A Documentary Support

for

Matric No. – 1.1.2

employability/ entrepreneurship/ skill development

under the

Criteria – I

(Curriculum Design and Development)

Key Indicator - 1.1

in

Matric No. – 1.1.2

MASTER OF SCIENCE (BIOTECHNOLOGY)

1997

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Mapping of the course to employability/ Entrepreneurship/skill development :

*EC: Employability Courses *EPC: Entrepreneurship Courses *SDC: Skill Development Courses

Choice Based Credit System (CBCS)
Department of Biotechnology,
School of Life Sciences,
Dr. Bhimrao Ambedkar University, Agra

Core Courses	Course Title M.Sc. Biotechnology I semester	Marks		Total 100	Credit	Course Mapping		
		CIE	End Semester Examination			EC	EPC	SDC
BT-C101	Cell Biology	25	75	100	4	-	-	-
BT-C102	Biomolecules and Basic Enzymology	25	75	100	4	-	-	-
BT-C103	Microbial Physiology and Metabolism	25	75	100	4			
BT-C104	Biostatistics and Computer Application	25	75	100	4			
BT-C105	Practical		100	100	4			
	Industrial training/Survey/Research Project							
	Total			**500**	**20**			
Core Courses	**Course Title M.Sc. Biotechnology II semester**	**Marks**		**Total**	**Credit**	**Course Mapping**		
		CIE	**End Semester Examination**			**EC**	**EPC**	**SDC**
BT-C 201	Molecular Biology	25	75	100	4			
BT-C202	Instrumentation and Techniques in Biotechnology	25	75	100	4			
BT-C203	Biology of the immune system	25	75	100	4			
BT-C204	Genetics	25	75	100	4			
BT-C 205	Practical		100	100	4			
BT-C206	**Industrial training/Survey/Research Project**		200	**200**	**8**			
	Minor	25	75	**100**	**4**			
	Total			**800**	**32**			
Core Courses	**Course TitleM.Sc. Biotechnology III semester**	**Marks**		**Total**	**Credit**	**Course Mapping**		
		CIE	**End Semester Examination**			**EC**	**EPC**	**SDC**
BT-C301	Animal Cell science and technology	25	75	100	4			
BT-C302	Genetic engineering	25	75	100	4			
BT-C303	Bioprocess engineering and Technology	25	75	100	4			
BT-E304	Basic Bioinformatics	25	75	100	4			
BT-E305	Basic Genomics and Proteomics							
BT-C306	Practical		100	100	4			
	Industrial training/Survey/Research Project							
	Total			**500**	**20**			
Core Courses	**Course Title**	**Marks**		**Total**	**Credit**	**Course Mapping**		
		CIE	**End Semester Examination**			**EC**	**EPC**	**SDC**
BT-C401	Plant Biotechnology	25	75	100	4			
BT-C402	Environmental Biotechnology	25	75	100	4			
BT-E403	Molecular Diagnostics	25	75	100	4			
BT-E404	Stem Cell Biology							
BT-E405	Food Biotechnology	25	75	100	4			
BT-E406	Agricultural Biotechnology							
BT-C407	Practical		100	100	4			
BT-C408	**Industrial training/Survey/Research Project**		200	**200**	**8**			
	Total			**700**	**28**			
	Grand Total of 1st and 2nd year (I, II, III and IV semester)			**2500**	**100**			

Note: The I and II semesters of the first year of the M. Sc. Biotechnology in Faculty of Life Science Programme will be Known as VII and VIII semester of the B. Sc. Research (in Faculty of Life Science).

*** Courses Code having 'C' abbreviation is Core course and having 'E' abbreviation is Elective course.***

No. of Total Courses - 26,

Mapping of the course to employability/ Entrepreneurship/skill development :

***EC:** **Employability Courses** ***EPC:** **Entrepreneurship Courses** ***SDC:** **Skill Development Courses**

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Mapping of the course to Local/ Regional/National/Global need :

***Loc:** Local Need ***Reg:** Regional Need ***Nati :** National Need ***Glob:** Global Need

Programme Educational Objectives (PEOs)

M.Sc. Biotechnology Program

The Program Educational Objectives (PEOs) for the M.Sc. Biotechnology program describe accomplishments that graduates are expected to attain within two years after graduation

PEO-1: To enable students to pursue research career in industry and academia by providing fundamental and practical knowledge in the field of Biotechnology.

PEO-2: To empower the students with analytical and research skills, enable them to critically analyze existing literature in an area of specialization and to nurture entrepreneurial endeavors.

PEO-3: To develop biotechnologists with professional ethics in order to address global and societal issues for sustainable development.

Programme Outcomes (POs)

The students of M. Sc. Biotechnology program will be able to:

PO-1: ***Sound knowledge of Science Area:*** To solve the biological problems by developing the new tools of diagnosis of various diseases and use of GMOs in various industries through good knowledge of biotechnology, microbiology, genetic engineering, molecular biology and bioinformatics

PO-2: ***Problem analysis:*** Identify, formulate, review research literature, and analyze complex biological problems reaching substantiated conclusions using various principles of biotechnology, bioinformatics, microbiology, biochemistry, cell and molecular biology sciences.

PO-3: ***Design/development of solutions:*** Design solutions for complex biological problems and design protocols or processes that meet the specified needs with appropriate consideration for the public health and safety, conservation of biodiversity, better understanding of the microorganisms, and using bioinformatics tools for finding solutions of various crippling human/plant diseases with ethical, societal, and environmental considerations.

PO-4: ***Modern Molecular Biology and Bioinformatics tools usage:*** Develop new technologies, protocols, resources, using modern molecular biology, biotechnology and bioinformatics tools and apply it to solve complex human health problems, plant stress tolerance and conserve endangered medicinal plants.

