology (UG)

Programme under NEP-2020

w.e.f. 2024-2025 Academic Session

Raja N.L. Khan Women's College
(Autonomous)
Department Of Biotechnology (UG)
Major Course
Full Marks=75(Wrtt.- 60; Cumulative Assessment-15(10+05)

Sl No.	Paper Code	Title of the Paper	Sem	Credit	Allot. Classes		
					Th.	Tu.	Practical
1	BIOTMJT-1	Chemistry of Bio molecules	I	03	03	01	00
	BIOTMJP-1	Chemistry of Bio molecules Experiments		01	00	00	01
2	BIOTMJT-2	Fundamental of Biotechnology	II	04	03	01	00
	BIOTMJP-2	Fundamental of Biotechnology Experiments					01
3	BIOTMJT-3	Cell biology	III	08	03	01	00
	BIOTMJP-3	Cell biology Experiments					01
4	BIOTMJT-4	Bio-Physics			03	01	00
	BIOTMJP-4	Bio-Physics Experiments					01
5	BIOTMJT-5	Molecular Biology	IV	12	03	01	00
	BIOTMJP-5	Molecular Biology Experiments					01
6	BIOTMJT-6	Microbiology			03	01	00
	BIOTMJP-6	Microbiology Experiments					01
7	BIOTMJT-7	Biotechniques			03	01	00
	BIOTMJP-7	Biotechniques Experiments					01
8	BIOTMJT-8	Metabolism & Enzymology	V	16	03	01	00
	BIOTMJP-8	Metabolism & Enzymology Experiments					01
9	BIOTMJT-9	Genetics & Biostatistics			03	01	00
	BIOTMJP-9	Genetics & Biostatistics Experiments					01
10	BIOTMJT-10	Mammalian Physiology			03	01	00
	BIOTMJP-10	Mammalian Physiology Experiments					01
11	BIOTMJT-11	Plant Physiology			03	01	00
	BIOTMJP-11	Plant Physiology Experiments					01
12	BIOTMJT-12	Immunology & Virology	VI	16	03	01	00
	BIOTMJP-12	Immunology & Virology Experiments					01
13	BIOTMJT-13	Recombinant DNA Technology			03	01	00

	BIOTMJP-13		Recombinant DNA Technology Experiments					01
14	BIOTMJT-14		Plant & Agricultural Biotechnology			03	01	00
	BIOTMJP-14		Plant & Agricultural Biotechnology Experiments					01
15	BIOTMJT-15		Animal Biotechnology				01	00
	BIOTMJP-15		Animal Biotechnology Experiments					01
16	BIOTMJT-16		Medical Biotechnology	VII	16	03	01	00
	BIOTMJP-16		Medical Biotechnology Experiments					01
17	BIOTMJT-17		Microbial Biotechnology & Bioprocess Engineering			03	01	00
	BIOTMJP-17		Microbial Biotechnology & Bioprocess Engineering Experiments					01
18	BIOTMJT-18		Biophysical chemistry & Instrumentation			03	01	00
	BIOTMJP-18		Biophysical chemistry & Instrumentation Experiments					01
19	BIOTMJT-19		Computer Application & Bioinformatics			03	01	00
	BIOTMJP-19		Computer Application & Bioinformatics Experiments					01
20	BIOTMJT-20		Proteomics & Genomics	VIII	20	03	01	00
	BIOTMJP-20		Proteomics & Genomics Experiments					01
21	BIOTMJT-21		Environmental Biotechnology, Bioethics & IPR			03	01	00
	BIOTMJP-21		Environmental Biotechnology, Bioethics & IPR Experiments					01
22	BIOTDSEIT	Re.Proj- I	Nanobiotechnology			03	01	00
	BIOTDSEIP	Re.Proj- I	Nanobiotechnology Experiments					01
23	BIOTDSE2T	Re.Proj-II	Ecology & Evolution			03	01	00
	BIOTDSE2P	Re.Proj-II	Ecology & Evolution Experiments					01
24	BIOTDSE3T	Re.Proj-III	Developmental Biology			03	01	00
	BIOTDSE3P	Re.Proj-III	Developmental Biology Experiments					01
Total Credits=					**96**			

Raja N.L. Khan Women's College
(Autonomous)
Department Of Bengali (UG)
Minor Course
Full Marks=75(Wrtt.-60; Cumulative Assessment-15(10+05)

