FACULTY OF SCIENCES

SYLLABUS FOR THE BATCH FROM THE YEAR 2024 TO YEAR 2026

Programme Code: MSBT

Programme Name: M.Sc. Biotechnology

(Semester I-II)

Examinations: 2024-2026

Department of PG Department of Biotechnology

Khalsa College, Amritsar

S.No.	PROGRAMME OBJECTIVES
1.	To improve, broaden, and deepen the knowledge of the students in order to provide students with an adaptable, research-intensive curriculum that meet the needs of both academia and industry.
2.	Enhancing career opportunities in industry, research locally and internationally,or serving as a foundation for further higher education through, cutting-edge laboratory exposures and dissertation-related activities that develop students' global competencies.
3.	Fostering a value system among students in order to promote critical thinking and a thorough understanding of key bioethical concepts.
4.	To inculcate the ability to work as entrepreneurs and technologists with strong ethics and communication abilities.

S.No.	PROGRAMME SPECIFIC OUTCOMES (PSOS)
PSO-1	To gain knowledge through theory and practical.
PSO-2	To establish a solid foundation at the cellular, molecular, genetic, and metabolic levels.
PSO-3	To make agricultural practices more efficient through the use of plant tissue culture and recombinant DNA technology.
PSO-4	To gain understanding of biomolecules, including their formation and interaction.
PSO-5	To do research on microorganisms and strain improvement for industrial applications.
PSO-6	To instill safe laboratory practices and procedures.
PSO-7	To get knowledge on different techniques and the usage of laboratory instruments.

M.Sc. Biotechnology Sem I

COURSE SCHEME											
SEMESTER – I											
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
Major Courses											
MA-MBTL411	Introductory Biomathematics and Biostatistics	4	3	1	-	4	75	-	25	100	5-6
BT-MBTL412	Cell Biology	4	3	1	-	4	75	-	25	100	7-8
BT-MBTP412	Cell Biology lab	4	-	-	2	2	-	37	13	50	9
BT-MBTL413	Molecular Biology	4	3	1	-	4	75	-	25	100	10-11
BT-MBTP413	Molecular Biology lab	4	-	-	2	2	-	37	13	50	12
BT-MBTL414	Biochemistry	4	3	1	-	4	75	-	25	100	13-14
BT-MBTP414	Biochemistry lab	4	-	-	2	2	-	37	13	50	15
BT-MBTL415	General Microbiology, Microbial Physiology & Biotechnology	4	3	1	-	4	75	-	25	100	16-17
BT-MBTP415	General Microbiology, Microbial Physiology & Biotechnology lab	4	-	-	2	2	-	37	13	50	18
Total		36	15	5	8	28	375	148	177	700	

M.Sc. Biotechnology Sem II

COURSE SCHEME											
SEMESTER – II											
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
Major Courses											
BT-MBTL421	Environmental Biotechnology	4	3	1	-	4	75	-	25	100	19-20
BT-MBTP421	Environmental Biotechnology lab	4	-	-	2	2	-	37	13	50	21
BT-MBTL422	Enzymology and Enzyme Technology	4	3	1	-	4	75	-	25	100	22-23
BT-MBTP422	Enzymology and Enzyme Technology lab	4	-	-	2	2	-	37	13	50	24
BT-MBTL423	Biophysical and Biochemical Techniques	4	3	1	-	4	75	-	25	100	25-26
BT-MBTP423	Biophysical and Biochemical Techniques lab	4	-	-	2	2	-	37	13	50	27
BT-MBTL424	Genetic Engineering	4	3	1	-	4	75	-	25	100	28-29
BT-MBTP424	Genetic Engineering lab	4	-	-	2	2	-	37	13	50	30
CS-MBTL425	Computer Applications & Data Analysis	3	2	1	-	3	56	-	19	75	31-32
CS-MBTP425	Computer Applications & Data Analysis lab	2	-	-	1	1	-	19	06	25	33
Total		37	14	5	9	28	356	167	177	700	

M.Sc. Biotechnology (Semester – I)

MA-MBTL411 - Introductory Biomathematics and Biostatistics

Credits:3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

Instructions for paper setters and candidates

60 Hrs.

The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper. Each question of section B,C,D and E should be subdivided into at most two subparts

Course Objectives

1. To help the students to solve Statistical problems using various measure of centraltendency.
2. To enable the students to collect the data and present it diagrammatically.
3. To establish linear association between two variables by using Correlation.
4. To help the students to use regression to predict the behavior of dependent variable.
5. To use t, chi square, F and z tests to solve problems related to different types of data.

Course content

Unit – I

Binomial Theorem, Pascal rule and Pascal triangle. Scientific notation, significant digits, rounding off. Scientific notation, Sampling, problem identification, designing of experiment, factorial designs: full factorial design, fractional factorial design, concept of population and sample, random sampling, Data collection.

Unit-II

Measures of central tendency, mean, arithmetic mean, geometric mean & harmonic mean, medium, mode, quartile, deciles, percentile, dispersion, mean deviation, standard deviation, geometric standard deviation, standard error, coefficient of variation, variance, coefficient of determinant and coefficient of non-determinant, moments, distribution of data, skewness and kurtosis.

Unit-III

Pearson's correlation coefficient, linear correlation and regression, Effect of change of origin and scale on correlation -coefficient, Angle between regression lines, exponential curve. Power function, log-function, Partial correlation.

Unit-IV

Probability, Addition and Multiplication law of Probability, Conditional Probability, Probability distribution function, Poisson distribution function, binomial distribution, , standard normal distribution, Testing of hypothesis, Null and alternative hypothesis, Type-I and Type-II errors, level of significance, two tailed and one tailed tests, Z-score, chi-square (χ^2) test, student „t" test, „F" test, student „t" distribution, chi square (χ^2) distribution, Analysis of variance, ANOVA-one way ANOVA and two way ANOVA.

Books Recommended

1) Kothari, C.R. (2004) Research Methodology Methods and Techniques, New Age InternationalPublications, New Delhi

2) P.S.S. Sundar Rao, P.H. Richard, An Introduction to Biostatistics, Prentice Hall of India (P.)Ltd. New Delhi 2003.

3) Jerrold H. Zar, Biostatistical Analysis, Tan Prints (I) Pvt. Ltd., New Delhi, 2003.

Course Outcomes

CO-1 Student will learn to solve Statistical problems using various measure of central tendency.
CO-2 It will enable the students to collect the data and present it diagrammatically.
CO-3 Students will learn to establish linear association between two variables by using Correlation.
CO-4 Students will use regression to predict the behavior of dependent variable.
CO-5 Students will learn to use t, chi square, F and z tests to solve problems related to different types of

M. Sc. Biotechnology (Semester-I)

BT-MBTL412
Cell Biology (Theory)

Credits: 3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

Instructions for paper setters and candidates

60 Hrs.

The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper.