PO-5: ***Post Graduate Student and society:*** Apply the classic and modern biological theoretical and practical knowledge gained to address societal, health, microbial and plant biodiversity studies, safety, ethical and cultural issues and the consequent responsibilities relevant to the professional upgradation of the student and society as a whole.

PO-6: Skill development: An ability to acquire the skills in handling scientific instruments, planning and performing in laboratory experiments to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability in biotechnology

PO-7: ***Environment and sustainability:*** The professional PG students will have a better understanding of societal and environmental concerns, and demonstrate their knowledge, and need for sustainable development.

PO-8: ***Ethics:*** Apply ethical principles established by different government agencies and commit to research ethics, responsibilities and norms to undertake their current and future research and development.

PO-9: ***Individual and team work:*** Be an independent thinker and researcher effectively as an individual, and as a member or leader of different teams, and in multidisciplinary research Institutions and Universities.

PO-10: ***Communication:*** Communicate effectively on complex research activities with the scientific community and with society at large, as a scientist or a teacher, be well versed with scientific writing and write effective reports and design research projects, make effective presentations, and be able to defend it efficiently.

PO-11*: Life-long learning:* Apply the discipline, ethics and knowledge obtained to engage in independent and life-long learning in their respective fields of interest wherever they go for further higher studies or jobs.

Programme Specific Outcome (PSOs)

After the successful completion of M.Sc. Biotechnology program, the students will able to:

PSO-1: The objective of the Master's Programme in Biotechnology is to equip the students to apply knowledge of living organisms and their cellular processes, classification and interaction among themselves, with physical and chemical agents and higher order organisms. Have advanced understanding of Biotechnology in its various domains including, health, nutrition, agriculture, biodiversity conservation, Biosafety etc.

PSO-2: The laboratory training in addition to theory is included to prepare them for careers in the industry, agriculture, and applied research where biological system is increasingly employed. Address research questions related to all the above mentioned domains through carrying out specific experiments.

PSO-3: Basics and current molecular updates in the areas of Industrial Biotechnology, Fermentation Technology, Agriculture and Environmental Biotechnology are included to train the students and also sensitize them to scope for research.

PSO-4: The study of Master of Biotechnology will impart in-depth understanding of basic aspects of Biotechnology pertaining to industrial applications that will make the students ready to contribute to:

- ✓ Better awareness of the major issues at the forefront of the discipline.
- ✓ Will possess an in-depth understanding of the area of Biotechnology chosen for research emphasis.
- ✓ Awareness of ethical issues in Medical, clinical and animal research and careers options.

PSO-5: Appear and successfully qualify the higher level examinations of various agencies like DBT (Department of Biotechnology), CSIR (Council of Scientific and Industrial Research), ARS (Agriculture Research Services), ICAR (Indian Council of Agriculture Research), and many more, so as to get chance to do research from reputed institutes within country and abroad with sound fellowships.

PSO-6: Develop inclination towards own professional goals over a wide range of carrier options expanding from R & D, industries or as an Entrepreneur.

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M. Sc. Biotechnology I semester

Core Course : BT-C101, Title: Cell Biology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: This course enable students to learn fundamental principles of various cellular concepts such as cell structure and transport, Cell communication, cell cycle and cell death pathway, cell differentiation and expression.

Topics	Teaching Hrs.
Unit I	
1. Plasma Membrane: Composition and structure, membrane proteins, lipid and carbohydrates, endo- and exocytosis. 2. Transport of small molecules across cell membrane: Types and mechanism. 3. Active transport by ATP powered pumps types: P type, V Type, F type and ABC transporters. 4. Cell motility: Structure and function of microfilaments and microtubules.	**15**
Unit II	
1. Structure of Mitochondria and cellular energy transaction by oxidative phosphorylation, 2. Structure of chloroplast and cellular energy transaction by photophosphorylation 3. Nucleus : Nuclear envelope, nuclear pore, nucleolus and chromosomes. 4. Cell organelles and Secretions : Golgi complex, endoplasmic reticulum, lysosomes and peroxisomes.	**15**
Unit III	
1. Cell Signaling : Paracrine, Endocrine, Autocrine. Signaling molecules – hormones, neurotransmitter, proteins and environmental factors.Cell surface receptors - G protein coupled receptor, receptor protein tyrosine kinase, cytokine receptor and non-receptor protein tyrosine kinase, receptor linked to other enzymatic activities. 2. Signaling pathways : Cyclic AMP pathway (second messenger and protein phosphorylation), cyclic GMP pathway, phospholipids and Ca^{2+} pathway, Ras-Raf and MAP kinase pathway, JAK/STAT pathway, 3. Apoptosis – Programmed cell death, apoptotic pathways and regulation. 4. Biology of cancer, difference between normal and cancer cells	**15**
Unit IV	
1. Molecular events of cell cycle 2. Components in cell cycle control – cyclin, CDKs, Check points in cell cycles, G0 to G1 transition, G1 – S transition, S – G2 Transition, G2 – M Transition, events of M phase, The spindle assembly checkpoints leading to anaphase. 3. DNA damage checkpoints by p53 protein, regulation of cell division. 4. Spatial and temporal regulation of gene expression. 5. Cellular Differentiation in Drosophila	**15**

Suggested reading

1. Molecular Biology of the Cell (2002), Alberts et al
2. Molecular Cell Biology (2004), Lodish et al
3. Working with Molecular Cell Biology: A study Companion (2000), Storrie et al
4. Cell and Molecular Biology: Concepts and Experiments (3rd Ed., 2002), Gerald Karp
5. The Cell: A Molecular Approach (2004), G.M. Cooper
6. The Word of the Cell (1996), Becker et al
7. Cell Proliferation and Apoptosis (2003), Hughes and Mehnet
8. Essential Cell Biology (1998), Alberts et al
9. Biochemistry and Molecular Biology of Plants (2000), Buchanan et al
10. Harpers Biochemistry Murray et al

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Course Outcomes :

After completing this course, student is expected to learn the following:

CO1: Earn how the organic and inorganic ions transport across the cell membrane and how electrical signals are carried to target cells. **U**nderstand the role of cytoskeleton and it's remodeling.