Sl No	Paper Code	Title of the Paper	Sem.		Credit	Allot. Class		
			1st Minor	2nd Minor		Th	Tu	Practical
1	BIOTMIT- 1	Chemistry of Bio molecules	I	III	03	03	01	
	BIOTMIP- 1	Chemistry of Bio molecules			01			01
2	BIOTMIT- 2	Fundamental of Biotechnology	II	IV	03	03	01	
	BIOTMIP- 2	Fundamental of Biotechnology			01			01
3	BIOTMIT- 3	Cell Biology	V	VI	03	03	01	
	BIOTMIP- 3	Cell Biology			01			01
4	BIOTMIT- 4	Molecularbiology	VII	VIII	03	03	01	
	BIOTMIP- 4	Molecularbiology			01			01
Total Credits=					**16**			

SEC Course
Full Marks=50(Wrtt.-40; Cumulative Assessment-10(05+05)

Sl No.	Paper Code	Title of the Paper	Sem.	Credit	Allot. Class		
					Th	Tu	Pract.
1	SECT-1	Bio safety & Instrumentation	I	02	02	01	
	SECP-1	Bio safety & Instrumentation		01			01
2	SECT-2	Fundamental in enzymatic assay & Fermentation	II	02	02	01	
	SECP-2	Fundamental in enzymatic assay & Fermentation		01			01
3	SECT-3	Molecular Diagnostics & Forensic Techniques	III	02	02	01	
	SECP-3	Molecular Diagnostics & Forensic Techniques		01			01
Total Credits=				**09**			

AEC Course
(Applicable for English & Bengali/Hindi)

Full Marks=50 (Wrtt.-40; Cumulative Assessment-10(05+05)

Sl No	Paper Code	Title of the Paper	Sem.	Credit
1	MIL BENG		II	02
2	MIL BENG		III	02
Total Credits=				**04**

Objectives and Outcomes of the Academic Program of B.Sc.(Major) in Biotechnology

Program objective:

The skill enhancement course on Fundamental of Biotechnology is designed to offer a concrete understanding of methods in Biotechnology. Additionally, the course is planned to introduce students to the use of basic biotechnological tools in modern and applied biology.

Program outcome:

Students will be able to develop concepts and skills that have a range of implications in various domains including agriculture, biomedicine, and the pharmaceutical industries. Students will be able to comprehend the contributions of biotechnology in biomedical fields such as diagnostics, genomics and therapeutics and also in multidisciplinary researches.

Skill enhancement as per National Occupational Standards (NOS) of Lab Technician/ Assistant will also be possible. The achievement of knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety, good laboratory practices and standard operating procedures will be possible.

Soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking, and documentation.

The course provides an introduction to biotechnology and the application of biotechnology for human welfare including Agriculture, industry, environment and human health care. After successfully completing this course, the students will be able to understand the scope and application of biotechnology in various areas.

Semester-I
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	01	04	75
2	Minor	01	04	75
3	IDC/MDC	01	03	50
4	AEC ENGLISH	01	02	50
5	SEC	01	03	50

6	VAC	02	04(02+02)	100(50+50)
Total=		***07***	***20***	***400***

Semester-I

Major Course

BIOTMJ1T : Chemistry of Biomolecules Credits: 03

Course Objective:

The objectives of the course allocated in this semester are to build fundamental knowledge on the chemistry of biomolecules in terms of their structures, properties, functions and classifications. In addition, to develop understanding about various biochemical principles, chemical interactions of biomolecules and their role in cellular systems and living organisms. The lab based course is designed for the learners to generate basic technical skills required for biochemical analysis, cellular biochemistry and quantitative methods employed in biology.

Course Outcome:

Students will gain fundamental knowledge in biochemistry and biochemical process. In particular, they will have sound idea and knowledge about the structure, synthesis and biological significance of important biomolecules and their action mechanisms and importance in the live process. The Learning of biochemical tests for amino acids,

carbohydrates, proteins, enzymes and nucleic acids will enrich them and the expertise will be helpful in the career advancements. Moreover, they will understand about the importance and scope of biochemistry from the experienced teachers in the relevant course.

BIOTMJT1T: Chemistry of Biomolecules

Course contents:

UNIT I:

Introduction to Biochemistry:

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

UNIT II

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Different Level of structural organization of proteins, alpha helix, beta sheet , Strategies of Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins. Membrane proteins (Ion channels and transporter).

UNIT III

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Watson and Crick double helical model of DNA structure, and forces responsible for A, B & Z form of DNA, denaturation and renaturation of DNA , Melting temperature (Tm), RNA structure and types.

UNIT IV

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria.

BIOTMJ1P Chemistry of Biomolecules Experiments :

Credit 1

1. Examination of optical properties of biomolecules.
2. Preparation of normal, molar, and gm % solutions.
3. Qualitative tests for Carbohydrates, proteins, and lipids.
4. Measurement pH of different biological samples..
5. Quantitative estimation of reducing sugars (DNS method)
6. Quantification of DNA (diphenylamine method).
7. Quantification of RNA (orcinol method).

