FACULTY OF SCIENCES

SYLLABUS FOR THE BATCH FROM THE YEAR 2023 TO YEAR 2025

Programme Code: MSBT

Programme Name: M.Sc. Biotechnology

(Semester I-IV)

Examinations: 2023-2025

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	7-8
BT-MBTL412	Cell Biology	4	3	1	-	4	75	-	25	100	9-10
BT-MBTP412	Cell Biology lab	4	-	-	2	2	-	37	13	50	11
BT-MBTL413	Molecular Biology	4	3	1	-	4	75	-	25	100	12-13
BT-MBTP413	Molecular Biology lab	4	-	-	2	2	-	37	13	50	14
BT-MBTL414	Biochemistry	4	3	1	-	4	75	-	25	100	15-16
BT-MBTP414	Biochemistry lab	4	-	-	2	2	-	37	13	50	17
BT-MBTL415	General Microbiology, Microbial Physiology & Biotechnology	4	3	1	-	4	75	-	25	100	18-19
BT-MBTP415	General Microbiology, Microbial Physiology & Biotechnology	4	-	-	2	2	-	37	13	50	20
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	21-22
BT-MBTP421	Environmental Biotechnology lab	4	-	-	2	2	-	37	13	50	23
BT-MBTL422	Enzymology and Enzyme Technology	4	3	1	-	4	75	-	25	100	24-25
BT-MBTP422	Enzymology and Enzyme Technology lab	4	-	-	2	2	-	37	13	50	26
BT-MBTL423	Biophysical and Biochemical Techniques	4	3	1	-	4	75	-	25	100	27-28
BT-MBTP423	Biophysical and Biochemical Techniques lab	4	-	-	2	2	-	37	13	50	29
BT-MBTL424	Genetic Engineering	4	3	1	-	4	75	-	25	100	30-31
BT-MBTP424	Genetic Engineering lab	4	-	-	2	2	-	37	13	50	32
CS-MBTL425	Computer Applications & Data Analysis	3	2	1	-	3	56	-	19	75	33-34
CS-MBTP425	Computer Applications & Data Analysis lab	2	-	-	1	1	-	19	06	25	35
Total		37	14	5	9	28	356	157	177	700	

M.Sc. Biotechnology Sem III

COURSE SCHEME											
SEMESTER – III											
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
Major Courses											
BT-MBTL531	Animal Tissue Culture & Animal Biotechnology	4	3	1	-	4	75	-	25	100	36-37
BT-MBTP531	Animal Tissue Culture & Animal Biotechnology Lab	4	-	-	2	2	-	37	13	50	38-39
BT-MBTL532	Plant Tissue Culture & Plan Biotechnology	4	3	1	-	4	75	-	25	100	40-41
BT-MBTP532	Plant Tissue Culture & Plan Biotechnology Lab	4	-	-	2	2	-	37	13	50	42
BT-MBTL533	Immunology	4	3	1	-	4	75	-	25	100	43-44
BT-MBTP533	Immunology Lab	4	-	-	2	2	-	37	13	50	45
BT-MBTL534	Bioprocess Engineering and Technology	4	3	1	-	4	75	-	25	100	46-47
BT-MBTP534	Bioprocess Engineering and Technology Lab	4	-	-	2	2	-	37	13	50	48
BT-MBTL535	* Seminar (3 Credit hours/Teacher)	3	3	-	-	3	75	-	-	75	49
Total		35	15	4	8	27	375	148	152	675	

Note: * BT-MBTL535 – Seminar – No Internal Assessment

M.Sc. Biotechnology Sem IV

COURSE SCHEME											
SEMESTER – IV											
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max Marks**				**Page No.**
			L	**T**	**P**		**Th**	**P**	**IA**	**Total**	
Major Courses											
BT-MBTL541A Or BT-MBTL541B	Genomics and Proteomics Or Introduction to Bioinformatics	4	3	1	-	4	75	-	25	100	50-53
BT-MBTL542A Or BT-MBTL542B Or BT-MBTL542C	Medical Biotechnology Or Advances in Plant Biotechnology Or Microbial Biotechnology	4	3	1	-	4	75	-	25	100	54-59
BT-MBTL543	Intellectual Property Rights, Bioethics and Biosafety	4	3	1	-	4	75	-	25	100	60-61
BT-MBTP544	* Research Project (Satisfactory/not satisfactory) (3 Credit hours/Teacher)	6	-	-	3	3	Satisfactory/Not Satisfactory				62
	Presentation based on Research Project						-	75	-	75	
BT-MBTP545	** Educational Tour/Industrial Visit	4	-	-	2	2	-	50	-	50	63
Total		22	9	3	5	17	225	125	75	425	

Note: * BT-MBTP544 - Research Project – No Internal Assessment

** BT-MBTP545 – Educational Tour/Industrial Visit – No Internal Assessment

M.Sc. Biotechnology (Semester – I)

MA-MBTL411

Introductory Biomathematics and Biostatistics **L-T-P: 3-1-0**

Credit Hours (Per Week) =4

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. 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, Analysisof 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 usingCorrelation.
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 todifferent types of

M. Sc. Biotechnology (Semester-I)
BT-MBTL412
Cell Biology (Theory)

L T
Credit Hours: 3+1=4
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 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 sections A, B, C and D 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

SECTION -A

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 ofassembly, 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.

SECTION -B

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.

SECTION -C

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,

SECTION -D

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

Credit Hours: 2
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

Course Objectives

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) **L T**

Credit Hours: 3+1=4
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 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 sections A, B, C and D 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

Section-A

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.

Section-B

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 oftranscription regulation, post-transcriptional modifications: processing of hnRNA, rRNA &tRNA; 5‟cap formation, 3‟-end processing, polyadenylation and splicing.

Section-C

Genetic code, prokaryotic & eukaryotic translation, the translation machinery, isoaccepting tRNA, wobble hypothesis, mechanism of initiation, elongation & termination, ribosomerecycling 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.

Section-D

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

Credit Hours: 2
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

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)

L T
Credit Hours: 3+1=4
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 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 sections A, B, C and D 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

SECTION –A

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

SECTION –B

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.

SECTION –C

Lipids: Definition and classification of lipids. Fatty acids- General formula, nomenclature and chemical 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.

SECTION –D

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

Credit Hours: 2
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

Course Objectives

1. To learn the Theory & Application of Buffers & pH.
2. To prepare various buffers: Phosphate buffer and Tris buffer for conductingexperiment.
3. To learn the protocol of quantitation of sugars: Anthrone method and Bradfordmethod.
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)

L T
Credit Hours: 3+1=4
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 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 sections A, B, C and D 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

Section – A

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.