CO2: Learn different areas of cell biology including structure, energy transaction and function of cell organelles.

CO3: Understand the cell Signaling pathways, Programmed cell death and Cancer.

CO4: Able to explain the cell cycle and its regulation.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	1	1	3	-	-	-	3	3	3	3	2	1	2	2	-
CO2	3	3	1	1	3	-	-	-	3	3	3	3	2	1	2	2	-
CO3	3	3	1	1	3	-	-	1	3	3	3	3	2	1	2	2	-
CO4	3	3	3	1	3	-	-	1	3	3	3	3	2	1	2	2	-

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

M. Sc. Biotechnology I semester

Core Course : BT- C102, Title: Biomolecules and Basic Enzymology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties, biological roles and functions and inter relations. Emphasis will be on the association between structure and function of various biomolecules at a chemical level with a biological perspective.

TOPIC	Teaching Hrs.
Unit I	
1. Biomolecules – Chemical composition and bonding, three dimensional structure, configuration and confirmation. 2. Chemical reactivity – five general types of chemical transformation of : oxidation reduction reactions, nucleophilic substitution, electron transfer with in molecules producting internal rearrangement, group transfer reaction, condensation reaction 3. Water – weak interactions in aqueous system, ionization of water, weak acid and weak base, concept of pH & pKa, Buffers (bicarbonate buffering system). 4. Principles of Bioenergentics – Entropy, enthalpy and free energy.	**15**
Unit II	
1. Carbohydrates: Classification, Structure, chemical feature and function. - Structure, properties and functions of homo and hetero polysachharides. - Blood groups and bacterial polysaccharides, Glycoprotein, Cardioglycosides 2. Lipids – Classification, Structure, chemical feature and function - Structure and properties of fatty acids, acyl glycerols, phosphor lipids, sphingolipids, glycolipids. - Structure and function of steroids, prostaglandins, thromboxanes and leucotrienes.	**15**
Unit III	
1. Amino acids, peptides and proteins - Classification, Reaction & physical properties. Elucidation of primary structure of proteins, secondary structure - α-helix, β-helix, triple helical structure. Ramachandran plot 2. Structure of insulin, ribonuclease, myoglobin, chymotrypsin. Quaternery structure – Hemoglobin , Protein denaturation, Protein Folding, Role of Heat Shock Proteins. 3. Nucleotides and nucleic acids: structure of nitrogenous bases, nucleosides, nucleotides	**15**
Unit IV	
1. Enzymes – Classification and factors affecting enzyme activity 2. Allosteric Enzymes and their regulation 3. Enzyme kinetics – Equilibrium and steady state theory (Michalis Menten equation) and determination of kinetic parameters. 4. Enzyme inhibition – reversible and irreversible inhibition, competitive, non-competitive and un-competitive inhibition	**15**

Suggested reading

1. Principles of Biochemistry by Nelson, Cox and Lehninger.
2. Biochemical Calculations, Irwin H. Segel, john Wiley and sons Inc
3. Biochemistry,DVoet and jGVoet , J Wiley and Sons
4. Laboratory Techniques in Biochemistry and molecular Biology, Work and Work
5. Principles of Biochemistry by A.L.Lehninger, 2 Ed. (worth).
6. Biochemistry by L.Stryer 5 Ed. (Freeman-Toppan).
7. Harper's Biochemistry (Langeman).
8. Enzymes by Palmer (East).

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Course Outcomes :

After completing this course, student is expected to learn the following:

CO1: Remember the chemical basis of life, properties of biomolecules in water, importance of pH and biomolecular hierarchy. Able to analyse and apply the knowledge related to bioenergetics in living system.

CO2: Understand the classification, structure and biological importance of carbohydrates and lipids. Get an insight into the biochemical methods for the estimation of carbohydrates and lipids both quantitatively and qualitatively.

CO3: Able to analyse the classification, structure and function of proteins and nucleotides.

CO4: Learn the concepts of enzyme, its kinetics, regulation, specificity and other physiological reactions inside the cell.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	2	3	1	-	3	-	2	-	3	3	3	3	1	3	3	3	-
CO2	2	3	1	-	3	-	2	-	3	3	3	3	1	3	3	3	-
CO3	2	3	1	1	3	-	2	-	3	3	3	3	1	3	3	3	-
CO4	2	3	1	-	3	-	2	-	3	3	3	3	1	3	3	3	-

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability

M. Sc. Biotechnology I semester

Core Course : BT- C103: Microbial Physiology and Metabolism

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives : The objective of the course is to make the students to understand the basic concepts of the microbial growth, nutrition habit of microorganisms and various type of media. To learn the microbiological techniques used for the classification, isolation, purification of microorganisms and microbial metabolism.