Suggested Readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.

3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

Minor Course (1st Paper of 1st Minor)

BIOTMI1T : **Chemistry of Biomolecules** Credits: 03

Course objective:

The objectives of the course allocated in this semester are to build fundamental knowledge on the chemistry of biomolecules in terms of their structures, properties, functions and classifications. In addition, to develop understanding about various biochemical principles, chemical interactions of biomolecules and their role in cellular systems and living organisms. The lab based course is designed for the learners to generate basic technical skills required for biochemical analysis, cellular biochemistry and quantitative methods employed in biology.

Course outcome:

Students will gain fundamental knowledge in biochemistry and biochemical process. In particular, they will have sound idea and knowledge about the structure, synthesis and biological significance of important biomolecules and their action mechanisms and importance in the live process. The Learning of biochemical tests for amino acids, carbohydrates, proteins, enzymes and nucleic acids will enrich them and the expertise will be helpful in the career advancements. Moreover, they will understand about the importance and scope of biochemistry from the experienced teachers in the relevant course.

BIOTMI1T: Chemistry of Biomolecules

Course contents:

UNIT I:

Introduction to Biochemistry:

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

UNIT II

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Different Level of structural organization of proteins, alpha helix, beta sheet , Strategies of Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins. Membrane proteinsb (Ion channels and transporter).

UNIT III

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Watson and Crick double helical model of DNA structure, and forces responsible for A, B & Z form of DNA, denaturation and renaturation of DNA , Melting temperature (Tm), RNA structure and types.

UNIT IV

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites,

enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria.

BIOTMI1P Chemistry of Biomolecules Experiments:

Credit 1

1. Examination of optical properties of biomolecules.
2. Preparation of normal, molar, and gm % solutions.
3. Qualitative tests for Carbohydrates, proteins, and lipids.
4. Measurement pH of different biological samples.
5. Quantitative estimation of reducing sugars (DNS method)
6. Quantification of DNA (diphenylamine method).
7. Quantification of RNA (orcinol method).

Suggested Readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.

3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

SKILL ENHANCEMENT COURSE (SEC) Course

BIOTSEC1T: Biosafety and instrumentation Credits: 2

Course objective:

The basic objective of this The skill enhancement course is to acquaint students with principles of biosafety, basic rules and regulations related to biotechnological work, complete guidance for the students entering the biological laboratory for the first time. In addition to these, promoting knowledge about basic instrumentation and biotechnological principles used to render biological safety in laboratory for conducting smooth research activities which include dealing with pathogens or pathogenic diseases. On the other hand, skill enhancement course on basic instrumentation used in Biotechnology has been incorporated in the syllabus for encouraging students to learn the principle and applications of microscopy, chromatography, centrifugation, electrophoresis, blotting techniques, spectroscopy etc.

Course outcome:

Through this course students will be able to gain knowledge about the routes of exposure for a pathogen to the human being, basic rules and regulations of bio-safety for conducting biotechnological research work. They will be careful/aware of personal hygiene, sterility maintenance, Good Laboratory Practices (GLP). They will learn to handle/work with the instruments such as biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, water bath used in the biotech laboratory. Skill enhancement as per National Occupational Standards (NOS) of Lab

Technician/ Assistant will also be possible. The achievement of knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety, good laboratory practices and standard operating procedures will be possible.

On the other hand, through the learning of instruments and their working mechanisms/principles, they would also learn basic tools of biotechnology and their applications.

BIOTSEC1T: Biosafety and instrumentation Course Outline:

Unit-1:

Biosafety Basic rules and regulations related to Biotechnological work, personal hygiene, sterility maintenance, Biotechnological Good Laboratory Practices and Biosafety. Level of Biosafety (BSL1-BSL4). Basic instrumentation in biotechnology Principle and applications of biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, water bath, shaker, light microscope, and pH meter used in the biotech laboratory.

Unit-2:

Qualitative and quantitative analysis of biomolecules Principle and applications of quantitative analysis through colorimeter and spectrophotometer. Principle and practical applications of different chromatographic approach (TLC, paper, column).

Unit-3:

Separation of biomolecules Agarose and polyacrylamide gel electrophoresis: principle, process and applications. Principle of centrifugation and its practical applications. Concept of RCF, rpm and sedimentation coefficient, density gradient centrifugation and ultracentrifugation.

BIOTSEC1P: Biosafety and instrumentation Experiments Credit 1

1. Separation of Cell organells by differential Centrifugation.
2. Separation of DNA by agarose gel electrophoresis.
3. Simple and double staining techniques and microscopic observation of cell.
4. Separation of Amino acids by Paper chromatography.

Suggested Readings:

1. Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino J and Sherman N. (2010).