Section-B

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.

Section – C

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.

Section- D

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). Molecularbiology 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 understand Virus life cycle, prokaryotic cells and their growth curvepatterns.

M. Sc. Biotechnology (Semester-I)
BT-MBTP415
General Microbiology, Microbial Physiology & Biotechnology lab

Credit Hours: 2
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

Course Objectives

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 ofobtaining 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 **L T**

Credit Hours: 3+1=4
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 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 sections A, B, C and D 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

SECTION –A

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 anaerobicprocess. Thin film techniques for waste water treatment using aquatic plants. Role of nanotechnology in environmental pollution control.

SECTION –B

Solid waste management with vermicomposting: Organic waste processing, composting, anaerobic digestion, vermiculture and vermicomposting, essential precautionary steps invermicomposting, 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 biofuelresearch.

SECTION –C

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.

SECTION –D

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 andApplications. 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

Credit Hours: 2
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

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 ofnitrogen 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) **L T**
Credit Hours: 3+1=4
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 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 sections A, B, C and D 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 andtheories 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

SECTION -A

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.

SECTION -B

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.

SECTION -C

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

SECTION -D

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

Credit Hours: 2
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

Course objectives

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 enzymecatalysed 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 **L T**
Biophysical and Biochemical Techniques (Theory)
Credit Hours: 3+1=4
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 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 sections A, B, C and D 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

SECTION –A

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.

SECTION –B

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

SECTION –C

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

SECTION –D

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 i

sotopes; 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 AgriculturalSciences, 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/compoun

M. Sc. Biotechnology (Semester-II)
BT-MBTP423
Biophysical and Biochemical Techniques lab

Credit Hours: 2
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

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 permeationchromatography.

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

M. Sc. Biotechnology (Semester-II)
BT-MBTL424
Genetic Engineering (Theory)

L T
Credit Hours: 3+1=4
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 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 sections A, B, C and D 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

Section-A

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

Section-B

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: codon optimization, Hosts: expression in bacteria and yeast, Inclusion bodies; Methodologies to reduce formation ofinclusion bodies, siRNA technology, Gene Editing (CRISPR-Cas)

Section-C

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)

Section-D

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

Credit Hours: 2
Maximum Marks: 50
Practical: 37
Time: 3 Hours **Internal Assessment: 13**

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. (Bio Tech)
Sem – II
CS-MBT425: Computer Applications & Data Analysis

L T

Time: 3 Hours **Credit Hours: 2+1=3**
Total Marks: 75
Theory Marks: 56
Internal Assessment: 19

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 and Discriminant Analysis, Factor Analysis, Cluster Analysis).

References:

1. Balaguruswamy: "Programming in ANSIC", 8/e, 2019
2. Scaum Outline Series: "Programming inC", 1996
3. Dennis & Ritchie: "Programming inC", 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 Publishers.**
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:

CO-1.	Use the fundamentals of C programming in trivial problem solving
CO-2.	Identify solution to a problem and apply control structures and user defined functions for solving the problem
CO-3.	Use SPSS as a data analysis tool.
CO-4.	Understand how to enter and organise information with SPSS.
CO-5.	Understand and interpret charts and understand the basic principles behind inferential statistics.

M. Sc. Biotechnology (Semester- II)

CS-MBT425

Computer Applications & Data Analysis (Practical)

Time: 3 Hours

Credit Hours: 1
Total Marks: 25
Theory 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.

M. Sc. Biotechnology (Semester- III)
BT-MBTL531
Animal Tissue Culture & Animal Biotechnology

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. Learning basic layout of ATC lab. And understanding importance of aseptic techniques in ATC.
2. Studying relevance of important solutions and medium used in ATC.
3. To learn how to establish and maintain cell lines, detection of contaminations and long term storage of these cell lines.
4. To apply ATC at large scale.

Course content

Unit I

Concept of aseptic techniques in ATC; design and layout of ATC lab, Equipment for ATC lab.Laboratory safety and Biohazards, balanced salt solution and tissue culture media.

Unit II

Detection of contamination, preservation, storage and shipment of cells. Constituents of serum, Serum free medium, design of serum free medium, Advantages and disadvantages ofserum supplemented and serum free medium.

Unit III

Dispersion and disruption of tissue, monolayer and suspension culture techniques, measurement of growth and viability of cells in culture, maintenance of cultured cell line, primary and established cell line cultures, cell separation.

Unit IV

Cell culture characteristics, scale up methods for propagation of anchorage dependent and suspension cell culture, concept of Bioreactors for mass culture of mammalian cells, microcarrier culture. Three dimensional culture system. Cell synchronization, cell transformation, cell immobilization techniques

Books Recommended

1. Spier, R. R. and Griffiths, J. B. (1990). Animal Cell Biotechnology, Academic Press, London.
2. Gareth, E. J. (1996). Human Cell Culture Protocols, Humana Press.
3. Julio, E., Celis (1998). Cell Biology-A Laboratory Hand Book, Vol. I-IV, 2nd Ed., Academic Press, New York.
4. Butler, M. (2004). Animal Cell Technology, 2nd Ed., BIOS Scientific Publishers, U.K.
5. John M. Davis (2011) Animal Cell Culture: Essential Methods: Publishers Wiley
6. R. Ian Freshney (2012) : A Manual of Basic Technique and Specialized Applications, 6th Edition, John Wiley and Sons, New York.

Course outcome

Upon completion of the course students should be able to:

CO-1. Successfully maintain cultures of animal cells and established cell lines with good viability, minimal contamination and appropriate documentation.

CO-2. Perform supportive or episodic tasks relevant to cell culture, including preparation and evaluation of media, cryopreservation and recovery, and assessment of cell growth/health.

CO-3. Establishment and maintenance of cell lines.

CO-4. Applications of cultured cell for large scale production of metabolites, transformation and in-vitro cell immobilization.

M. Sc. Biotechnology (Semester-III)

BT-MBTP531

Animal Tissue Culture & Animal Biotechnology Lab

Credit Hours: 0-0-1
Maximum Marks: 50
Practical: 37
Internal Assessment: 13

30 Hrs.

Time: 3 Hours

Course Objectives

1. To gain important skills like preparation of basic buffers and medium.
2. To learn the process of preparation and sterilization of Animal Tissue Culture medium.
3. To prepare cells for culturing.
4. To acquire knowledge of counting and estimating cell number in the culture.
5. Long term preservation of Cell lines.