Topics	Teaching Hrs.
Unit I	
1. Development of Microbiology in twentieth century 2. General characteristics of prokaryotes, cynobacteria, Viruses, Viriods and Prions. 3. Methods of Pure culture techniques, Theory and practice of sterilization, Construction of culture media, enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. 4. Microbial Systematic and Taxonomy New approaches of bacterial taxonomy, classification including ribotyping, ribosomal RNA sequencing.	**15**
Unit II	
1. Overview of Microbial nutrition. 2. Metabolic diversity among Microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, Carotenoids and phycobilins. - Chemolithotrophy: Hydrogen-ion-nitrate-oxidizing bacteria; nitrate and sulfate reduction. - Methanogenesis and acetogenesis: fermentation's-diversity. Homo and Heterolactic Fermentation. - Role of anoxic decompositions: nitrogen metabolism, nitrogen fixation; hydrocarbon transformation. 3. Microbial Growth The definition of growth; mathematical expression of growth; growth curve; measurement of growth and yields; Synchronous growth; Growth as affected by environmental factors likes temperature; acidity; alkalinity water availability and oxygen	**15**
Unit III	
1. Carbohydrate Catabolism: Glycolysis, Citiric acid cycle, Pentose phosphate pathway, Embeden Mayerhoff pathway. 2. Lipid Catabolism –Oxidation of fatty acids. 3. Amino acid oxidation and production of Urea. 4. Oxidative and Photophosphorylation, ATP Production	**15**
Unit IV	
1. Carbohydrate Anabolism – Gluconeogensis, glyoxalate pathway and regulation. 2. Lipid Biosynthesis 3. Biosynthesis of Amino acids – tryptophan, alanine, cysteine, histidine, glutamate 4. Biosynthesis of nucleotides and poly amines	**15**

Suggested reading

1. Microbiology, Pelczar, M.J., Chan E.C.S. and Kreig, N.R., Tata McGraw Hill.
2. Microbiology by Tortora, Funk & Case.
3. Microbiology by Prescott.

Course Outcomes :

After completing this course, student is expected to learn the following:

CO1: Explore the fascinating world of microorganism and their role (both beneficial and harmful) in day to day life. It imparts knowledge on the various phases and contribution of different Scientists how Microbiology established itself as a separate branch of Science. Theoretical knowledge of microbial diversity & systematics, Experimental knowledge of Sterilization, disinfection, safety in microbiological laboratory. Preparation of media, Isolation and maintenance of organisms by plating, Streaking and Serial dilution methods, Gram Staining and enumeration of microorganisms. Demonstrate the practical skills in basic microbiological techniques.

CO2 : Able to analyse the growth pattern and nutrition type of microbes. Get an insight on the existence of microbes in different spheres of the environment and how the microbes are affected/induced in these environments or vice versa.

CO3: Knowledge and understand the catabolic pathways, principles and metabolic regulation of biochemical processes. Advanced knowledge of synthesis and catabolism of major biomolecules.

CO4: Understand the anabolism and biosynthesis of lipids, amino acids and nucleic acids and their role in biological systems. Comprehensive knowledge to distinguish between different metabolic processes and their impact in metabolism of biomolecules.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	3	1	3	-	3	-	3	2	3	3	2	2	2	2	1
CO2	3	2	3	1	3	-	3	-	3	2	3	3	2	2	2	2	1
CO3	3	2	3	1	3	-	3	-	3	2	3	3	2	2	2	2	1
CO4	3	2	3	1	3	-	3	-	3	2	3	3	2	2	2	2	1

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

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Employability and Skill Development

M. Sc. Biotechnology I semester

Core Course : BT-C104: Biostatistics and Computer Application

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course objectives: This course enables students to learn basic concepts of biostatistics, sampling, distribution and presentation, hypothesis testing, design, correlation and regression analysis, statistical methods. To provide basic knowledge of computers.

Topics	Teaching Hrs.
Unit I	
1. Brief description, classification, tabulation of data and its graphical representation 2. Measures of central tendency and dispersion mean; median; mode range. Standard division, variance. 3. Simple linear regression and correlation. 4. Probability, Theorems of probability and probability distribution – Bionomial, Poission and Normal distribution	**15**
Unit II	
1. Test of significance; null hypothesis, alternative hypothesis, two types of errors, Level of significance 2. T test, Comparison of means of two samples (equal and unequal) 3. ANOVA : Comparison of means by three or more samples (a). Analysis of variance in one way classification (one factor analysis). (b). Analysis of variance in two way classification (two factor analysis). 4. Chi Square test: Goodness of Fit, Independence of attributes	**15**
Unit III	
1. Classification of Computers: Notebook, Personal computers, Workstation, Main frame system, Supercomputers 2. Introduction of digital computers organization, low level and high level language. 3. Number systems : Positional and non Positional 4. Binary, Octal and Hexadecimal number system. 5. Computer Codes: BCD code, EBCIDC, Zoned and Packed Decimal Number	**15**
Unit IV	
1. Flow chart and programing techniques 2. Introduction to Business data processing: Data storage Hierarchy, The standard methods of organizing data, file management system and data based management system 3. Introduction to MS-office software, covering Word processing. spreadsheets and presentation 4. Introduction to internet and its application.	**15**

Suggested reading

1. Wayne W. Daniel, Biostatistics: A foundation for Analysis in the Health Sciences, 8th Edition, Wiley.
2. Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.
3. John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press.
4. Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
5. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.
6. Computer Fundamental by Pradeep K Sinha and Priti Sinha third Edition BPB publication 2003

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: Able to analyze and apply the basics of biostatistics for easy interpretation and representation of data. Gain knowledge about Measures of Central tendency, Dispersion and Probability.

CO2: Theoretical and Practical knowledge of application of correlation and regression analysis, test of significance: F and t tests, Chi square test etc. To collect data relating to variables which will be examined and calculate descriptive statistics from these data.

CO3: Provide knowledge of basic principles and concepts of computers existing software to extract information and Basic idea of computer languages, number system and codes.