2. Practical Microbiology, Dubey and Maheshwari ,S.Chand Publication, First edition 2002

3. Introductory Practical Biochemistry, S.K. Sawhney and Randhir Singh, Narosa publisher (2016)

4. An Introduction to Practical Biochemistry, D.T. Plummer (2001)

Semester-II
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	01	04	75
2	Minor	01	04	75
3	IDC/MDC	01	03	50
4	AEC MIL (Beng./ Hindi)	01	02	50
5	SEC	01	03	50
6	VAC	02	04(2+2)	100(50+50)
7	CESR	01	02	50
Total=		***08***	***22***	***450***

Semester-II

Major Course

BIOTMJ2T : Fundamental of Biotechnology Credits: 03

Course objective:

The course Fundamental of Biotechnology is designed to offer a concrete understanding of methods in Biotechnology. Additionally, the course is planned to introduce students to the use of basic biotechnological tools in modern and applied biology.

The course provides an introduction to biotechnology and the application of biotechnology for human welfare including Agriculture, industry, environment and human health care. After successfully completing this course, the students will be able to understand the scope and application of biotechnology in various areas.

Course outcome:

Students will be able to develop concepts and skills that have a range of implications in various domains including agriculture, bio-medicine, and the pharmaceutical industries. Students will be able to comprehend the contributions of biotechnology in biomedical fields such as diagnostics, genomics and therapeutics and also in multidisciplinary researches.

Skill enhancement as per National Occupational Standards (NOS) of Lab Technician/ Assistant will also be possible. The achievement of knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety, good laboratory practices and standard operating procedures will be possible.

Soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking, and documentation.

BIOTMJ2T : Fundamental of Biotechnology

Course contents:

Unit 1: Introduction to Biotechnology

Definition & scope of Biotechnology; Introduction to RDT, Proteins and the Central Dogma; Microbes and their Culturing; Principles of Genetic engineering: Concept of cloning vectors, restriction and modification enzymes, Construction of recombinant DNA, Bioprocess technology.

Unit 2: Biotechnology in Agriculture and Industry

Genetically Modified (GM) crops, Golden rice, Bt Cotton & FlavrSavr Tomato; Overview of Industrial production of alcoholic beverages, antibiotics & enzymes, Bio-fertilizers and Bio-pesticides, Bioplastics and Biofuels.

Unit 3: Biotechnology in Environment

Biodegradation of potential pollutants, recycling of wastes and other waste treatment technologies. Controlling environmental pollution through bioremediation, biomonitoring, biotreatment and biodegradation of all solid, liquid and gaseous wastes.

Unit 4: Biotechnology in Human healthcare

Human Genome Project, Gene therapy, Molecular Diagnostics tools - PCR, Recombinant insulin.

BIOTMJ2P: Fundamental of Biotechnology Experiments 01 Credit

1. Preparation of microbial culture media, isolation of microorganisms from soil, air and water.
2. Colony purification, bacterial staining: simple staining, negative staining and Gram's Staining.
3. Isolation of pure culture by streak plate technique.
4. Isolation and purification bacterial lipase enzymes.
5. Lipase assay.
6. Quantitative estimation of proteins (Folin-Phenol).
7. Demonstration of Protein sequencing techniques (Virtual).
8. Demonstration of Enzyme/Cell Immobilization.
9. Demonstration of PCR

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

5. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.

6. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition,

7. Molecular Cloning: A Laboratory Manual (3rd Edition)

8. Sambrook and Russell Vol. I to III, 1989.

9. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001. Snustad, D.P., Simmons, M.J. (2009).

10.Principles of Genetics. V Edition. John Wiley and Sons Inc. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009).

11. Concepts of Genetics. IX Edition. Benjamin Cummings. Russell, P. J. (2009).

12.iGenetics- A Molecular Approach. III Edition. Benjamin Cummings. Glick, B.R., Pasternak, J.J. (2003).

13. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington. Pevsner, J. (2009).

Minor Course

BIOTMI2T : Fundamental of Biotechnology Credits: 03

Course objective:

The course Fundamental of Biotechnology is designed to offer a concrete understanding of methods in Biotechnology. Additionally, the course is planned to introduce students to the use of basic biotechnological tools in modern and applied biology.

The course provides an introduction to biotechnology and the application of biotechnology for human welfare including Agriculture, industry, environment and human health care. After successfully completing this course, the students will be able to understand the scope and application of biotechnology in various areas.

Course outcome:

Students will be able to develop concepts and skills that have a range of implications in various domains including agriculture, bio-medicine, and the pharmaceutical industries. Students will be able to comprehend the contributions of biotechnology in biomedical fields such as diagnostics, genomics and therapeutics and also in multidisciplinary researches.