Course content

1. Introduction to cell culture laboratory and instruments (Inverted microscope, CO2 incubator, Refrigerated centrifuges, Bio-safety cabinets, cryo cans, Water Bath, Deep freezers etc) used in the lab
2. Preparation of tissue culture medium
3. Sterilization of medium by membrane filtration technique
4. Maintenance of a cell line
5. Trypsinization of monolayer and sub culturing of cells
6. Counting of viable cells by trypan blue dye with the help of haemocytometer
7. Cryopreservation and revival of cells.
8. Determination of cell doubling time of a given cell line.

Books Recommended

1. Culture of Animal Cells, (3rd Edition), R. Ian Freshney. Wiley-Liss.
2. Animal Cell Culture – Practical Approach, Ed. John R.W. Masters, OXFORD.
3. Cell Growth and division: A practical Approach. Ed. R. Basega, IRL Press.
4. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd. Oxford.
5. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Matherand David Barnes. Academic Press.
7. R. Ian Freshney (2012) : A Manual of Basic Technique and Specialized Applications,6th Edition, John Wiley and Sons, New York.

Course outcome

CO-1. The course will focus on practical aspects of cell culture, like design and layout of thelaboratory and introduction to the instruments used in Animal Biotechnology lab.

CO-2. Students will get the knowledge and hands on training on media preparation andsterilization.

CO-3. Crypreservation, revival of cells, maintenance and subculturing cell lines.

CO-4. Students will get practical hands on how to determine viability count of cultured cellsand determine cell doubling time.

M. Sc. Biotechnology (Semester- III)
BT-MBTL532
Plant Tissue Culture & Plant Biotechnology

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 main objective of this course is to introduce principles and practices of plant biotechnology, plant tissue culture, genetic transformation and transgenic plant production to students.
2. This course presents the applications of plant tissue culture and plant biotechnology for the improvement of agricultural crops.
3. Students will be able to gain fundamental knowledge of plant tissue culture and plant biotechnology for the production of important secondary metabolites.

Course content

Unit I

Introduction to cell and tissue culture, History of plant cell culture, Laboratory design, Culture media types, Media composition, Plant growth regulators, Gelling agents, Cellular totipotency, Dedifferention and Redifferentiation, Callus and cell culture, Organogenesis and embryogenesis.

Unit II

Micropropagation methods, stages of micropropagation, types, applications and limitations. Somatic embryogenesis types, protocol, media requirements, embryogenic callus,Embryogenic determined cells (EDCs), advantages and disadvantages of somatic embryogenesis. Applications of propagation techniques in crop improvement. Acclimatization of micropropagated plantlets, Technical problems in PTC.. Embryo culture technique and rescuing hybrid embryos.

Unit III

Production of synthetic seed and their applications. Virus free plant production by PTC. Anther and microspore culture, Development of haploid plants, diploidization, applications. Protoplast isolation, culture and fusion, Somatic hybridization, Methods of somatic cell fusion, selection of somatic hybrids, cybrids and their applications. Somaclonal variations

Unit IV

Secondary metabolites production: Mass propagation of plant cells: Plant Cell Immobilization and free cell suspension culture, Hairy Root Culture, Biotransformation, Applications and Limitations. Productionof transgenic plants, Ti plasmids*, Agrobacterium*

infection and tumour growth, *Agrobacterium*mediated genetic transformation of plants, Direct DNA transfer methods for genetic transformation, Crop improvement through transgenics and applications of transgenic plantproduction.

Books Recommended

- Reinert, J. and Bajaj, Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell,Tissue and Organ Culture, Springer Verlang, Berlin.
- Ammirato, P.V., D.A. Evans, N.D. Sharp and Y.P.S. Bajaj (1990). Hand Book of PlantCell Culture, Vols. 1 – 5. McGraw Hill Publishing Company, New York.
- Shaw C.H. (1988), Plant Molecular Biology – A Practical Approach IRL Press Oxford.
- Gupta P.K., (1990), An Introduction to Biotechnology, Rastogi Publications, Meerut.
- Kung, Shain – Dow and Arntzen, C.J. (1989). Plant Biotechnology, ButterWorths,London.
- Bhojwani, S.S. and M.K. Razdan (1983), Plant Tissue Culture. Theory and PracticeElsevier science publications Amsterdam.
- Draper J.R. Scott, P. Armitage, R. Walden, (1988). Plant Genetic Transformation andGene Expression – A Laboratory Manual. Blackwell Scientific Publications, Oxford.
- Grierson, D. and Covey, S.N. (1984). Plant Molecular Biology, Black Publishers, NewYork
- Old, R.W. and Primrose S.B. (1991). Principles of Gene Manipulation, AnIntroduction to Genetic Engineering, Blackwell Scientific Publications, Oxford.
- Hopkins W.G. (2006) Plant Biotechnology, Infobase Publishing, pp 153

Course Outcome

CO-1 The students will learn about important milestones in plant tissue culture and plantbiotechnology.

CO-2 The students will understand the concepts and principles of plant tissue culture andplant biotechnology.

CO-3 The students will learn about different pathways of plant regeneration under *in vitro* conditions - organogenesis and somatic embryogenesis.

CO-4 The students will learn about techniques of establishing cell suspension culture, production of synthetic seeds and their applications.

CO-5 The students will learn about large scale production of secondary metabolites usingdifferent plant tissue culture techniques and bioreactors.

CO-6 The students will gain knowledge about Agrobacterium mediated plant transformationand genetic elements present on the Ti plasmid

CO-7 This course will help students to acquire information about hardening and field transplantation of tissue culture raised plants.

M. Sc. Biotechnology (Semester- III)
BT-MBTP532
Plant Tissue Culture & Plant Biotechnology Lab

Credit Hours: 0-0-1
Maximum Marks: 50
Practical: 37
Internal Assessment: 13

30 Hrs.

Time: 3 Hours

Course Objectives

1. To learn preparation and sterilization of the plant tissue culture medium
2. To study the effect of plant growth hormones on growth and proliferation of explants.
3. To study micro-propagation of plants.
4. To study acclimatization of tissue culture raised plantlets.

Course content

1. Methods of sterilization.
2. Preparation of media-MS (full strength, half strength).
3. Filter sterilization of thermo labile components
4. Micropropagation.
5. Effect of various growth hormones on cell division and cell proliferation
6. Callus induction & sub culturing, organogenesis.
7. Anther culture technique.
8. Acclimatization of tissue culture raised plantlets.