CO4: Familiarization with data processing, MS office, internet and its applications.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	1	3	-	-	-	3	-	-	3	3	2	-	1	2	1	1	-
CO2	1	3	-	-	-	3	-	-	3	3	2	-	1	2	1	1	-
CO3	1	3	-	-	-	3	-	-	3	3	2	-	1	2	1	1	-
CO4	1	3	-	-	-	3	-	-	3	3	2	-	1	2	1	1	-

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Skill Development

M. Sc. Biotechnology I semester

Core Course : BT-C105: Practical

[Total Credits : 04; Total Marks= 100; End Semester Exam= 100]

Course objectives: This course enables the students to learn the Basic principles, Instrumentation and applications of tools and techniques used in biotechnology lab. The student will also learn the statistical principles to apply in an experiment designing.

Topics	Teaching Hrs.
1. To study the Basic principles, Instrumentation and applications of Hot Air Oven. 2. To study the Basic principles, Instrumentation and applications of Autoclave. 3. To study the Basic principles, Instrumentation and applications of Centrifuge. 4. To study the Basic principles, Instrumentation and applications of Laminar Air Flow. 5. To study the Basic principles, Instrumentation and applications of Water Bath. 6. To study different stages of meiosis in onion bud. 7. To study different stages of mitosis on onion root tip. 8. To perform vital staining of mitochondria of plant/animal cell. 9. To identify the presence of protein in different samples. 10. To identify the presence of cholesterol/lipid molecules. 11. To identify the presence of sucrose/carbohydrate molecules 12. To prepare the buffer at required pH (Sodium /potassium phosphate buffer). 13. To prepare nutrient broth and nutrient agar plates for bacterial growth. 14. To prepare serial dilution of soil samples for isolation microbes. 15. To isolate bacteria by using pour- plate method. 16. To isolate bacteria by using spreading method. 17. To isolate bacteria by using streaking method. 18. To prepare different reagents of Gram staining method. 19. To detect gram - positive and – negative bacteria by using Gram staining methods. 20. To prepare Potato Dextrose Agra (PDA) for fungal growth. 21. To stain fungi using Lacto phenol Cotton Blue. 22. To perform Acid Fast staining with given samples. 23. To study and perform of T-Test with given samples. 24. To study and perform of χ^2 -Test with given samples.	

Suggested reading

1. Biotechnology Department Practical Manual
2. Wilson Walker Practical Biochemistry
3. Laboratory Manual for Biotechnology by Ashish Verma et al, S chand Publication

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Course Outcomes : After completing this course, student is expected to learn the following:

CO1 : To develop practical skills on sterilization, pure culture techniques and identification biomolecules.

CO2 : To understand the working and handing of laboratory instruments.

CO3 : To gain knowledge for cultivation of microorganism.

CO4 : To develop skills for analysis of data/ population samples.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	1	2	3	3	-	3	2	3	1	3	1	-	1	1
CO2	3	3	3	1	2	3	-	-	3	2	3	1	3	1	-	1	1
CO3	3	3	3	1	2	3	3	-	3	2	3	1	3	1	-	1	1
CO4	3	3	3	1	2	3	-	-	3	2	3	1	3	1	-	1	1

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability

M. Sc. Biotechnology II semester

Core Course : BT-C201: Molecular Biology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objective: The objective of the course is to understand the principles and techniques of molecular biology

The students will learn the concept of gene, modulation of gene its regulation, modes of transmission including advanced knowledge in a specialized field of molecular biology\

TOPIC	TEACHING HOURS
Unit I 1. Introduction of molecular biology and genetics. 2. Genome organization – genome, c-value, c-value paradox, genome complexity, 3. DNA Replication Prokaryotic and eukaryotic DNA replication, mechanism of DNA replication, enzymes and accessory proteins involved in DNA replication.	**15**
Unit II 1. Transcription Prokaryotic transcription and eukaryotic transcription, RNA polymerase, General and specific transcription factors, regulatory element and mechanisms of transcription regulation. 2. Transcriptional and post transcriptional gene silencing. 3. Modification of RNA 5'-cap formation, transcription termination, 3' end processing and polyadenylation, splicing, Editing, Nuclear export of mRNA, mRNA stability.	**15**
Unit III 1. Translation Prokaryotic and eukaryotic translation, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation. **2.** Co- and Post- translational modifications of proteins.	**15**
Unit IV 1. Protein localization and transport Synthesis of secretary and membrane, import into nucleus. Mitochondria E. R., Golgi complex, chloroplast, and peroxisomes, Receptor mediated endocytosis. 2. Antisense and ribozyme technology Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation. Disruption of RNA structure and capping biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozyme, application of antisense and ribozyme technologies.	**15**

Suggested Books:

1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
5. Benjamin Lewin, Gene X, Edition, Jones and Barlett Publishers, 2007.
6. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.
7. Recombinant DNA technology by Watson et. al., (Scientific American Books).
8. Principles of Gene Manipulation by Old and Primrose.(Blackwell).
9. Molecular Biotechnology by Glick.

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: Advanced understanding of fundamental concepts of molecular biology and genetics. Improved understanding of molecular basis of genome organization and function. Develop deep understanding of mechanism of DNA replication.

CO2: Understand mechanism of transcription in prokaryotes and eukaryotes. Enhance fine molecular understanding of operon gene regulation ion in prokaryotes. Develop understanding of the molecular basis of gene silencing and RNA processing.

CO3: Knowledge of mechanism of translation and Co- & post- translation modification in prokaryotic and eukaryotic system. To get an insight in to the wide range of mechanisms required for gene regulation in different organisms.