Course Objectives

1. To recall the history of cytology, distinguish the structure of prokaryotic and eukaryotic cell, and to learn about principles and working of various kinds of microscopes.
2. To know the fundamentals of cell division, cell cycle and its regulation.
3. In-depth study of different pathways of cell signalling.
4. Understanding the communications of cells with other cells and to the environment.

Course content

Unit I

History of cell biology: Development of cell theory and First cell, Evolution of metabolism Diversity of cell size and shape: General organization of prokaryotic and eukaryotic cells, Origin of cells: Assembly of macromolecules (proteins and nucleic acid), mechanism of assembly, evolutionary steps in the origin of cells (Chemical evolution).

Cell biology techniques: Microscopy-light, phase-contrast, fluorescence, confocal, transmission electron microscopy scanningelectron microscopy. stereo microscope Use of radioisotopes, cell culture, fractionation of cells contents.

Unit II

Cell motility: Cilia, flagella of eukaryotes and prokaryotes, their molecular mechanism
Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, andcontrol of cell cycle.
Regulators of cell cycle progression: MPF, families of cyclins and cyclin dependent kinases,Growth factors, cell cycle inhibitors.

Unit III

Cell signaling: Mechanism of signal transduction, Modes of cell signaling, steroid hormone receptors, G-protein coupled receptors, second messengers, c- AMP pathway of signal transduction ; c GMP, phospholipids and calcium ions , Ras, Raf , MAP kinase pathway , JAK–STAT pathway, bacterial and plant two component systems, bacterial chemotaxis and quorum sensing,

Unit IV

Cellular communication: Extracellular matrix; Matrix structural proteins, Matrix polysaccharides, Adhesion proteins, cell-matrix interactions. Adhesion junctions, Tight junctions, Gap junctions Protein Sorting and Transport : Targeting proteins to endoplasmic reticulum, Protein export from ER; Protein sorting and export from Golgi Apparatus, Mechanism of vesicular transport

Books Recommended

1) Smith, C.A. and Wood, E.J. (1993). Cell Biology: Molecular and Cell Biochemistry.Chapman & Hall, London.
2) Karp, G. (1999). Cell and Molecular Biology: Concepts and Experiments. John Wiley& Sons Inc., New York.
3) Pollard, T.D. and Ernshaw, W.C. (2002). Cell Biology. Elsevier Science (USA)
4) Becker, W.M., Kleinsmith, L.J. and Hardin, J. (2000). The World of the Cell. TheBenjamin/Cummings Publishing Company.
5) Cooper, G.M. (2000). The Cell – A Molecular Approach. ASM Press, Washington,D.C.
6) Rastogi, S.C. (2005) Cell Biology, New Age International, pp. 532
7) Alberts, B., Bray, D., Hopkin, K., Johnson, A.D., Johnson, A., Lewis, J., Raff, M.,Roberts, K., Walter, P (2009) Essential Cell Biology, Garland Science, pp 860

Course outcomes

Upon completion of this course, students will be able to:

CO-1. Understand the structureand purpose of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles. The studentswill get familiarized with basic principles of working of Microscopy.

CO-2. Gain knowledge about the cellular components underlying mitotic and meiotic cell division.

CO-3. Learnabout the phases of cell cycle and its regulation.

CO-4. Acquire knowledge about the mechanism of signal transduction, modes of cell signalling and various pathways involved in cell signalling.

CO-5. Describe the mechanism of cellular communication, protein sorting and its transportation across organelles.

M. Sc. Biotechnology (Semester-I)
BT-MBTP412
Cell Biology lab

Credits=0-0-1
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

Course Objectives

30 Hrs.

1. Slide preparation and examination of different cell types under microscope.
2. To examine different stages of cell division.
3. Staining techniques employed for different cell organelles.
4. In-depth knowledge of centrifugation and chromatography.

Course content

1. Microscopic examination of bacteria, yeast and plant cell
2. Preparation of permanent slides of eukaryotic and prokaryotic cell.
3. Study of different stages of mitosis and meiosis.
4. Staining and visualization of different cell organelles.
5. Instrumental methods for cell biology-centrifugation, chromatography.
6. Histochemical techniques.

Course outcomes

Upon completion of this course, students will be able to:

CO-1. Differentiate between eukaryotic and prokaryotic cell structure.
CO-2. Understand the structure and function of various cell organelles.
CO-3. Get familiarized with different phases of mitosis and meiosis.
CO-4. Perform different types of staining techniques employed in cell biology.
CO-5. Learn about various instrumental methods used in cell biology such as centrifugation, chromatography and microscopy.

M. Sc. Biotechnology (Semester-I)

BT-MBTL413
Molecular Biology (Theory)

Credits: 3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

Instructions for paper setters and candidates
The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper.

Course Objectives

1. To understand heredity of life and basic makeup of genetic material.
2. To know the complete process of duplicating cells genetic material.
3. To understand how genotype is expressed in phenotype by learning the process ofmRNA transcription and protein translation.
4. To understand the genes and their expression.

Course content

60 Hrs.

Unit I

DNA: the vehicle of inheritance, DNA replication, Repair and Recombination: Replication initiation, elongation and termination in prokaryotes & eukaryotes, enzymes and accessory proteins involved in DNA replication, Fidelity; DNA repair- photoreactivation, nucleotide andbase excision repair, mismatch repair, SOS response, Introduction to mobile genetic elements, nucleic acid hybridization – cot curves.

Unit II

Prokaryotic transcription; transcription unit, promoters: constitutive and inducible, initiation, termination- rho dependent and independent. Eukaryotic transcription, promoters for RNA polymerase I, II and III, transcription factors, regulatory elements & mechanism of transcription regulation, post-transcriptional modifications: processing of hnRNA, rRNA &tRNA; 5‟cap formation, 3‟-end processing, polyadenylation and splicing.

Unit III

Genetic code, prokaryotic & eukaryotic translation, the translation machinery, isoaccepting tRNA, wobble hypothesis, mechanism of initiation, elongation & termination, ribosome recycling factor, tm RNA, regulation of translation, co & post translation modification of proteins and intracellular protein targeting import into nucleus, mitochondria and peroxiome, non-ribosomal polypeptide synthesis, prions.

Unit IV

Regulation of gene expression in prokaryotes and eukaryotes; (operon concept; lac, trp and araoperons), RNA interference, Viral & cellular oncogenes, tumor suppressor genes from humans, structure, function & mechanism of action of p53 tumor suppressor proteins, Molecular mechanism of antisense molecules, ribozymes, applications of antisense & ribozyme technologies.