Course outcome

CO-1 The students will be able to prepare and sterilize the plant tissue culture medium
CO-2 The students‟ will learn the effect of plant growth hormones on cell division and cell proliferation.
CO-3 The students willbe able toknow about different methods and steps involved in micro-propagation of plants.
CO-4 The students will be able to perform experiments related tocallus induction, sub culturing and organogenesis from different explants.
CO-5 The students‟ will able toacclimatizethe tissue culture raised plantlets.

M. Sc. Biotechnology (Semester- III)
BT-MBTL533
Immunology

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

Time: 3 Hours

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

Course contents are designed to enable students to learn:

1. Basics, organization of immune system, types of immunity and immunoglobulins.
2. Detailed inside out of histocompatibility, lymphocytes and their receptors, Cytokines and other components, immune regulation.
3. Brief account of Mechanisms of cytotoxicity, types of hypersensitivity, autoimmunediseases and infections.
4. Knowledge about transplantation, immunodeficiency diseases, hybridoma technology.

Course content

Unit I

Introduction: Phylogeny of immune System, Innate and acquired immunity, Clonal nature of immune response, Organization and structure of lymphoid organs (Thymus, Lymph node, Spleen, MALT, M cells), Nature and biology of antigens (Immunogen, Hapten, Epitope, Valency) and super antigens, Antibody structure and function, Antigen-Antibody interactions (Affinity, Avidity).

Unit II

Cells of the Immune system: Heamtopoiesis and differentiation, lymphocytes trafficking, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cell, eosinophils, neutrophils and mast Cells. Stages in T and B lymphocyte maturation, Regulation of immune response: Antigen processing and presentation, generation of humoral and cell mediated immune responses, Activation of B- and T- lymphocytes, T- cell regulation, MHC restriction, Immunological tolerance. Major histocompatibility complex, BCR & TCR, generation of diversity,

Unit III

Complement system (Classical and Alternative pathways), Cytokines and their role in immune regulation, Cell- mediated cytotoxicity; Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity. Hypersensitivity. Autoimmunity.

Unit IV

Transplantation: Graft rejection & Immunosuppression, Immunity to infectious agents (intercellular parasites, helminthes & viruses), Tumor immunology (Immunological surveillance, Immune response to

tumors), Immunodeficiencies and AIDS (HIV Infection, progression), Hybridoma Technology and Monoclonal antibodies.

Books Recommended

1. Kuby, J. (2004), Immunology, 5th Edition. W.H. Freeman and Company, New York
2. Roitt, I.M., Brostoff, J., Male, D.K., & Roth, D. (2006). Immunology (7th ed.).The C.V. Mosby Company. St. Louis
3. Murphy, K.M. (2011). Janeway's Immunobiology, 8th Edition (Immunobiology: TheImmune System (Janeway)) Garland Science. Taylor and Francis Group.
4. Kanfmann, S.H.E., Sher A., Ahmed, R. (2002). Immunology of Infections Diseases,ASM Press, Washington
5. Strites D.P., Terr. A.I. & Parslow T.G. (1997), Medical Immunology, 9th Ed., PHI,Cambridge.
6. Paul, W./E. (1995), Fundamental Immunology, 3rd Ed., Raven Press, New York
7. Austyn, J.M. and Wood K.J. (1993), Principles of Cellular and molecular Immunology,Oxford University Press Inc. New York.
8. Britch, J.R. and Lennox, E.S. (1995), Monoclonal Antibodies Principles andApplication, Wiley Liss.

Course Outcomes

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

1. Acquire the basic knowledge of different immunological components and processes at the cellular levels.
2. Cultivate the apprehension regarding mechanisms of generation of immune response and their different types
3. Learn about the role of specialized lymphocytes, their action process along with diseases related with self defense mechanisms of body like allergic reaction and abnormality in antigen recognition.
4. Realize about the direct involvement of medical science procedures involved in certain disease treatments as well as industrial aspect like monoclonal immunoglobulins generation and their utility.

M. Sc. Biotechnology (Semester- III)

BT-MBTP533

Immunology Lab

Credit Hours: 0-0-1
Maximum Marks: 50
Practical: 37
Internal Assessment: 13
30 Hrs.

Time: 3 Hours

Course objectives

Course contents are designed to enable students to

1. Understand the basics of blood and its components.
2. Learn the cellular and other non-cellular factors of blood.
3. Comprehend the antigen-antibody reaction systems
4. Know inside out of certain immunologic techniques.

Course content

1. Blood film preparation and identification of cells.
2. R.B.C. Counting.
3. Total leukocyte count & Differential leukocyte count
4. A.B,O Blood group testing
5. Direct and indirect haemagglutination assays.
6. Isolation of mononuclear cells from peripheral blood and viability test by dyeexclusion method
7. Separation of serum / plasma from blood
8. Double immunodiffusion test
9. Dot Immuno blot assay (DIBA)

Books Recommended

1. Stevans, C.D. (2009). Clinical Immunology and Serology : A Laboratory Perspective F.A. Davis Company, Philadelphia
2. Hay, F.C. Westwood O.M.R. (2002). Practical Immunology, 4th Ed., Blackwell Science, U.K.
3. Celis, K.E. (1998). Cell Biology: A laboratory handbook. Vol-I Academic Press, U.K.

Course Outcomes:

Upon completion of the course the students will be capable to understand and perform following in the laboratory

1. Staining techniques and Microscopy for the identification as well as morphological characterization of blood cells.
2. Haematological studies using counting chamber for Erythrocyte, leukocyte count
3. Antigen- antibody interaction studies for blood group testing and immunodiffusion.
4. Erythrocyte cross-links studies by lectin glycoproteins for carbohydrate determinants.
5. Centrifugation technique for serum and plasma separation; Density gradient centrifugation for blood cell isolation and viability test.
6. Immunoblotting to identify target protein among unrelated proteins

M. Sc. Biotechnology (Semester- III)

BT-MBTL534

Bioprocess Engineering & Technology

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 study various optimization methods for the growth of living organisms includingstatistical and mathematical modelling techniques.
2. To make the pupils aware of various types of designs, types, operations and kinetics of industrial bioreactors.
3. The students made to learn all the engineering principles used for metabolite production in industry.
4. The practical work of metabolite separation engineering from the Bioprocess media will be elaborately taught to the students.
5. The students will be given knowledge about various microbiological techniques for primary secondary and tertiary treatment of industrial waste.
6. The pupils will be familiarized with the complete aspect of the Bioprocess Engineering & Technology including Design, Instrumentation, Operation, Maintenance, and Scale-up.