CO4: Ability to understand the protein localization in various organelles and learn the molecular mechanism of antisense and ribozyme technology.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	3	2	1	-	2	3	3	3	3	3	3	2	-
CO2	3	3	3	3	3	2	1	-	2	3	3	3	3	3	3	2	-
CO3	3	3	3	3	3	2	1	-	2	3	3	3	3	3	3	2	-
CO4	3	3	3	3	3	2	1	-	2	3	3	3	3	3	3	2	-

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability and Skill Development

M. Sc. Biotechnology II semester

Core Course : BT-C202 : Instrumentation and Techniques in Biotechnology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: To introduce the learner to the basic concept of qualitative and quantitative analysis of various biological samples. Students would be taught about the biophysical and biochemical techniques currently available to investigate the structure and function of the biological macromolecules. Learner would be made aware about the various separation techniques and its instrumentation, principles behind each technique, make them familiar with various methods of analysing the output data and to build a strong foundation in the area of Biotechnology.

Topics	Teaching Hrs.
Unit I	
1. Photometry – Basic principles, Instrumentation and applications of UV-Visible spectrophotometry 2. Infrared (IR) spectroscopy and its applications 3. Fluorescence spectroscopy – principle, instrumentation and applications. 4. Mass spectroscopy – Mass analyzers, principle, instrumentation and applications.	**15**
Unit II	
1. Raman spectroscopy and its applications 2. Electron spin resonance (ESR) spectroscopy and applications 3. Nuclear magnetic resonance (NMR) Spectroscopy – principle, instrumentation and applications 4. Circular Dichroism (CD) spectroscopy – principle, instrumentation and applications 5. X-ray Crystallography – principle, instrumentation and applications	**15**
Unit III	
1. Centrifugation – basic principle, types and applications 2. Chromatography: Principle, types and applications of Paper, Thin layer, High performance liquid chromatography; Column Chromatography – Gel filtration, Ion exchange chromatography, affinity chromatography, adsorption chromatography. 3. Electrophoresis: Principle, types and applications; Agarose gel, PAGE, SDS-PAGE, Iso-electric focusing, Two Dimensional gel electrophoresis, Immuno-electrophoresis, Capillary electrophoresis, Pulse Field gel electrophoresis. 4. Autoradiography – Principle and applications, radioisotopes used in biology and their application.	**15**
Unit IV	
1. Microscopy – Basic principle and components of microscope, phase contrast and fluorescent and Confocal microscopes 2. Electron microscopy – principle and applications 3. Sequencing techniques for proteins and nucleic acids 4. Detection of molecules using flow cytometry and *in-situ* localization by hybridization techniques such as FISH and GISH	**15**

Suggested reading

1. Biochemical Techniques : Theory and Practice by Robyt and White
2. Principles of Instrumental Analysis by Skoog and West
3. Analytical Biochemistry by Holme and Peck
4. Biological Spectroscopy by Campbell and Dwek
5. Organic Spectroscopy by Kemp
6. A Biologist's Guide to Pronciples and Techniques of Practical Biochemistry by Wilson and Goulding

7. Principles of Instrumental Analysis by Skoog, Hollar and Nicman
8. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by Freifelder
9. Hawk's physiological chemistry Ed. by Oser (McGraw Hill).
10.Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
11. An introduction to practical biochemistry by D.T.Plummer (McGraw Hill).
12. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
13. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).
14. Manual of clinical laboratory immunology by Rose NR.
15. The experimental foundations of modern immunology by Clark W.R.
16 Practical Biochemistry, by Wilson Walker

Course Outcomes : **After completing this course, student is expected to learn the following:**

CO1: Understand and interpret the basic principles, Instrumentation and applications of UV-Visible spectrophotometry, Infrared (IR) spectroscopy, Fluorescence spectroscopy, Mass spectroscopy.

CO2: Gain knowledge of principle, instrumentation and applications Raman spectroscopy, Electron spin resonance (ESR) spectroscopy, Nuclear magnetic resonance (NMR) Spectroscopy, Circular-Dichroism (CD) spectroscopy, X-ray Crystallography.

CO3: Understand and Interpret the Basic Principle, Types and Applications of Centrifugation, Chromatography, Electrophoresis, Autoradiography. It also helps students to develop the idea of separation of plant pigments and amino acids using chromatographic methods and determine the tissue (or cell) localization of a radioactive substance.

CO4: Remember the basic principle and components of Microscopy, process of sequencing techniques for proteins and nucleic acids, interpret and analyzed the molecules using flow cytometry and *in-situ* localization by hybridization techniques such as FISH & GISH

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	-	3	-	-	2	3	3	-	3	2	3	2	2
CO2	3	3	3	3	-	3	-	-	2	3	3	-	3	2	3	2	2
CO3	3	3	3	3	-	3	-	-	2	3	3	-	3	2	3	2	2
CO4	3	3	3	3	-	3	-	-	2	3	3	-	3	2	3	2	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability

M. Sc. Biotechnology II semester

Core Course : BT-C203:Biology of Immune System

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: The objective of this course is to provide a detailed overview of immune system to the learners. The learner will understand structure, organization and functions of various components of the immune system like antigen, antibody, organs, MHC, cytokines and others in the defence system of the body. It would also make them understand the concepts of innate and adaptive immunity, immune diversity and specificity, autoimmunity, hypersensitivity, transplantation and others.