Books Recommended

1. Rawn, J. D. (1989). Biochemistry, 2nd edition, Neil Patterson Publications, U. S. A. , NorthCarolina,
2. Damal, J., Lodish, H., and Baltimore, D. (1990). Molecular Cell Biology, 2nd ed., ScientificAmerican Books, Distributed by W. H. Freeman and Co., New York.
3. Adams, R. L. P., Knowler, J. T., and Leader, D. P. (1992). The Biochemistry of Nucleic acids, 11th ed., Champman and Hall, The New York/London/Tokyo/Melbourne/Madras.
4. Stryer, L. (1995). Biochemistry, 4th ed., W. H. Freeman and Co., New York.
5. Nelson, D. L. & Cox, M. M. (2005). Lehninger Principles of Biochemistry, 4th ed., WorthPublishers, New York.
6. Watson J., Baker T., Bell S., Gann A, Levine M and Loscik R. (2008). Molecular Biologyof the Gene. 6th Ed. Pearson Education.
7. Krebs J.E., Goldstein E.S. and Kilpatrick ST (2009), Lewin‟s Genes, Jones and BartlettPublishers, U.K.
8. Michael R. Green, Joseph Sambrook (2012) Molecular Cloning: A Laboratory Manual (Fourth Edition): Three-volume set Cold Spring Harbor Laboratory Press
9. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (2013) Molecular Biology of the Gene (7th Edition) Benjamin Cummings, Publishers.

Course outcomes

Upon completion of the unit the student shall be able to understand:

CO-1 Structure of DNA, DNA as genetic material and complete process of replication, transposition and recombination in prokaryotes and eukaryotes.
CO-2 Molecular Events of Transcription and processing of transcripts, RNA editing.
CO-3 Understanding the regulation of gene expression in prokaryotes using operon concept andEukaryotes.
CO-4 Molecular Events of Translation leading to protein synthesis and Post translational modification.

M. Sc. Biotechnology (Semester-I)

BT-MBTP413
Molecular Biology lab

Credits: 0-0-1
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

30 Hrs.

Course Objectives

1. To learn the preparation of reagents and buffers used in rDNA Technology.
2. To acquire the knowledge of basic chemicals involved, their applications and stepsinvolved in the isolation of DNA from prokaryotes and Eukaryotes.
3. To perform quantification and separation of isolated DNA.
4. To understand the concept of Restriction Digestion and DNA ligation by performing it.

Course content

1. Isolation of genomic DNA from plant tissues.
2. Isolation of genomic DNA from *E. coli* cells.
3. Spectrophotometric analysis of DNA.
4. Restriction digestion of DNA.
5. Separation of digested fragments by agarose gel electrophoresis.
6. Transfer of resolved DNA fragments from agarose gel to nylon/nitrocellulose membrane.
7. Hybridization of nylon/nitrocellulose blots.

Books Recommended

1. Practical handbook of biochemistry and molecular biology (1989) by Gerald D. Fasman(CRC Press, Taylor and Francis Group).
2. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F. Fritish and T.Maniatis (Cold Spring Harbor Laboratory Press, New York).
3. Michael R. Green, Joseph Sambrook (2012) Molecular Cloning: A Laboratory Manual (Fourth Edition): Three-volume set Cold Spring Harbor Laboratory Press, New York.

Course outcomes

CO-1. Students practically learn technique DNA isolation (bacterial and plant sample) andagarose gel electrophoresis

CO-2. Students practices various technique in recombinant DNA technology like restriction digestion and quantification of DNA.

CO-3. Students get idea about transformation in bacterial cells and screening of transformants.

CO-4. Students will get hand-on training in performing Southern Blotting.

M. Sc. Biotechnology (Semester-I)

BT-MBTL414
Biochemistry (Theory)

Credits:3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

60 Hrs.

Instructions for paper setters and candidates
The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper.

Course Objectives

1. To analyse, appreciate, understand the basic concepts of chemical reactions that occur in living systems, which enable them to understand the various perspectives of applied sciences that benefit the mankind.
2. To understand the concept of Biochemistry regarding Biomolecules Carbohydrates, proteins, lipids, Nucleic acids.
3. Have knowledge of intermediary metabolism of the above & regulation of individual metabolism.
4. To inculcate the .overview of metabolite pathways: Glycolysis, citric acid cycle, oxidative phosphorylation, pentose phosphate pathway and gluconeogenesis and their regulation; photosynthesis

Course content

Unit I

Carbohydrates: Classification, characteristics and functions of monosaccharides, disaccharides- polysaccharides. Epimers, isomers, anomers, chiral carbon atom, chair and boat form, glucopyranose and fructopyranose.

Unit II

Amino acids & peptides: Classification, chemical reactions and physical properties.
titration curve of amino acid, concept of zwitter ionic structure.
Proteins: Classification of proteins. Primary, Secondary (Alpha helix and beta pleated structure), Tertiary and Quaternary structures of proteins. Disulphide bridges, Ramachandran plot. Domains and motifs, Role of weak forces in biology, Forces stabilizing protein structure and shape.

Unit III

Lipids: Definition and classification of lipids. Fatty acids- General formula, nomenclature andchemical properties structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins.
Beta oxidation - Pathway and regulation. Role of acyl carnitine in fatty acyl transport.

Synthesis of fatty acid - Structure and composition of fatty acid synthetase complex, pathway and regulation. synthesis of triacyl glycerides. Ketone bodies - Formation and utilization.

Unit IV

Nucleic Acids: Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis. Experimental evidence for nucleic acids as genetic material. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, T_m and itsrelation to GC content.

Overview of metabolite pathways: Glycolysis, citric acid cycle, oxidative phosphorylation,pentose phosphate pathway and gluconeogenesis and their regulation; photosynthesis.

Books Recommended

1. Stryer, L. (2012). Biochemistry: 7th Edition, W.H. Freeman and Company, New York
2. Lehninger, A.L., Nelson, D.L. and Lox, M.M. (2012). Principles of Biochemistry 6th Ed., W.H. Freeman and Company, New York
3. Moran, Horton, Scrimgeour & Perry (2011)Principles of Biochemistry, Prentice Hall.
4. Zubay, G.L., Parson. W.W. and Vance, D.E. (1995). Principles of Biochemistry: StudentStudy Art Notebook, Wm. C. Brown Publishers.
5. Rawn, J.D. (1989). Biochemistry, Neil Patterson Publishers.
6. Bucke C., (1999)), Carbohydrate Biotechnology Protocols, Humara Press.

Course outcomes

CO-1. The students will have a detailed understanding on the bio-molecules of life, theirstructure and function

CO-2. Students will be acquainted with the knowledge of structures, function, and interactionsof proteins, nucleic acids, carbohydrates and lipids

CO-3. Students will be aware of basic biosynthetic and catabolic pathways for Carbohydrate,Lipid, Amino Acids and Nucleotide metabolism.