Skill enhancement as per National Occupational Standards (NOS) of Lab Technician/ Assistant will also be possible. The achievement of knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety, good laboratory practices and standard operating procedures will be possible.

Soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking, and documentation.

BIOTMI2T : Fundamental of Biotechnology

Course contents:

Unit 1: Introduction to Biotechnology

Definition & scope of Biotechnology; Introduction to RDT, Proteins and the Central Dogma; Microbes and their Culturing; Principles of Genetic engineering: Concept of cloning vectors, restriction and modification enzymes, Construction of recombinant DNA, Bioprocess technology.

Unit 2: Biotechnology in Agriculture and Industry

Genetically Modified (GM) crops, Golden rice, Bt Cotton & FlavrSavr Tomato; Overview of Industrial production of alcoholic beverages, antibiotics & enzymes, Bio-fertilizers and Bio-pesticides, Bioplastics and Biofuels.

Unit 3: Biotechnology in Environment

Biodegradation of potential pollutants, recycling of wastes and other waste treatment technologies. Controlling environmental pollution through bioremediation, biomonitoring, biotreatment and biodegradation of all solid, liquid and gaseous wastes.

Unit 4: Biotechnology in Human healthcare

Human Genome Project, Gene therapy, Molecular Diagnostics tools - PCR, Recombinant insulin.

BIOTMJ2P: Fundamental of Biotechnology Experiments 01 Credit

1. Preparation of microbial culture media, isolation of microorganisms from soil, air and water.
2. Colony purification, bacterial staining: simple staining, negative staining and Gram's Staining.
3. Isolation of pure culture by streak plate technique.
4. Isolation and purification bacterial lipase enzymes.
5. Lipase assay.
6. Quantitative estimation of proteins (Folin-Phenol).
7. Demonstration of Protein sequencing techniques (Virtual).
8. Demonstration of Enzyme/Cell Immobilization.
9. Demonstration of PCR

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

5. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.

6. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition,

7. Molecular Cloning: A Laboratory Manual (3rd Edition)

8. Sambrook and Russell Vol. I to III, 1989.

9. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001. Snustad, D.P., Simmons, M.J. (2009).

10.Principles of Genetics. V Edition. John Wiley and Sons Inc. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009).

11. Concepts of Genetics. IX Edition. Benjamin Cummings. Russell, P. J. (2009).

12.iGenetics- A Molecular Approach. III Edition. Benjamin Cummings. Glick, B.R., Pasternak, J.J. (2003).

13. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington. Pevsner, J. (2009).

SEC Course

BIOTSEC2T: **Fundamentals in Enzymatic assay and Fermentation**

Credits: 02

Course objective:

The course is designed to create understanding among the students about the enzyme substrate reactions and their kinetics, enzymatic assays and quantitative evaluation of the influencing parameters such as concentrations of substrate / enzyme, pH, temperature and effects of inhibitors on enzyme activity, knowledge of isolation and purification of enzymes and significance of enzymatic actions and their regulation in the physiological system. On the other hand, the topic Fermentation is encrypted to make the students well versed with the basics of fermentation process and bio-techniques which include fermentation and their industrial applications. In particular, this sort of course has been designed to give overview of various fermentation techniques, types of fermentors, equipments & instruments used in fermentation and sterilization processers, screening techniques, microbial assays, various industrial products (generated through fermentation) and their significance in various domains including pharmaceutical and medicinal industry and food technology.

Course outcome:

Students will be able to work confidently and competently with enzyme systems in both Academia and Industry. They will be capable in planning and executing different enzymatic assays, analyzing enzyme kinetic data and also determining the mechanism of inhibition of enzyme action. On the other hand, by studying the topic of fermentation encompassing basic fermentation techniques and their industrial applications, the students will be able to develop mastery & expertise in fermentation technology. Students will come to know about the designs and types of fermenters, fermentation media, inoculum preparation, microbial growth kinetics, scale up &.various downstream processes used in large-scale fermentation process.These knowledge will open up various job opportunities in biotech industries, food industries and other sectors.

Course Contents:

UNIT – I:

Kinetics of enzyme activity, Michaelis- Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, Effect of substrate concentration, enzyme concentration, pH, temperature, inhibitors, salt on enzyme activity. Methods for immobilization of enzymes.

UNIT- II

Selection of substrate, inoculum, strain improvement for fermentation. Types of fermentation: submerged, solid state, batch, continuous. Major industrial products and their significance: chemicals, biochemicals and chemotherapeutic/pharmaceutical products, Biofuels, Enzymes, Microbial polysaccharides, Microbial insecticides, microbial flavours and fragrances, anticancer agents, amino acids.