Course content

Unit I

Introduction: Historical development of bioprocessing as industry. Scale up of a bioprocesses and its parameters from lab, pilot plant and industrial scales. Growth parameters, growth rate, specific growth rate and biomass doubling, degree of multiplication, growth yield , Ydx/ds, Ydx/do2, metabolic quotient, effect of substrate concentration on growth rate, Monod growth relation, saturation constants and its importance.

Unit II

Bioreactors type: Introduction, Basic function of a bioreactor, microbial, animal and plant bioreactors (Wald hof-type acetators and cavitators, tower bioreactor, cylindroconical vessels, air lift bioreators, deep jet bioreactor, cyclone column, packed tower, rotating disc bioreactor). Aspectic operation and contamination. Sterilization of bioreactors and medium, Body construction, Temperature control and measurement. Aeration and agitation, impellers, Stirrer, glands and bearings, packed gland seal, mechanical seal, magnetic drives, Baffles, different types of spargers, different ports, temperature probes. Dissolve oxygen probe. Basic concepts of Valves and stream traps

(Gate valves, plug valves, ball valves, butterfly valves, Diaphragm valves, pressure control valves, safety valves, steam traps only).

Unit III

Mass and Gas transfer in Microbial systems: Introduction, The oxygen requirement for industrial bioreactors, oxygen demand and supply. Volumetric oxygen transfer, determination of KLa values, sulphite oxidation techniques, gassing out techniques: static method anddynamic method, oxygen balance method. Fluid rheology: Bingham plastic, pseudo plastic, Dilatants, Casson body. Factors affecting KLa values in bioreactors, the effect of medium rheology on KLa values.

Unit IV

Sterilization

Introduction, design of batch sterilization process, del factor, sterilization cycle, Richardsrapid method for design of sterilization cycles, batch sterilization, continuous sterilization, sterilization of feed, sterilization of wastes. Filter sterilization, filter sterilization of media and air, Depth filters design and theory.

Books Recommended

1. Stansbury, P.F., Whittaker, A. Hall, S.J. Principles of Fermentation Technology 3 Edition. Pergamon Press. 2008.
2. Bailey, J.E., and Olis, D.R. Biochemical Engineering Fundamentals. McGraw Hill.
3 Moo-Young, M. Comprehensive Biotechnology. Vol 1-4.
3. Doran, P.M. Bioprocess Engineering Principles. Academic Press 2011.
4. Michael, L. Shuler and Kargi, F. Bioprocess Engineering: Basic Concepts. Pearson-Prentice Hall. 2009.
5. Crueger, W. and Crueger, A. Biotechnology: a Textbook of Industrial Microbiology.Panima Publishing Corporation.
6. McNeil, B and Harvey, L.M. Fermentation a practical approach. IRL Press (Oxford University Press). 2007.
7. Shijie Liu. Bioprocess Engineering: Kinetics, Biosystems, Sustainability, and Reactor Design. Elsevier Sci. Publishers. 2012.
8. Kim Gail Clarke. Bioprocess Engineering: An Introductory Engineering and Life Science Approach. Woodhead Publishing Ltd. 2013.
9. B. Atkinson Biochemical Engineering and Biotechnology Hand Book. MacMillan Press 2009.
10. J.M. Lee. Biochemical Engineering Prentice Hall 2008.

Course Outcome

CO-1. Students will practically learn Bioreaction and process engineering.

CO-2. Students will learn about applications of various types of bioreactors as are scaled – up in industry for industrial fermentations.

CO-3. Students will be able to design up-stream, down-stream, economical, post production, processing and overall aspects of Fermentation technology. This aspect is desirable to join and work in nearly bioprocess industries.

CO-4. Students will be able to compare and use various types of bioprocess for different typesof microbial processes.

CO–5. The students are perfectly ready for jobs of Bioprocess Engineer in Distillaries, Breweries, Food processing plants, Soft-drink bottling plants, Milk processing industry etc.

M. Sc. Biotechnology (Semester- III)

BT-MBTP534

Bioprocess Engineering & Technology Lab

Credits: 0-0-1
Maximum Marks: 50
Practical: 37
Internal Assessment: 13

Time: 3 Hours **30 Hrs.**

Course Objectives

1. To study design of batch bioreactor, one used in nearly all fermentation industries acrossIndia.
2. To make the pupils aware of various parts, probes, maintenance, and mantling- dismantling ofbioreactors.
3. The students practically produce microbial products in batch bioreactor and use it to treatindustrial effluents.
4. The pupils practically learn handling of bioreactor and sterilization &maintenance of asepticconditions in lab area.
5. The pupils will be familiarized with the complete aspect of the Bioprocess Engineering & Technology including Design, Instrumentation, Operation, Maintenance, and Scale-up.

Course content

1. Determination of TDS, pH and conductivity of given wastewater sample after standardization of given probes/instruments.
2. Screening and Isolation of cellulose degrading microbes.
3. Bioremediation of dyes using different fungal/bacterial strain isolated from soil at shake flasklevel.
4. To study the parts of a bioreactor working and functioning of any bioreactor studied in theorypaper by bioreactors assembling and dismantling.
5. Sterilization of fermenter and fermentation media.
6. To characterize and isolate the effluent decolorization product by TLC/GLC.
7. Determinations of thermal death point (TDP) and thermal death time (TDT) of microbes for designing of sterilization.
8. Study the effect agitation on aeration and determination of KLa volumetric oxygen transferrate in the bioreactor by dynamic gassing out technique.

Course Outcome

CO-1. Students in this course will learn to scale up of a bioprocesses and various growth parameters, **CO- 2.**Students will learn about design of batch sterilization process and other sterilization techniques **CO-3.** Students will practically learn Bioreaction and process engineering aspects including Students
will learn about aeration, agitation, mass flow, gas flow etc. for industrial bioreactors.

CO -4. Students will learn about applications of various types of bioreactors as are scaled – up in industry for industrial fermentations.

CO -5. Students will be able to design up-stream, down-stream, economical, post production, processing and overall aspects of Fermentation technology. This aspect is desirable to join and work in nearly all Bioprocess industries. ng,

CO-6. Students will be able to compare and use various types of bioprocess for different types of microbial processes.

M. Sc. Biotechnology (Semester- III)

BT-MBTL535
Seminar

Credits: 3-0-0
Maximum Marks: 75

To make the students conversant with latest happening in the field of Biotechnology and to improve their communicational skill, seminars covering latest topics in Biotechnology have been included in the curriculum. Each candidate will select topic and deliver seminar on important recent scientific discovery published in prestigious scientific journals. Presentation of Seminars will carry 50 marks. An objective type common paper of 25 marks on all the seminars will be taken at the end of the session. The question paper will be set and evaluated by a board of three internal examiners.