M. Sc. Biotechnology (Semester-I)

BT-MBTP414
Biochemistry lab

Credits: 0-0-1
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

30 Hrs.

Course Objectives

1. To learn the Theory & Application of Buffers & pH.
2. To prepare various buffers: Phosphate buffer and Tris buffer for conducting experiment.
3. To learn the protocol of quantitation of sugars: Anthrone method and Bradford method.
4. To learn protein estimation by Lowry‟s method.
5. To determine the saponification and acid value of fat, Iodine number of fat & Separation of amino acids by TLC.

Course content

1. Theory & Application of Buffers & pH
2. Preparation of buffers: Phosphate buffer and Tris buffer
3. Quantitation of sugars: Anthrone method and Bradford method
4. Protein estimation: Lowry‟s method
5. Determination of saponification and acid value of fat.
6. Determination of Iodine number of fat.
7. Separation of amino acids by TLC.

Books Recommended

1. Singh, S.P. (2006) Practical manual of Biochemistry. 6th Edition, CBS publication.
2. Sawhney, S.K. and Randhir Singh (2001). Introductory Practical Biochemistry. NarosaPublishing House, New Delhi.
3. Plummer D.T. (1998). An Introduction of Practical Biochemistry, 3rd Ed. TataMcGraw Hill Publishers Co. Ltd., New Delhi.
Bansal, D.D., Khardori, R. & Gupta, M.M. (1985). Practical Biochemistry. StandardPublication, Chandigarh.

Course outcomes

CO-1. Have knowledge regarding the preparation of various buffers: Phosphate buffer andTris buffer for conducting experiment.
CO-2. Develop skills of performing quantitation of sugars: Anthrone method and Bradfordmethod.
CO-3. Possess the knowledge protein estimation by Lowry‟s method.
CO-4. Understand the process of saponification and acid value of fat, Iodine number of fat & Separation of amino acids by TLC.

M. Sc. Biotechnology (Semester-I)

BT-MBTL415
General Microbiology, Microbial Physiology & Biotechnology (Theory)

Credits=3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

Instructions for paper setters and candidates

60 Hrs.

The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper.

Course Objectives

1. To give students insights about the principles and application of microscopy.
2. To make students aware about the concepts of pure culture techniques, sterilizationtechniques.
3. Students will learn about the prokaryotic cells and eukaryotic cells in detail at structural and molecular level. They will also learn about their growth curve patterns.
4. To give students detailed concept about bacterial classification and genetics,mechanisms of drug-resistance.
5. Students will also study about viral biology details pertaining to their characteristics,classification and life cycle.

Course content

Unit I

Principles of Microbiology: Principles and applications of bright field, dark field, phase contrast, fluorescence and scanning tunnelling microscopy, electron microscopy (SEM and TEM).

Methods in Microbiology; pure culture techniques, theory and practice of sterilization, principles of microbial nutrition, microbial culture media, enrichment culture techniques, culture collection, culture purification and preservation methods.

Unit II

Prokaryotic cells: Organelle of microbes and their structure and functions. Cell wall types of Gram-positive and Gram-negative bacteria, capsules, Pili, Fimbriae, flagella. Classification of microorganisms based on their nutritional requirements. Sporulation and regeneration in bacteria. Brief comparison of archaea and eubacteria.

Unit III

Microbial Growth: Definition of growth, mathematical expression of growth, growth curve, diauxic and synchronous growth, effect of temperature, pH (acidity, basicity), oxygen and water availability on growth.

Virology: General characteristics , classicfication, ultrastructure of virus, viroids. Methods of isolation and purification of virus (T4,Mu, X174, M13 only). Lytic and lysogenic life cycles ofvirus.

Unit IV

Bacterial Genetics: Recombination in bacteria, transformation, transduction, conjugation,plasmids; drug resistance in bacteria, transposons.

Bacterial classification: Bacterial classification according to Bergey‟s manual, 16S rRNA, %GC ratio, DNA-DNA homology, fatty acid analysis methods of classification.

Books Recommended

1. Damal. J, Lodish, H. and Baltimore, D. (2007). Molecular Cell Biology, 6th edition, Scientific American Books, Distributed by W.H. Freeman and Co., New York.
2. Lewin, B. (2007). Gene IX, 9th edition, Jones and Bartlett Publishers.
3. Lehninger, Nelson, D. L. & Cox, M. M. (2005). Lehninger Principles of Biochemistry, 4thed., Worth Publishers, New York.
4. Freifelder, D. (2000). Microbial Genetics, Narosa Publishing House.
5. Watson,J.D., Baker,T.A, Bell,S.P., Gann,A., Levine,M., Losick,R. (2004). Molecular biology of the gene (5th Ed.). Pearson Education (Singapore) Pvt. Ltd.
6. Chander,M, Puri, P. (2008). A Concise course in Microbiology. Krishna Publishing House.Pvt. Ltd.
7. Presscott, L.M., Harley, J.P. and Klein,D.A. (2011). Microbiology (6th Edition). McGrawHill Inc.
8. Ronald, A.M. (1995). Principles of Microbiology. Mosby Year Book Inc. Missouri.
9. Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (2010). Microbiology: Concepts and Applications.McGraw Hill, NY.
10. Tortora, G.J., Funke, B.R., Case, C.L. (2012). Microbiology an Introduction (11th edition),Benzamin Cummins.

Course outcomes

At the end of the course

CO-1 Students will have detailed insights about the principles, working and application ofdifferent microscopes in microbiology.

CO-2 Students will be able to distinguish prokaryotic and eukaryotic cells based on morphological features and other key differences.

CO-3 Students will have knowledge about bacterial classification and concepts about bacterialreplication.

CO-4 Students will be understanding Virus life cycle, prokaryotic cells and their growth curve patterns.

M. Sc. Biotechnology (Semester-I)

BT-MBTP415
General Microbiology, Microbial Physiology & Biotechnology lab

Credits: 0-0-1
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

Course Objectives

30 Hrs.

1. Students will learn to handle lab equipments and microscopes.
2. To provide students hands-on training to perform serial dilutions of bacterial samples andcalculate CFU.
3. Students will perform bacterial and fungal DNA isolation and perform spectro-photometricanalysis.
4. Students will perform the MIC test for antibiotic sensitivity of a bacterial strain against aspecific antibiotic
5. Students will learn to test microbiological quality of potable water by MPN/MTFT method.
6. Students will learn to perform bacterial staining methods.