UNIT- III

Fermentation scale-up and factors affecting scale up, Upstream and downstream processing, Types of Bioreactors and their operation. Mathematical derivation of growth kinetics in batch and continuous culture operations.

BIOTSEC2P:: Fundamentals in Enzymatic assay and Fermentation Experiments:

1. Effect of temperature and pH on the activity of enzyme.

2. Effect of substrate concentration on enzyme activity

3. Calculation of kinetic parameters such as Km, Vmax.

4. Effect of reaction time on the activity of enzyme.

5. Screening of microbial culture for the ability to produce extracellular enzymes

6. Alcohol fermentation and its assay.

7. Zymogram Assay

Suggested Readings:

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.

2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009

3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons,1995.

Semester-III
Course Structure

Sl. No.	Name of the Courses	No. of Papers	Credits	Full Marks
1	Major	02	08	150
2	Minor	01	04	75
3	IDC/MDC	01	03	50
4	AEC MIL (Beng./ Hindi)	01	02	50
5	SEC	01	03	50
Total=		***06***	***20***	***375***

Semester-III

Major Course

BIOTMJ3T : CELL BIOLOGY Credits: 03

Course Objective: The main objective of this course is to build a sound knowledge among students in various aspects of the cells including structure and function of cell and cellular organelles, cell signaling/communication, cellular metabolism, cell cycle, cell divisions, programmed cell death/apoptosis, cell aging and biology of different types of cells in human and other organisms.

Course outcome:

This course will assist students in understanding the fundamental aspects of biological processes at cellular level. This course will also help students to develop problem solving attitude on a diverse variety of disciplines that include cell biology.

BIOTMJ3T : CELL BIOLOGY

Course contents:

Unit I

Structure of Prokaryotic and Eukaryotic cell, Plasma membrane organization and Fluid Mosaic Model, Cell wall, **Nucleus:** Structure and function, chromosomes and their structure. **Mitochondria:** Structure and function, Genomes, biogenesis **Golgi bodies:** Structure, biogenesis and functions including role in protein secretion. **Lysosomes:** Vacuoles and micro bodies: Structure and functions. **Ribosome:** Structures and function including role in protein synthesis. Peroxisomes, Vacuoles, **Endoplasmic Reticulum:** Structure, function including role in protein segregation, Plastids and **Chloroplast:** Structure and function, genomes, biogenesis. Cell motility- cilia and flagella.

Unit II

Structure and organization of cell skeleton; Microfilaments and Microtubule-structure and assembly, actins, myosin muscle contraction, Cell matrix interactions, Adhesion junction, Tight junctions, Gap junctions

Unit III

Membrane transport; Ways to move molecules across membranes; carrier proteins, Ion channels; Nuclear transport (export and import), transport across mitochondria and chloroplasts; exocytosis & endocytosis, protein
modification in the secretory pathway.

Unit IV

Molecular mechanism of signal transduction, Integration of signals, second messengers; G Protein Signaling
Cell cycle- steps and control of cell cycle; Cell cycle and cancer; Details of mitosis and meiosis cell division, Cellular death and regulation: different modes of cell death and their regulation (apoptosis, necrosis, autophagy, senescence etc.)

Essential Readings:

1) B. Alberts *et. al*., Molecular Biology of Cell, Garland Science, 2014, 6 th edition
2) H. Lodish *et al*., Molecular Cell Biology, W H Freeman & Co (Sd), 2016, 8 th edition
3) E. D. P De Robertis, Cell and Molecular biology, Wolter Kluwer, 2011.
4) G. Karp, Cell Biology, Wiley, 2013, 7 th edition

BIOTMJ3P: Cell Biology Experiments: **Credit 1**

1. Microscopic observation of prokaryotic and eukaryotic cell.
2. Dialysis demonstration of ammonium sulfate precipitate protein .
3. Study of plasmolysis and de-plasmolysis.
4. Microscopic examination of cell division and stages (Slide visualization).
5. Cell division in onion root tip/ insect gonads
6. Preparation of Mitotic Chromosome from onion root tip.
7. Artificial induction of polyploidy/aneuploidy in onion root through colchicine exposure.
8. Cell counting by Hemocytometer.
9. Study of cell viability using trypan blue.
10. Cell separation through histopaqe and analysis.

Essential Readings:

1) J. Davey and J.M. Lord, Essential Cell Biology (Vol 1-2): Cell Structure (A practical approach), Oxford University Press, 2003
2) J. E. Celis, Cell Biology: A laboratory handbook (Vol 1-4), Elsevier Academic Press, 2008, 3 rd edition
3) E. Goldman and L. H. Green, Practical Handbook of Microbiology, CRC press, 2015, 3 rd edition

Minor Course

BIOTMI3T : CELL BIOLOGY Credits: 03

Course Objective: The main objective of this course is to build a sound knowledge among students in various aspects of the cells including structure and function of cell and cellular organelles, cell signaling/communication, cellular metabolism, cell cycle, cell divisions, programmed cell death/apoptosis, cell aging and biology of different types of cells in human and other organisms.