M. Sc. Biotechnology (Semester-IV)

Genomics and Proteomics
BT-MBTL541A

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

- Genomics and Proteomics aims to give students an overview of the fundamental technological concepts of genomics, functional genomics, and proteomics methods.
- To acquaint the student with genome organization, gene identification, expression and applications of genomics analysis. Also about proteomics, analysis and its applications.
- Genomics and Proteomics give students foundational skills in omics data analysis, as well as a broad overview on genomics and proteomics technologies and show how these are applied to real-life biomedical problems.
- Students will learn about genomics and proteomics methods, the data these experiments produce, as well as about sequence and proteome analysis.

Course content

Unit I

Whole genome analysis: Preparation of genomic library in vectors, ordered cosmid libraries,BAC libraries, shotgun libraries, comparative genomes (Arabidopsis, rice and panda)

DNA sequencing: conventional sequencing (Sanger, Maxam and Gilbert), pyrosequencing, next generation sequencing, automated sequencing, translation to large scale projects, epigenomics, cancer genomes.

Unit II

FISH, Comparative Genomic Hybridization (CGH), SKY (Spectral Karyotyping).

DNA Microarrays: Chemical DNA synthesis, Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Fluorescence based assay formats and signal amplification strategies, Analysis of single nucleotide polymorphism using DNA chips.

Gene Identification and Expression Analysis: DNA microarrays, ESTs, SAGE, MPSS.

Unit III

Proteome analysis: Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarrays, Protein sequencing methods (Edman degradation, Sanger degradation) yeast 2-hybrid system, FRET, bimolecular fluorescence complementation assay GST pull down, protein localization..

Unit IV

Advantages and disadvantages of DNA and protein microarrays. Total expression vs functional proteomics, oligosaccharide microarrays for glycomics, pharmacogenomics, introduction to metabolomics.

Books Recommended

1. Peruski, L.F. Jr. and Peruski, A.H. (1997). The Internet and New Biology: Tools forGenomic and Molecular Research ASM.
2. Schena, M.ed. (1999). DNA Microarrays: A practical approach. Oxford University Press.
3. Hunt, S. and Livesey, F. ed. (2000). Functional Genomics: A practical approach. OxfordUniversity Press.
4. Josip Lovric. (2011). Introducing Proteomics: From concepts to sample separation, massspectrometry and data analysis. Wiley
5. R. Varshney. (2013). Translational Genomics for Crop Breeding. Wiley-Blackwell Ltd.
6. Sandy B. Primrose, Richard Twyman (2009). Principles of Gene Manipulation and Genomics, 7th Edition. Wiley.
7. Genomics: Essential Methods (2010). by Mike Starkey (Editor), Ramnath Elaswarapu(Editor). Wiley.
8. Nawin C. Mishra, Günter Blobel (2010). Introduction to Proteomics: Principles and Applications. Wiley
9. Jonathan Pevsner. (2009). Bioinformatics and Functional Genomics, 2nd Edition. WileyBlackwell.
10. Molecular Analysis and Genome Discovery, 2nd Edition (2011). Ralph Rapley (Editor),Stuart Harbron (Editor). Wiley Sci Publishers.
11. Introduction to Proteomics. (2008). Agnieszka Kraj (Editor), Jerzy Silberring (Editor).Wiley Publishers.

Course outcomes

On completion of this course, the student will be able to:

1. Explain basic concepts of vectors, gene libraries and next generation sequencing including the differences between the conventional and modern methods;
2. Develop technical skills for analysis and interpretation of data employing techniques like FISH, Microarray, SAGE and MPSS.
3. Know about various methods of proteome analysis of a cell
4. Develop an appreciation of the importance of experimental design for genomics and proteomics and will learn how to apply this knowledge in biomedical field

M. Sc. Biotechnology (Semester-IV)

BT-MBTL541B

Introduction to Bioinformatics

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 the importance and applications of bioinformatics.
2. To provide students with the knowledge of genome sequencing projects includingHuman genome project
3. To increase student's learning about numerous protein and nucleic acid databases andhave insights about the algorithms (BLAST, Smith-Waterman, Needleman-Wunch)
4. To give students hands on practical training on running sequence search tools,construct phylogenetic tree, perform and analyze sequence alignments.

Course content

Unit I

Introduction to Bioinformatics: History of Bioinformatics, milestones, Genome sequencingProjects, Human Genome Project, objectives and applications of Bioinformatics.
Introduction to databases: Type and kind of databases, e.g. PUBMED, MEDLINE Nucleic acid and protein databases: GenBank, EMBL, DDBJ, SWISS PROT, INTERPRO,UNIPROT. Genome project TIGR database, SGD, PLASMODB Data format

Unit II

Sequence alignment: Scoring matrices, PAM, BLOSUM, Local and global alignment concepts; Dot matrix sequence comparison; Dynamic programming; Needleman-Wunch algorithm, SmithWaterman algorithm;

Unit III

Database searches for homologous sequences, FASTA and BLAST, PSSM searching, PSIBLAST and PHI-BLAST, Multiple sequence alignment; Phyllogenetic analysis Motifs andPattern Databases: PROSITE, Pfam, BLOCKS, PRINTS

Unit IV

Protein sequence analysis tools, secondary structure prediction, tertiary structure prediction homology modelling, fold recognition, ab initio methods structure visiualization and analysis tools, rasmol chimera spdviwer, Structure analysis Structural databases: PDB, PDBsum, NDBetc. SCOP, CATH

Books Recommended

1. Cynthia Gibas & Per Jamesbeck, (2000). " Developing Bioinformatics Computer Skills,"O" Rilley & Associates.
2. Campbell and Heyer, Discovering Genomics, Proteomics & Bioinformatics, 2nd Edition,Benjamin Cummings, 2002.
3. Bourhe P. E. and Weissig H. (2003). Structural Bioinformatics (Methods of structuralAnalysis). Wiley-Liss.
4. Mount D. W. (2004). Bioinformatics & Genome Analysis. Cold Spring Harbor LaboratoryPress.
5. Wayne W. Danile (2004), Biostatistics: A foundation for Analysis in the Health Sciences,8th Edition Wiley.

Course Outcome

At the end of this course, students will

CO-1. Learn about Genome sequencing Projects, various primary and secondary databases.

CO-2. Be able to perform sequence alignment, multiple sequence alignment; Phyllogenetictree construction and analysis.

CO-3. Have insights into sequence search tool algorithms; dynamic programming; structural databases and learn about the tools for protein structure prediction.