Course content

1. To study the morphology and structural characteristics of different bacteria and fungi using lightmicroscope.
2. To perform serial dilution of the soil sample to isolate bacterial and fungal CFU.
3. To perform the Gram staining of given bacterial samples isolated in above experiment.
4. To evaluate the microbiological quality of potable water by MPN/MTFT method.
5. To isolate bacterial or fungal DNA and purify it by gel electrophoresis.
6. To test for the antibiotic sensitivity of the bacterial sample.
7. To perform the MIC test for antibiotic sensitivity of a bacterial strain against a specific antibiotic.
8. Preservation/cryopreservation of a microbial strain.

Books Recommended

1. Claus, W.G. and Claus, G.W. (1991). Understanding microbes: Laboratory Text Book forMicrobiology, W.H. Freeman Company.
2. Benson, H.J. (1994). Microbiological Applications, 6th ed., Win, C. Brown Publishers,England.
3. Cappucino, J.G. (1999). Microbiology-A laboratory manual, 4th ed., Harlow, Addition-Wesley.

Course outcome

At the end of the course

CO-1. Students will be able to handle microscopes and be able to work on microorganisms.

CO-2 By performing serial dilutions of bacterial samples, students will learn the techniques Of obtaining pure cultures in lab and practice sterilization techniques.

CO-3 Students will accomplish the testing of microbiological quality of potable water.

CO-4 Students will be able to perform antibiotic sensitivity of a bacterial strain using antibiotic discs.

CO-5 Students will be able to distinguish *E.coli*. bacterial strains using staining techniques.

M. Sc. Biotechnology (Semester-II)

BT-MBTL421

Environmental Biotechnology

Credits: 3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

Instructions for paper setters and candidates

60 Hrs.

The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper.

Course Objectives

1. To correlate the knowledge of fundamental Science‟s to explore types,, sources and impactof various types of pollution.
2. To make the pupils aware of the viral, fungal, bacterial and general disease.
3. The students made to learn all the techniques of analysing waste and use/study various techniques availed for treatment of these diseases?
4. The theoretical knowledge along with the practical work further strengthened by use and application of ultra-modern instrumentation in world class labs to give first hand practical knowledge of Environmental Biotechnology / Microbiology.
5. The students will be given knowledge about industrial, medical, municipal environmental pollution and use of physical, chemical and microbiological tools to treat that waste.

Course content

Unit I

Environmental Pollution and management: Types of pollution including electronic pollution, methods for the measurement of pollution, Air pollution and its control through Biotechnology; sources of water pollution, waste water treatment: physical, chemical and biological treatment processes. Microbiology of waste water treatments, aerobic and anaerobic process. Thin film techniques for waste water treatment using aquatic plants. Role of nanotechnology in environmental pollution control.

Unit II

Solid waste management with vermicomposting: Organic waste processing, composting, anaerobic digestion, vermiculture and vermicomposting, essential precautionary steps in vermicomposting, vermiculturing, vermiwash, overall benefits, economics and marketing.
Biomass production and Biofuels: Introduction, plant biomass, sources of biomass, forest biomass, crop residues (cereals, leguminous crops, sugar cane etc.) aquatic biomass, wastes as a source of energy, composition of plant biomass (cellulose, hemicellulose and lignins), biomass conversion, biological and non- biological processes, useful products biomass (ethyl

alcohol, methanol, methane), Application and future prospects, Recent trends in biofuel research.

Unit III

Biological nitrogen fixation and biofertilizer:The range of nitrogen fixing organisms, biochemistry of nitrogenase, genetics of nitrogen fixation, regulation of *nif* gene expression, symbiotic nitrogen fixation, genetic analysis of *Rhizobium* bacteria, regulation of nod gene expression, transfer of *nif* genes from *Klebsiella pneumoniae* to other organisms, applicationand future prospects. green manuring, the blue green algae, algalization,*Azolla*, present statusand improvements.

Unit IV

Bioremediation: Types of bioremediation, use of fungi, algae and bacteria in biosorption, ecological considerations, biodegradation of oil spills, surfactants, TNT wastes, dye stuff wastes, insecticides, herbicides, antibiotics. plastic menace, biodegradable plastics, volatiletoxic gases and biofiltration.

Books Recommended

1. Manahan, S. E. (2000), Environmental Science and Technology, Lewis Publishers, NewYork.
2. Anderson, D. & Conning, D.M. (1984). Experimental Toxicology, Royal Society of Chemistry.
3. Abbasi, S.A., and Ramasami, E. (1999). Biotechnological Methods of Pollution Control.Universities Press, Hyderabad.
4. Alexander, M.(1999). Biodegradation and Bioremediation. Acadamic Press, San Diego.
5. David, T.G. (1984). Microbial Degradation of Organic Compounds, Marcel Dekkar Inc.,New York.
6. Omenn, G.E. (1987). Environmental Biotechnology, Plenum Press, New York.
7. Rittmann, D.E., McCarty, P.L. (2001). Environmental Biotechnology: Principles and Applications. McGraw Hill, New York.

Course outcome

CO-1. Students will learn about management of waste water environmental pollution, solid waste with vermicomposting.

CO-2. Students will learn about applications of Biomass production, mechanisms of nitrogen fixation and applications of Biofuels, Bioremediation.

CO-3. Students will be able to determine the quality of portable water, perform BOD/COD, study techniques of vermicomposting, Bioremediation and enrichment culture technique.

CO-4. Students will be able to compare and use various types of bioremediation technologies to treat different types of pollutants.

M. Sc. Biotechnology (Semester-II)

BT-MBTP421
Environmental Biotechnology lab

Credits: 0-0-1
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**
30 Hrs.

Course Objectives

1. To correlate the theoretical knowledge of Environmental Biotechnology to experimentvarious ideas and protocols for treatment of various types of pollution.
2. To make the pupils aware of diagnostic environmental engineering.
3. The students made to learn all the techniques of analysing waste and use/study various techniques availed for treatment of these wastes.
4. The practical work by applying experimentation like BOD, COD, Bioreactor studies, Vermicomposting in world class labs to give first hand practical knowledge of Environmental Biotechnology.
5. The students will be given knowledge about industrial, medical, municipal environmental pollution and use of physical, chemical and microbiological tools to treat that waste.

Course content

1. Determination of potable water quality in terms of coliforms, *Enterobacter*, *Shigella*,*Salmonella* qualitative assay.
2. Determination of BOD of given water/wastewater sample.
3. Determination of COD of given water/wastewater sample.
4. Isolation of *Rhizobium* from root nodule and mass cultivation.
5. Study the technique of vermicomposting.
6. Bioremediation of dyes using different fungi strains from soil.
7. Isolation of xenobiotic degrading microbes by enrichment culture technique.