Topics	Teaching Hrs.
Unit I	
1. Immune response: innate and adaptive immune system, cells and molecules of immune system, Cells of the Immune system : Hematopoiesis and differentiation , Lymphocyte trafficking , B-lymphocyte , Macrophage Dendritic cells , Natural killer and Lymphokine activated killer cells, Eosinophils , Neutrophils and Mast cells . 2. Clonal selection theory. 3. Organization and structure of lymphoid organ. 4. Nature and biology of antigens and super antigens. 5. Antibodies structure and function.	**15**
Unit II	
1. Antigens antibody interactions. 2. Major histocompatibility complex. 3. BCR & TCR, generation of diversity. 4. Regulation of immune response: - Antigen processing and presentation , generation of humoral and cell mediated immune response . - Activation of B & T –lymphocytes. - Cytokines and their role in immune regulation. - T-cell regulation, MHC restriction. - Immunological tolerance.	**15**
Unit III	
1. Complement system. 2. Cell mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity. 3. Hypersensitivity. 4. Autoimmunity	**15**
Unit IV	
1. Transplantation 2. Immunity of infectious agents (intercellular, parasites helminthes & viruses) 3. Tumor Immunology. 4. AIDS and other Immunodeficiency. 5. Hybridoma Technology and monoclonal antibodies. 6. Catalytic antibodies	**15**

Suggested reading

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5. Goding, Monoclonal antibodies, Academic Press. 1985.
6. Essentials of Immunology by Roit (ELBS).
7. Immunology by Roit et.al (Harper Row).
8. Text book of Immunology by S.T,Barrot (Mosby).
9. Principles of Microbiology and Immunology by Davis et.al., (Harper).

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: Familiarize with the concept of non-specific (innate) and specific (acquired) resistance mechanism developed in human beings against pathogens and other non-self factors which is the basis of this course.

CO2. Get an insight into the formation, types, organization and functional specificity of different cellular and organ level components conferring resistance in human being. To understand the nature, types and function of antigens that induce immunological response in man and how the product of this response (antibody, B and T cells) help in neutralizing them (agglutination and precipitation reactions). To have the concept of different mediators/cell signaling molecules (cytokines: interferons, Interleukins and chemokines) associated with immunological responses as well as their biological consequences. Understanding the role of antibody/antigen in disease diagnosis. To deal with the different diagnostic and serological approaches for the study of interaction between an antigen and its specific antibody including Widal Test, immunodiffusion, Immuno-electrophoresis, ELISA and RIA.

CO3. Understand the concepts of Complement system; Cell mediated cytotoxicity, Hypersensitivity, and Autoimmune disorders.

CO4. Analyse the immune system in organ transplantation oncogenesis and immune deficiency and induced immunity to overcome such abnormalities.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	2	2	3	-	2	-	3	2	3	3	2	2	3	1	2
CO2	3	2	2	2	3	-	2	1	3	2	3	3	3	2	3	1	2
CO3	3	2	2	2	3	-	2	-	3	2	3	3	2	2	3	1	2
CO4	3	2	2	2	3	-	2	1	3	2	3	3	2	2	3	1	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

M. Sc. Biotechnology II semester

Core Course : BT-C204 : Genetics

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: The objective of this course is to provide a detailed overview of DNA Damage and DNA repair. The student will able to learn the methods of gene mapping, molecular markers for genome analysis as well as new generation recombinant DNA vaccines

TOPIC	Teaching Hrs.
UNIT –I	
1. Gene as unit of mutation and recombination. 2. Molecular nature of mutations; mutagens. 3. Type of DNA damage (deamination, oxidative damage, alkylation, pyridine dimmers). 4. Ame's test for mutagenesis 5. DNA repair- photorepair, excision or dark repair, recombinational repair, SOS repair.	**15**
UNIT-II	
1. Methods of genetic analysis and genetic mapping, Pedigree analysis, lod score for linkage testing. 2. Recombination - Homologus recombination - Holiday junction, site specific recombination - FLP/FRT and Cre lox recombination, Rec A and other recombinases 3. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. 4. Molecular markers in genome analysis, RFLP, RAPD, AFLP, STS, SCAR (Sequence characterized amplified regions), microsatellite, SSCP, QTL.	**15**
UNIT- III	
1. Bacterial genetic system: transformation, conjugation and transduction. Bacterial genetics map with reference to *E.coli*. 2. Complementation analysis, cir-trans test, deletion mapping, Benzer's concept of cistron, concept of overlapping genes.	**15**
UNIT- IV	
1. Southern, Northern and florescence in situ hybridization for genome analysis 2. Chromosome micro-dissection and micro-cloning. 3. Important application of advances in microbial genetics. Production of proteins. 4. Conventional as well as new generation recombinant DNA vaccines, design and advantages	**15**

Suggested Reading

1. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.
2. Principles of Genetics by Sinnet et.al,., (McGraw Hill).
3. Principles of Heridity by Robert Tumarin.
4. Genetics by M.W.Strick Berger (Mac Millan).
5. Cell and Molecular Biology by E, D. P. De Roberties (International edition).
6. Microbial Genetics, Malloy, S.R., Cronan, J.E. Jr and Freifelder, D.Jones, Bartlett Publishers

Course Outcomes : After completing this course, student is expected to learn the following:

CO1 : Understand the gene mutation, recombination, DNA damage and repair mechanism and their role in livings cells. Learn the identification of various chemical and physical mutagens.

CO2: Learn the concepts of Linkage, Sex Determination, Autosomal and Sex Linked inheritance by Pedigree analysis, Quantitative genetics and Physical and genetic mapping.

CO3: Learn the concepts of bacterial genetics, recombination, complementation analysis and apply it.