M. Sc. Biotechnology (Semester-IV)

BT-MBTL542A
Medical Biotechnology

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:

a. To understand and link various assets of Biotechnology to the medical field.
b. Students will learn how stem cells can be applied for the treatment of various diseases.
c. Different immune molecules can be applied for overcoming human ailments whichwill be clarified in this course.
d. Student will be introduced in detailed to the process of gene therapy.
e. Process of drug developments and its various stages will be learned.

Course content

Unit I

Cellular therapy; Stem cells: definition, properties, Classification based on potency and sources; Genetically engineered stem cells in cancer treatment, Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells in tissue engineering; Clinical applications; Ethical issues

Unit II

Immunotherapy: Cancer immunotherapy; Role of cytokine therapy in cancers; Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants, Immunosuppressive therapy; Vaccine development process; recombinant vaccines and clinical applications.

Unit III

Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery Recombinant therapy; Clinical applications of recombinant technology; Erythropoietin; Recombinanthuman growth hormone; Insulin analogs and its role in diabetes; Streptokinase and urokinase in thrombosis; Recombinant coagulationfactors.

Unit IV

Genetic markers-Biomarkers in early drug development; Biomarkers in Clinical development; Biomarkers for molecular Diagnostics- example of cancer biomarkers; IVET Drugs; Types of Drugs - examples of latest drugs; steps in drug designing, HTS, In silico drug designing, structure based drug designing, methods of docking concept of ADME metabolism & Drug Excretion; QSAR; Drug Legislation & safety.

Books Recommended:

1.Spier, R.R. and Griffttths, J.B. (1994). Animal Cell biotechnology, 6th Ed., Academic Press, London.

2.Krogsgaard-larsen P. , Liljefors T., Madsen U. and Larsen K, Liljefors T. Madsen U. (2002).

3.Text Book of Drug Design and Discovery, Taylor and Francis Publications, Washington D.C. Palson, O.B. and Bhatia, N.S. (2009). Tissue Engineering. Dorling Kindersley (India) Pvt.Ltd.

4.Robert L. and other (2009) .Essentials of Stem Cell Biology. 2nd Ed. Academic Press, London.

5. Khan, F.A. (2013) Medical Biotechnology, Academic Press, pp 368

Course Outcomes:

CO-1. In this course students will learn about the role of genetically engineered stem cells in cancer treatment, clinical applications of tissue engineering.

CO-2. Students will acquire in depth knowledge about Immunotherapy, significance of monoclonal antibodies, Vaccine development and clinical applications of recombinant vaccines.

CO-3. Students will learn about various concepts of gene therapy; Recombinant therapy and Clinical applications of recombinant technology.

CO-4. Students will learn about biomarkers in early drug development, Clinical development

and in molecular Diagnostics, methods of docking concept of ADME metabolism & Drug Excretion, in silico drug designing, structure based drug designing

M. Sc. Biotechnology (Semester-IV)

Advances in Plant Biotechnology
MBTL542B

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. The main objective of this course is to introduce recent technologies of secondarymetabolites production
2. This course presents various plant biotechnology techniques and their applications for thecrop improvement.
3. Students will be able to gain fundamental knowledge of genetic transformation andtransgenic plant production.

Course content

Unit I

Hairy Root Research: Recent Scenario and Exciting Prospects Production of hairy root cultures, hairy roots for high-value metabolite production, Biotransformation, Plant Cell Immobilization and free cell suspension cultures.

Unit II

Gene Silencing Techniques and Crop Improvement, Overview of different strategies for gene silencing, RNA interference, Construction of RNA interference vectors, Applications of RNA interference in crop improvements

Unit III

Reactive Oxygen Species (ROS) in Plants, ROS in biotic and abiotic stress, ROS in plant growth and development. Hormonal Regulation of Plant Growth and Development. Interplay of different hormones for plant growth and development.

Unit IV

Production of transgenic plants,Crop improvement through transgenics, *Agrobacterium* mediated genetic transformation of plants, Direct DNA transfer methods for genetic transformation, Applications of transgenic plant production.

Books Recommended

1. Cellular and Molecular Biology of Plant Seed Development. Larkins, Brian A.; Vasil, IndraK. (Eds.), Vol. 4, 1997, ISBN 978-0-7923-4645-6
2. Mei-Liang Zhou, Xue-Mei Zhu, Ji-Rong Shao,Yi-Xiong Tang & Yan-Min Wu (2011) Production and metabolic engineering of bioactive substances in plant hairy root culture. Appl Microbiol Biotechnol 90:1229–1239
3. Klaus Apel and Heribert Hirt (2004) Reactive Oxygen Species: Metabolism, Oxidative Stress, and Signal Transduction. Annu. Rev. Plant Biol. 2004. 55:373–99
4. Ron Mittler, Sandy Vanderauwera, Nobuhiro Suzuki, Gad Miller, Vanesa B. Tognetti, Klaas Vandepoele, Marty Gollery, Vladimir Shulaev, Frank Van Breusegem (2011) ROS signaling: the new wave? Trends in Plant Science. 16 (6), 300-309
5. Matthew, L. (2004), RNAi for plant functional genomics, Comparative and Functional Genomics, 5, 240-244.
6. Umesh Balkrishna Jagtap, Ranjit Gajanan Gurav and Vishwas Anant Bapat Role of RNA interference in plant improvement. Naturwissenschaften (2011) 98:473–492
7. William M Gray (2004) Hormonal Regulation of Plant Growth and Development. PLoS Biology. 2 (9) e311
8. Stephen Depuydt and Christian S. Hardtke (2011) Hormone Signalling Crosstalk in Plant Growth Regulation. Current Biology 21: R365–R373
9. Hopkins W.G. (2006) Plant Biotechnology, Infobase Publishing, pp 153
10. Grierson, D. and Covey, S.N. (1984). Plant Molecular Biology, Black Publishers, New York
11. Old, R.W. and Primrose S.B. (1991). Principles of Gene Manipulation, An Introduction to Genetic Engineering, Blackwell Scientific Publications, Oxford.

Course outcomes

CO-1: The students will learn about production of secondary metabolites using different techniques.

CO-2: The students will understand the concepts and principles of gene silencing techniques.

CO-3: The students will learn about hormonal regulation of growth and development inplants.

CO-6: The students will gain knowledge about Agrobacterium mediated genetictransformation and production of transgenic plan

M. Sc. Biotechnology (Semester-IV)

BT-MBTL542C
Microbial Biotechnology

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:

- This course presents the utility of Microbes and their products in food, health andhealth care industry
- Students will be introduced to the advanced techniques like comparative genomics andgenome sequencing projects.
- the student will understand: Fermentation and production of Microbial products,Vaccine and antibiotics.
- Students will also acquire knowledge about application of microbes in nanotechnologyand bioremediation of xenobiotics.