Course Outcome

CO-1 Students will practically learn waste management and remediation.
CO-2. Students will learn about applications of Biomass production, mechanisms of nitrogen fixation and applications of Biofuels.
CO-3. Students will be able to determine the quality of portable water, perform BOD/COD, study techniques of vermicomposting,
CO-4. Students will be able to compare and use various types of bioremediation technologies to treat different types of pollutants.
CO–5. The students are perfectly ready for jobs of Environmental Biotechnologists in Pollution Control Boards, Effluent Treatment Plants, Municipal Solid Waste disposal Plants etc.
CO-6. The students may become an entrepreneur in field of Environmental Pollution Control Consultant, owning of Bio-compost manufacturing unit or vermi-compost production industry.

M. Sc. Biotechnology (Semester-II)

BT-MBTL422
Enzymology and Enzyme Technology (Theory)

Credits: 3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

Instructions for paper setters and candidates

60 Hrs.

The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper.

Course Objectives

Course contents are designed to enable students to learn:

1. Understand Classification, nomenclature of enzymes, coenzymes, energetics and theories of enzyme catalysis along with extraction from natural sources.
2. Learn the mathematical kinetics of enzymatic conversions, various inhibitory mechanisms
3. Brief account of Mechanisms of enzyme action, activity regulation, isoenzymes, ribozymes.
4. Knowledge about enzymes immobilization techniques, Allosteric, product inhibition,Lipid-protein interactions in membrane bound enzymes.

Course content

Unit I

Classification and nomenclature of enzymes, enzyme properties and denaturation; Energetics of enzyme catalyzed reactions, transition state; Mechanism of enzyme action; Regulation of enzyme activity; Isoenzymes, co-factors and co-enzyme, Concept of active centre, binding sites, stereospecificity and ES complex formation, activation energy and transition state theory. Effect of temperature, pH and substrate concentration on reaction rate. Extraction, and purification of enzymes.

Unit II

Basic aspects of Enzyme Kinetics: Pre-steady state kinetics. Michaelis-Menten, Line Weaver-Burke, Eadie-Hofstee and Hanes-Woolf equations and Km value.
Enzyme inhibitors: Types of inhibitors–Reversible and irreversible, their mode of action.Enzyme activity, International units, Standard enzyme unit, Katal, specific activity, turnover number.

Unit III

Regulation of enzyme activity and concentration: Brief account of enzyme induction and repression, covalent modification, isoenzymes and allostery, ribozymes and abzyme.
Enzyme specificity, Enzyme substrate complex. Nueleophilic and electrophilic attack. Role of metal ions in enzyme catalysis. Mechanism of enzyme action: Lysozyme, Chymotrypsin, zymogens and enzyme activation

Unit IV

Enzymes extraction (chemical and physical methods) and purification (Ammonium Sulphate fractionation and dialysis, Gel filtration chromatography). Allosteric interactions and product inhibition. Membrane bound Enzymes- Lipid-protein interaction and Effect of fluidity on enzyme activity. Immobilization of Enzymes: Techniques of immobilization(Entrapment, Binding and Cross linking of enzyme), Properties and applications of immobilized enzymes.

Books Recommended

1) Principles of Biochemistry, AL. Lehninger, D.L. Nelson and M. M. Cox. 1993.

WorthPublishers, New York.
2) Palmer, T. (2001). Enzymes. Horwood Publishing, Chichester
3) Methods in enzymology Vol.185 (1990) Gene Expression technology edited by D.V. Goeddel (Academic Press Inc. San Diego).
4) Enzymes: biochemistry, biotechnology and clinical chemistry (2001) by Trevor Palmer (Horwood).
5) Fundamentals of enzymology: The cell and molecular biology of catalytic proteins (2003) by Nicholas C. Price, Lewis Stevens, Lewis Stevens published (Oxford University Press, USA).
6) Principles and reactions of protein extraction, purification, and characterization (2004)edited by Hafiz Ahmed PhD (CRC, Taylor Francis Group).
7) Shultz, A.R. (1994). Enzyme Kinetics, Cambridge Press.
8) Trevor, P. (1995). Understanding Enzymes, 4th ed. Prentice Hall/Ellis Horwood, England.
9) Engel, P.C. (1996). Enzymology Labfax, Bios Scientific Publisher, Academic Press, U.K.
10) Price, N.C. and Strevens, L. (1999). Fundamentals of Enzymology, 3rd ed., Oxford University Press.
11) Bisswanger, H. (2013) Practical Enzymology, Willey BlackWell

Course Outcome:

Upon completion of this course, students will be able to:

1. Learn about international Classification and nomenclature along with concepts, mechanisms involved in catalysis and extraction, purification techniques of enzymes.
2. Learn different mathematical models involved in enzymatic reaction kinetics alongwith different types of inhibitors.
3. Deeply understand the regulatory mechanisms including induction, repression, covalent modification, along with different types of catalysis as well.
4. Acquire apprehension about Membrane bound Enzymes, immobilization techniquesand industrial applications

M. Sc. Biotechnology (Semester-II)

BT-MBTP422
Enzymology and Enzyme Technology lab

Credits: 0-0-1
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

Course objectives

30 Hrs.

Course contents are designed to enable students to

1. Understand the location of enzyme with in the cell and procedures for its removal.
2. Know inside out of parameters affecting enzymatic reactions.
3. Acquire skills in performing enzymatic investigations.
4. Learn how enzymes are fixed to solid supports for their repeated use in reactionmixture.

Course content

1. Enzymatic assay for alpha-amylase
2. Effect of pH on enzyme activity.
3. Effect of temperature on enzyme activity.
4. The effect of enzyme concentration on the rate of enzyme catalyzed reaction.
5. Effect of substrate concentration on enzyme activity and demonstration of the Km andVmax of the reaction.
6. Immobilization of enzymes.

Course outcome

CO-1. Students learn aboutthe extraction of enzyme from natural source along with its further purification in the laboratory by salt fractionation and dialysis techniques.

CO-2. Students learn about the effect of proton or hydroxyl concentrationon theenzymatic activityleading to determination pH optima of an enzyme.

CO-3. Laboratory outcome includes learning of effect of temperature on theenzymatic activityleading to determination temperature optima of a particular enzyme.

CO-2. Students learn about the effect of increasing enzyme concentrationon therate of enzyme catalysed reaction.

CO-4. Students learn about the dependence of reaction rates of enzyme catalysed reaction on thesubstrate concentrationand further estimation of Michalis constant Km and by estimating the maximum velocity of the reaction.

CO-5. Students learnthe technique to immobilise the enzyme for repeated use in reaction mixture

M. Sc. Biotechnology (Semester-II)

BT-MBTL423
Biophysical and Biochemical Techniques (Theory)

Credits: 3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

60 Hrs.

Instructions for paper setters and candidates
The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper.