Course outcome:

This course will assist students in understanding the fundamental aspects of biological processes at cellular level. This course will also help students to develop problem solving attitude on a diverse variety of disciplines that include cell biology.

BIOTMI3T : CELL BIOLOGY

Course contents:

Unit I

Structure of Prokaryotic and Eukaryotic cell, Plasma membrane organization and Fluid Mosaic Model, Cell wall, **Nucleus:** Structure and function, chromosomes and their structure. **Mitochondria:** Structure and function, Genomes, biogenesis **Golgi bodies:** Structure, biogenesis and functions including role in protein secretion. **Lysosomes:** Vacuoles and micro bodies: Structure and functions. **Ribosome:** Structures and function including role in protein synthesis. Peroxisomes, Vacuoles, **Endoplasmic Reticulum:** Structure, function including role in protein segregation, Plastids and **Chloroplast:** Structure and function, genomes, biogenesis. Cell motility- cilia and flagella.

Unit II

Structure and organization of cell skeleton; Microfilaments and Microtubule-structure and assembly, actins, myosin muscle contraction, Cell matrix interactions, Adhesion junction, Tight junctions, Gap junctions

Unit III

Membrane transport; Ways to move molecules across membranes; carrier proteins, Ion channels; Nuclear transport (export and import), transport across mitochondria and chloroplasts; exocytosis & endocytosis, protein
modification in the secretory pathway.

Unit IV

Molecular mechanism of signal transduction, Integration of signals, second messengers; G Protein Signaling

Cell cycle- steps and control of cell cycle; Cell cycle and cancer; Details of mitosis and meiosis cell division, Cellular death and regulation: different modes of cell death and their regulation (apoptosis, necrosis, autophagy, senescence etc.)

Essential Readings:

1) B. Alberts *et. al*., Molecular Biology of Cell, Garland Science, 2014, 6 th edition
2) H. Lodish *et al*., Molecular Cell Biology, W H Freeman & Co (Sd), 2016, 8 th edition
3) E. D. P De Robertis, Cell and Molecular biology, Wolter Kluwer, 2011.
4) G. Karp, Cell Biology, Wiley, 2013, 7 th edition

BIOTMI3P: Cell Biology Experiments: **Credit 1**

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7. Artificial induction of polyploidy/aneuploidy in onion root through colchicine exposure.
8. Cell counting by Hemocytometer.
9. Study of cell viability using trypan blue.
10. Cell separation through histopaqe and analysis.

Essential Readings:

1) J. Davey and J.M. Lord, Essential Cell Biology (Vol 1-2): Cell Structure (A practical approach), Oxford University Press, 2003
2) J. E. Celis, Cell Biology: A laboratory handbook (Vol 1-4), Elsevier Academic Press, 2008, 3 rd edition
3) E. Goldman and L. H. Green, Practical Handbook of Microbiology, CRC press, 2015, 3 rd edition

Major Course

BIOTMJ4T : Bio-Physics Credits:03

Course Objective:

This course is designed to provide a sound knowledge to the students, the details about the various biophysical processes and their applications and also to help students to decipher the working principles of various instruments used in biological research which have been developed based on the principle of Physics. Moreover, this course aims to introduce the students to various domains of physics including mechanics, heat and thermodynamics, electricity, optics and radioactivity etc.

Course outcome:

The implication of this learning will be effective in various research, Biomedical and clinical laboratories, and also in industries. The budding minds will be more inclined to cutting edge research through generation of innovative ideas, troubleshooting of day-to-day problems and application of biophysical techniques for the betterment of environment and society.

Unit-I

Acid-base chemistry: Physical and chemical properties of water, Weak interactions in aqueous systems, Basis of acidity and alkalinity, Ionization of water, weak acids and weak bases, Equilibrium constant, Dissociation constant and the pH scale, Ionic product of water, Buffers – systems, Henderson-Hasselbalch equation, HSAB concept, significance of pH in biological systems, Measurement of pH – indicators, pH meter.

Unit-II

Atomic and molecular structure and bonding: Intermolecular attractions, hydrogen bonding, vanderwaals force, hydrophobic and hydrophillic bond, polar bond.

Hydrodynamic properties factors affecting: Surface tension, diffusion, osmosis, sedimentation at molecular level. Factors affecting them.

Unit-III

Thermodynamics, reaction kinetics and energy transduction:Isolated, closed and open systems; First and second laws of thermodynamics and their biological significance; Activation energy and transition-state theory; Different orders of chemical reactions, free energy and chemical reaction. high energy phosphate compounds (ATP, creatine phosphate, thioesters).