Course content

Unit I

Introduction to microbial technology, Microbial metabolites : Primary & Secondary, microbial applications in food and health care industries. Introduction to microbial genomes, phylogenetic relationships between various genera of microbes- 16SrRNA sequencing and Ribosomal Database project.

Unit II

Prokaryotic genome organization, chromids, Bacterial and viral metagenomics, synthetic genomics, microbial sequencing projects, comparative genomics of relevant organisms such aspathogens and non-pathogens, human microbiome project.

Unit III

Microbial biofilms, polyketide synthase, antibiotic resistance, extremophiles and

extremophilic biocatalysts, lantibiotics, biosynthesis of nanomaterials, probiotics, microbial degradation of xenobiotics, viral enzymes in modern biotechnology and clinical applications.

Unit IV

Microbial bio-products : penicillin G, Microbial Enzymes : amylases, cellulases, cellobiohydrolase, endoglucanase, cellobiase, β-glucosidase, proteases. Microbial cultures, microbial product recovery. Alcohol biotechnology : Beer, Whisky, and Wine. Microbialculture, fermentation media, microbial bio-processes and product recovery for beer, whiskyand wine.

Course Outcomes:

1. Important Goals of this course is to make the student to learn the wide range of applications of Microbes.
2. Students will understand microbes and their products and will be acquainted with the techniques to identify the useful microbes.
3. Various aspects of fermentation technology and their application in the productions of various products of microbial origin will be studied.
4. Recent application of microbes will be explored in detailed.

M. Sc. Biotechnology (Semester-IV)

BT-MBTL543

Intellectual Property Rights, Bioethics and Biosafety

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. Introduction to different types of IPR.
2. It will help in the introduction of history of IPR in India, Benefits, Problems and Management of IPR.
3. To deal with Principles, objectives, structure and functions of various international organizations like WTO, WIPO, GATT, USPTO, TRIPS, TRIMS, MFN.
4. It will help in learning the bio-entrepreneurship Patentability of Biotech inventions.
5. It will inculcate the basic information about the biosafety of Genetically Engineered Products, Ecological Safety Assessment of Recombinant Organisms, Good Laboratory Biosafety Practices, Web-based Information of Biosafety on GMO.

Course content

Unit I

Introduction to intellectual property rights and its different forms. Ownership of Tangible and Intellectual Property, Farmers Rights, Animal and Plant Breeders Rights, Brief history of IPR system in India. Introduction to Indian Patent law, Basic requirements of patentability, Patentable subject matter.

Unit II

World Trade Organization and its related intellectual property provisions, TRIPS agreement, Patent Cooperation Treaty, Budapest treaty. Patent Litigation: Substantive Aspectsof Patent Litigation, Procedural Aspects of Patent Litigation. Recent Development in Patent System. Compulsory licensing, Patent infringements and revocation. Patentability ofBiotechnological invention.

Unit III

Ethical issues of patenting in Biotechnology, Disclosure Requirements. Collaborative and competitive research, Challenges for the Indian Biotechnological research and industries.

Introduction to Biosafety, Overview of biosafety, Biological Safety Cabinets,, Genetically modified organisms (GMOs), Concerns and Challenges, National and International RegulatoryMechanism for GMOs, Cartegana Protocol, Benefits of transgenic to human health, society and environment.

Unit IV

Biosafety of Genetically Engineered Products, Ecological Safety Assessment of Recombinant Organisms, Good Laboratory Biosafety Practices, Web-based Information of Biosafety on GMO. Introduction to Bioethics, Different Approaches to Ethics, Biological Weapons and Their Social and Ethical Implications. NGOs for Biosafety and Bioethics. Publicand Private sector organizations for biosafety and bioethics, Cross border movement of germplasm, risk management issues-containment.

Books Recommended

1. Beier F.K, Crespi R.S and Straus T. Biotechnology and Patent protection, Oxford andIBH Publishing Co. New Delhi.
2. Jeffrey M. Gimble, Academia to Biotechnology, Elsevier Academic Press.
3. Rajmohan Joshi (Ed.). 2006. Biosafety and Bioethics. Isha Books, Delhi.
4. Sasson A, Biotechnologies and Development, UNESCO Publications.
5. Senthil Kumar Sadasivam and Mohammed Jaabir M. S. (2008). IPR, Biosafety and Biotechnology Management, Jasen Publications, India.
6. Intellectual Property rights in the WTO and Developing countries (2001) by Watal, J.Oxford University Press, New Delhi.
7. Law Relating to Intellectual Property Rights, 1st Edition (2007) by Ahuja, V.K
8. Patent law and Entrepreneurship, 3rd Edition, Kalyani publishers (2010) by Singh, I.and Kaur, B
9. New developments in biotechnology: Patenting life-special report (1990) Office of Technology Assessment (OTA), US Congress (Washington D.C. Dekker).
10. Draft manual of patent practice and procedure (2008) Patent Office, India.
11. Intellectual Property Bulletin.

Course Outcome

CO-1. The goal of this course is to introduce to the students the concept of intellectual propertyrights and its different forms, introduce Indian Patent law and patentable subject matter.

CO-2. Students will learn about World Trade Organization, Patentability of Biotechnological invention, TRIPS agreement, National and international regulatory mechanisms for genetically modified organisms, Cartegana protocol

CO-3. At the end of this course students will be able to define the Bio-ethics, good laboratory and bio-safety practices, NGOs, public and private sectors for bio-safety and bio-ethics.

M. Sc. Biotechnology (Semester-IV)

BT-MBTP544

Research Project

Credits: 0-0-3
Maximum Marks: 75

To give the students sufficient experience and proficiency in the research methodology and to enable them to carry out independent research, projects will be assigned to the students as per individual interest and availability of specialized faculty. The project report will be submitted in the form of dissertation. The project will be presented for evaluation at the end of semester and viva voce examination will be conducted. It will be graded as Satisfactory/Not Satisfactory. However, the final viva voce or presentation will be of 75 marks.

M. Sc. Biotechnology (Semester-IV)

BT-MBTP545

Educational Tour/Industrial Visit

Credits: 0-0-2
MaximumMarks: 50

To enrich students‟ learning experiences and to help them to acquire practical knowledge about the subject, industrial visits will be arranged by the Department. The students are required to submit written report about the visit at the end of semester. Viva voce will be conducted.