Course objectives
1. To make students aware of principle, theory and applications of microscopic, chromatographic, spectroscopic, radio isotopic and electrophoretic techniques.
2. Students will learn about radio isotopes and radiolabeling techniques.
3. Studies will learn about qualitative and quantitative determination of biomolecules in different samples using different techniques

Course content

Unit I

Principles and application of light, phase contrast, fluorescence scanning and transmission electron microscopy, cytophotometry and flow cytometry, fixation and staining.
Centrifugation: Types of centrifuges and centrifugation, rotors and applications, ultracentrifuge-Analytical and preparative.

Unit II

Principles and techniques of nucleic acid: hybridisation and Cot curves; Sequencing of proteins and nucleic acids; Southern, Northern and South Western blotting techniques; Polymerase chain reaction. Principles and applications of gel filteration, ion-exchange and affinity chromatography, thin layer and gas chromatography, high pressure liquid (HPLC) chromatography

Unit III

Principles of biophysical methods used for analysis of biopolymeric structure, X-ray diffraction fluorescence UV/CD, visible NMR and ESR spectroscopy, hydrodynamic methods,Atomic absorption and plasma emission spectroscopy. Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit IV

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method;Applications of isotopes in biochemistry; Radiotracer techniques

Books Recommended

1) Wilson K. and Walker J. (Eds.) (1995). Practical Biochemistry : Principles and Techniques, Cambridge University Press, U.K.
2) Riley, T. and Tomilson, C. (1987). Principles of Electroanalytical Methods. JohnWiley and Sons Ltd. , Chichester, England.
3) Sheehan, D. (2000). Physical Biochemistry: Principles and Applications, John Wileyand Sons Ltd. , Chichester, England.
4) Cooper, T.G (1977). The Tools of Biochemistry, John Wiley & Sons, N.Y.
5) Freifelder, D. (1982). Physical Biochemistry. Applications to Biochemistry & Molecular Biology, W.H. Freeman & Co.
6) Sadasivam, S. and Manickam, A. (1992). Biochemical Methods for Agricultural Sciences, Wiley Eastern Limited, New Delhi.
7) Sawhney, S.K. and Singh, R. (2001). Introductory Practical Biochemistry. NarosaPub.House, New Delhi.
8) Plummer, D.T. (1990). An Introduction to Practical Biochemistry 3rd ed. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
9) Rana, S.V.S (2008) Bio-Techniques, Rastogi publications

Course outcome

CO-1 The course will help students to learn the basic instrumentation, principle and procedure of various sophisticated instruments like electron microscope, fluorescence microscope, UV-VIS spectrophotometer, gas chromatography, NMR and ESR spectroscopy.

CO-2 The students will get theoretical knowledge of various instruments and their practical applications like Geiger-Muller counter, liquid scintillation counter, autoradiography andX-ray crystallography

CO-3 The students will learn about centrifugation, electrophoresis, polymerase chain reaction and blotting techniques.

CO-4 This course will enable the students to implement these techniques in biological research and in discovering new products/compound

M. Sc. Biotechnology (Semester-II)

BT-MBTP423
Biophysical and Biochemical Techniques lab

Credits: 0-0-1
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

30 Hrs.

Course Objectives

1. Students will learn about the principle and methodology for the isolation of DNA andprotein from biological samples
2. Students will learn to estimate DNA and protein by gel electrophoresis andspectrophotometric methods
3. Students will learn the preparation of protein standard curve
4. Students will perform chromatographic techniques *viz* Ion exchange, affinity chromatography, thin layer chromatography and gel permeation chromatography.

Course content

1. Isolation of DNA and protein from biological samples.
2. Estimation of DNA and protein by Spectrophotometer
3. Preparation of standard curve of protein by Bradford method.
4. Electrophoresis of proteins-Native and denaturing PAGE.
5. Ion exchange chromatography of proteins.
6. Affinity chromatography of proteins
7. Thin layer chromatography of biomolecules.
8. Gel permeation chromatography

Course Outcome

CO-1 The students will be able to isolate and estimate DNA and proteinfrom biological samples.

CO-2 The students will be able to separate sample components using TLC, ion exchange,affinity and gel permeation chromatography.

CO-3 The students will be able to separate proteins using electrophoresis (Native and SDS-PAGE)

M. Sc. Biotechnology (Semester-II)

BT-MBTL424
Genetic Engineering (Theory)

Credits:3-1-0
Maximum Marks: 100
Theory: 75
Time: 3 Hours **Internal Assessment: 25**

60 Hrs.

Instructions for paper setters and candidates
The question paper will consist of five sections: A, B, C, D, and E. Section A is compulsory covering whole syllabus and will consist of 8 short-answer type questions, with each question carrying 2.5 marks. Candidates are required to attempt six questions from this Section. Sections B, C, D, and E will have two questions from the Unit I, II, III and IV respectively of the syllabus and carry 15 marks. Candidates are required to attempt one question each from Sections B, C, D, and E of the question paper.

Course Objectives

1. The aim of this core-course is to acquaint the students to versatile tools and techniques employed in genetic engineering.
2. This course provides theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.
3. Students will also be introduced to prominent nucleic acid labeling techniques. Introduction to various types of vectors viz. cloning, transformation, expression; and also vectors for genomic and cDNA library and whole genome sequencing will be provided.
4. A critical appraisal of methods for Polymerase Chain reaction and site-directed mutagenesis and sequencing of cloned genomic fragments will also be covered.

Course content

Unit I

Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotidekinase, Alkaline phosphatase; Cohesive and blunt end ligation; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes (digoxigenin andbiotin), Cloning vectors: Plasmids, M13, phagemids, insertion and replacement lambda vectors

Unit II

Cloning vectors: Cosmids, Artificial chromosome vectors (YACs; BACs); yeast vectors, Expression vectors: principle of recombinant protein expression as His- and GST-tags by cloningin pET and pGEX; Expression strategies for heterologous genes: codonoptimization, Hosts: expression in bacteria and yeast, Inclusion bodies; Methodologies to reduce formation ofinclusion bodies, siRNA technology, Gene Editing (CRISPR-Cas)

Unit III

Linkers; Adaptors; Homopolymeric tailing, strategies for making cDNA libraries; Colony Hybridization, Transformation; Northern and Southern, hybridization, cloning differentially expressed genes(mRNA differential display and subtractive cloning). DNA-Protein Interactions (Electromobility shift assay)

Unit IV

PCR and Its Applications: Primer design; DNA polymerases (Taq & Pfu); Types of PCR – multiplex, nested, reversetranscriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCRproducts, Site specific mutagenesis by PCR, Splice Overlap Extension (SOE)- PCR

Books Recommended:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition,S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL,2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.