Unit-IV

Radioactivity- Alpha, beta, gamma radiation, law of radioactive decay, Half life, unit of radioactivity, Artificial radioactivity, application-radiolabelling.

BIOTMJ4P : Bio-Physics Experiments Credits:01

1. Preparation of buffers and measurement of P^H: Citrate, Tris-HCl, Phosphate buffer.

2. Determination of pKa by titrimetric method of amino acid (Glycine)

3. Separation of Amino acids, sugar, carbohydrate by Thin Layer chromatography.
5. Interpretation of X-ray diffraction pattern.
6. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission.

SUGGEST READING:

1. Physical Biochemistry. David Friefelder.2-nd edition, W.H.Freeman and Company.

2. Physical Biochemistry, Upadhaya, Upadhaya, Nath, Himalaya Publishers.

3. Nelson, D.L. Cox M.M. Lehninger Principles of Biochemistry, 6-th edition.

SEC Course

BIOTSEC3T: Molecular Diagnostic and Forensic Techniques

Credits: 02

Course objective:

The course Molecular Diagnostics has been designed to acquaint students with molecular diagnostic technologies and the historical evolution and advantages of molecular techniques, to increase student's intuition and understanding of computational methods used to analyze molecular diagnostic data and to build student's abilities in interpreting molecular diagnostic testing and integrating results into clinical decision making. The course encompassing the Forensic Techniques has been designed to make students understand the importance of scientific methods and technologies used in Forensic Science for crime detection, to disseminate facts on the advancements in this multidisciplinary field and also the implications/applications of forensic science in the welfare of the society.

To gain knowledge of the fundamental concepts and techniques used in molecular

diagnostics, including polymerase chain reaction (PCR) and DNA sequencing,

To explore the applications of molecular techniques in forensic investigations, including DNA profiling, forensic DNA analysis, and forensic pathology.

Course outcome:

The course in molecular diagnostics can enhance their skills and knowledge in using advanced molecular techniques for disease diagnosis and performing clinical research. Students can implement the concepts and expertise of molecular diagnostics in diagnosis and treatment of various clinical diseases such as infectious diseases, cancer, genetics and many more. In regards to Forensic Techniques, students will be able to build up a conceptual understanding of criminal justice system, rules of evidence collection, legal system, critical thinking and analysis in a stepwise fashion that builds through the sequence of courses. They will be capable of applying the

concepts and skills learned in the classroom in various domains of Biotechnology and making conclusions based on scientific thinking. They will become competent in problem-solving, legal analysis and application, quantitative reasoning, investigation and scientific laboratory procedures which will impose added advantage for immediate placement in state and central level organizations, R&D sectors and also for advanced studies in future. Upon the completion of this course with relevant degree; with this knowledge and expertise, students will get a platform for exchanging their views with the forensic scientists, chalking out collaborative programs and working in a holistic manner which will be beneficial for them in the career advancement in Forensic Science.

This course is designed to provide students with basic knowledge of various aspects of biotechnology and its applications specifically in the domains of health Biotechnology including forensic science. By acquiring knowledge from this course, students will be equipped to apply these techniques effectively in their future employment opportunities.

Unit I

Molecular methods in Clinical Microbiology, Applications of PCR, RFLP, Hybridization (Nucleic acid base) methods, Immunofluorescent, Immune diagnostic test. Enzyme Immunoassay- Enzymes available for Enzyme immune assays and conjugation of enzymes: General Idea. Solid phases used in Enzyme Immunoassays. Homogeneous and Heterogenous Enzyme Immunoassays. Enzyme Immune Histochemical Techniques. Use of Monoclonal and Polyclonal Antibodies in Enzyme Immunoassays.

Unit II

Introduction and Principles of Forensic Science and Techniques. Forensic Science Laboratory and its Organization and Services. Tools and Techniques in Forensic Science. Criminology- Causes of crime and role of modus operandi in investigation. Injury types, methods of assessing various types of death.

Unit III

Principles of DNA Fingerprinting: Role of satellite DNA, Different types of repetitive sequences in Fingerprinting. Application of DNA Fingerprinting in Forensic media.

BIOTSEC3P: **Molecular Diagnostic and Forensic Techniques Experiments**

Credits: 01

1. Separation of serum from blood

2. Haemagglutination assay

3. Haemagglutination inhibition assay

4. Single and Double immunodiffusion test using specific antibody and antigen (SRD,ODD).

5. Determination of blood group and R^h typing

Suggested readings

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).

3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).

4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and

Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).

5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).

6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).

7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene

Investigation, CRC Press, Boca Raton (2013).