Course outcome

CO-1. Students practically learn technique DNA isolation (bacterial and plant sample) and agarosegel electrophoresis

CO-2. Students practices various technique in recombinant DNA technology like restriction digestion and quantification of DNA.

CO-3. Students get idea about transformation in bacterial cells and screening of transformants.

CO-4. Students will get hand-on training in performing Southern Blotting.

M. Sc. Biotechnology (Semester-II)

BT-MBTP424
Genetic Engineering lab

Credits: 0-0-1
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

30 Hrs.

Course Objectives

1. To learn problems encountered and their troubleshoot during isolation of plasmidDNA.
2. To cut plasmid with enzymes so as to incorporate foreign DNA in the vector.
3. To carry out DNA transformation in the bacteria and identify the transormants.
4. To perform southern blotting to identify DNA fragment of interest.

Course content

1. Isolation of plasmid DNA from *E. coli* cells
2. Qualitative analysis of plasmid DNA
3. Quantitative analysis of plasmid DNA
4. Making competent cells of *E.coli*.
5. Transformation of competent *E.coli* cells.
6. Ligation of DNA with T4 DNA ligase
7. Isolation of total RNA.
8. Polymerase Chain Reaction

Books Recommended

1. Practical handbook of biochemistry and molecular biology (1989) byGerald D. Fasman(CRC Press, Taylor and Francis Group).
2. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F.Fritish and T. Maniatis(Cold Spring Harbor Laboratory Press, NewYork).
3. Michael R. Green, Joseph Sambrook (2012) Molecular Cloning: A Laboratory Manual (Fourth Edition): Three-volume setCold Spring Harbor Laboratory Press, New York.

Course outcome

After completion of this course, students should be able

CO-1. To gain hands on experience in gene isolation, cloning and amplification.
CO-2. To get expertise in isolation of plasmids, cloning of gene, transformation into suitable bacteria for selection of recombinant clones and to learn gene cloning in an expression vector.
CO-3. To conduct gene amplification experiments by PCR analysis and to isolate RNA for cDNA synthesis.
CO-4. This practical experience would enable them to begin a career in biotech as well as pharmaceutical industry that engages in genetic engineering

M. Sc. Biotechnology (Semester-II)

CS-MBTL425: Computer Applications & Data Analysis

Time: 3 Hours

Total Marks: 75
Theory Marks: 56
Internal Assessment M: 19

Credits		
L	**T**	**P**
2	**1**	**0**

Instructions for Paper Setters examiners:
The question paper will consist of five sections.
Section A is compulsory and will consist of 8 short answer type questions ,with each question will carry two marks. Candidates are required to attempt 6 questions from this section.
Section B, C, D and E: will have 2 questions from Section A, B,C and D of the syllabus and carry 11 marks. Candidate are required to attempt 1 question, each from section B,C,D and E of question paper.

Course Objectives:

1.	The course is designed to provide complete knowledge of C language.
2.	Students will be able to develop logics which will help them to create programs, applications in C.
3.	Also, by learning the basic programming constructs they can easily switch over to any other language in future.
4.	The course is designed to provide students with the skills to understand the use of SPSS, as a tool to summarize and aid in the interpretation of research findings.

Section-A

Introduction to programming in C, Overview , Character set, C Tokens, Keywords, Identifiers, Variables, Constant , Data Types, Comments, Structure of a C. Program Operators & Expression, Types of Operators , Precedence and Associativity, Type Conversion, Expression , Statement and Types of statements Built-in functions: printf(), scanf(), getch(), getchar(), putchar(), header files, Pre-processor directives : #include, #define , Control Statements : If, If-else ,Nested If-else, switch ,while, do-while ,for ,Nested for loop ,break ,continue, Goto etc.

Section-B

Arrays, One Dimensional arrays, Two Dimensional Arrays, storing data into arrays, searching (Linear Search, Binary Search) and sorting(Bubble Sort) , function, calling a function, passing arguments, call by reference, call by value, Recursion, Strings(Declaration, Initialisation, Traversing Strings, String Handling Functions), Pointers(Pointer Declaration, Initialisation, Operations on pointers, malloc(), calloc(), realloc() functions).

Section -C

Developing the familiarity with SPSS Processer: Entering and editing data in SPSS editor, Importing Data, Inserting and defining variables and cases, creating a Codebook in SPSS. Working with descriptive statistics - Frequency tables, Graphical representation of statistical data (histogram, Boxplot, line charts, scatter plot, P-P plots, Q-Q plots).

Section-D

SPSS: Testing the differences between group means - t – test (one sample, independent – sample, paired sample), ANOVA-GLM 1 (one-way). Regression Analysis: The method of Least Squares, Assessing the goodness of fit, simple regression.

Non-parametric tests – Independent chi square Test, Mann Whitney Test, Wilcoxon signed rank test, Kruskal Wallis test. Advance Models (Logistic Regression sand Discriminant Analysis, Factor Analysis, Cluster Analysis).

References:

1) Balaguruswamy: "Programming in ANSIC", 8/e, 2019
2) Scaum Outline Series: "Programming in C", 1996
3) Dennis & Ritchie: "Programming in C", 2015
4) Stephen G. Kochar: "C Programming", 2017
5) Statistical Methods for Research: A Step by Step Approach Using IBM SPSS.2010. By- K. Kalyanaraman;Hareesh N. Ramanathan;P.N. Harikumar. Atlantic Publish**ers.**
6) Statistics Made Simple: Do it Yourself on PC. by Sarma K.V.S. Prentice-Hall of India Pvt.Ltd (2004) ISBN: 9788120317413.
7) SPSS 20.0: A Guide to Statistical Analysis for Reseachers Paperback – 2018. by Dr. Dinesh Gabhane , Dr. S.B. Kishor, Ms.MadhuriBankar. Himalaya Publishing House; First edition (2018). ISBN-13: 978-9352993062

Course Outcomes:

Upon completion of this course, the students will be able to:

CO1	Use the fundamentals of C programming in trivial problem solving
CO2	Identify solution to a problem and apply control structures and user defined functions for solving the problem
CO3	Use SPSS as a data analysis tool.
CO4	Understand how to enter and organise information with SPSS.
CO5	Understand and interpret charts and understand the basic principles behind inferential statistics.

M. Sc. Biotechnology (Semester- II)

CS-MBTP425 Computer Applications & Data Analysis Lab

Time: 3 Hours **Total Marks: 25**
Credit Hours: (per week): 1 **Practical Marks: 19**
Internal Assessment: 06

1. Write programme to demonstrate conditional statements using c language.
2. Write programme to manipulate matrices.
3. To demonstrate array function.
5. Use of SPSS software: Entering and editing data.
6. Plotting histogram, Boxplot, line charts, scatter plot from the given data.