CO4: Apply the genetic technique to analyse the diseases and generation of recombinant DNA vaccines by genetic engineering and diverse application in industrial set up.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	1	2	2	-	2	-	1	1	3	3	3	3	3	1	1	2	2
CO2	1	2	2	-	2	-	1	1	3	3	3	3	3	1	2	2	2
CO3	1	2	2	-	2	-	1	1	3	3	3	3	3	1	1	2	2
CO4	1	2	2	2	2	-	1	1	3	3	3	3	3	3	3	2	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Skill Development

M. Sc. Biotechnology II semester

Core Course : BT-C205: Practical

[Total Credits : 04; Total Marks= 100; End Semester Exam= 100]

Course objectives: This course enables the students to learn basic practical knowledge of biotechnology lab and principles associated with experimentation.

Topics	Teaching Hrs.
1. To isolate DNA from plant /animal cell/bacterial samples. 2. To isolate RNA from plant /animal/bacterial samples. 3. To prepare 50X TAE buffer for gel electrophoresis. 4. To determine the purity of DNA by using agarose gel electrophoresis. 5. To determine the concentration of DNA and RNA by using UV spectrophotometer. 6. To separate the mixture of amino acid by paper chromatography. 7. To separate the component of mixture of amino acid by thin-layer chromatography (TLC). 8. To study the structure and function of HPLC. 9. To separate proteins by Polyacrlyamide gel electrophoresis (PAGE). 10. To separate subunits of protein by sodium dodecyl sulphate polyacrlyamide gel electrophoresis (SDS-PAGE). 11. To perform FISH for detection the expression of gene. 12. To perform ABO blood group typing by using Haemaggulation Method. 13. To perform cell counting by haemocytometer. 14. To determine blood sugar level in blood sample. 15. To detect the Ag-Abs interaction by double immune diffusion method. 16. To prepare single cell suspension cell culture from spleen. 17. To isolate peripheral blood mononuclear cells from blood sample. 18. To perform Ames test for detection of mutagenic potency of compound. 19. To perform restriction fragment length polymorphism (RFLP). 20. To performed Southern blot for the identification of copy numbers of gene. 21. To detect genetic disorder related to Sex-linked by using pedigree analysis in a given problem.	

Suggested reading

1. Biotechnology Department Practical Manual
2. Wilson Walker Practical Biochemistry
3. Laboratory Manual for Biotechnology by Ashish Verma et al, S chand Publication

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: To impart hands-on training in DNA, RNA, protein isolation and estimation methods.

CO2: To impart practical knowledge on understand pattern of Sex- linked disorders in human population**.**

CO3: Understand the procedure of separating compounds by using chromatography

CO4: To develop skills for identification genes and potency of mutagenic chemicals.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	1	3	-	-	2	1	3	2	3	3	2	2	2
CO2	3	3	3	3	1	3	-	-	2	1	3	2	3	3	2	2	2
CO3	3	3	3	1	1	3	-	-	2	1	3	2	3	3	2	2	2
CO4	3	3	3	3	1	3	1	1	2	1	3	2	3	3	2	2	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability and Skill Development

M. Sc. Biotechnology III semester,

Core Course : BT-C301: Animal Cell Science and Technology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: The objective of this course is to provide a Theoretical knowledge of various topics as per the syllabus including basic cell culture techniques; Primary culture, secondary culture; Transfection, pleuripotency, stem cells etc application of animal biotechnology in tissue engineering and vaccines.

Topics	Teaching Hrs.
Unit I	
1. Structure and organization of animal cell. 2. Equipment and materials for animal cell culture technology. 3. Primary and established cell line culture. 4. Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon-dioxide; Role of serum and supplements. 5. Serum and protein free defined media and their application.	**15**
Unit II	
1. Measurement of viability and cytotoxicity. 2. Biology and characterization of culture cells. Measuring parameters of growth 3. Basic techniques of mammalian cell culture in vitro; disaggregation of tissue andprimaryculture; cell separation. 4. Scaling-up of animal cell culture.	**15**
Unit III	
1. Cell synchronization. 2. Cell cloning and micromanipulation. 3. Cell transformation. 4. Application of animal cell culture. 5. Stem cell culture, embryonic stem cells and their applications. 6. Cell culture based vaccines.	**15**
Unit IV	
1. Somatic cell genetics. 2. Organ and histotypic culture. 3. Measurement of cell death. 4. Three dimensional culture and tissue engineering. 5. Animal Cloning – methodology, its application and limitations.	**15**

Suggested Reading

1. Animal cell culture – A practical approach Ed. By John R.W. Masters (IRL Press).
2. Animal cell culture techniques, Ed. Martin clyenes (Springer).
3. Comprehensive Biotechnology. Vol. 4. M. Moo-Young (Ed-in-chief), Pergamon Press, Oxford.
4. Elements of Biotechnology by PK Gupta (Rastogi& Co).
5. Biotechnology by Kashav. T (Wiley Eastern Ltd).
6.Concepts in Biotechnology by Balasubrahmanianet. al.,(University press).
7.Principles and practices of aquaculture by TVR Pillay.
8.Coastal aquaculture by Santhanam.
9.Animal cell culture by Ian Freshney.
10.Molecular Biotechnology by Glick.

Course Outcomes : After completing this course, student is expected to learn the following:

CO1. Familiarize with the reagents, equipments, cell culture media, cell line culture and other relevant material to animal cell culture technology.

CO2. Apply the knowledge of viability and cytotoxicity of the cultured cells and scaling up.

CO3. Explore the biomedical research involving tissue engineering that aims to grow and replace tissue in-vitro using stem cell technology. Learn vectorless and vector mediated gene transfer methods for animal cell cloning, cell synchronization and transformation. Study of various approaches related to vaccine production, disease diagnostic assays and many other assays involved in animal health management.

CO4. Able to measure the cell death, organ and histotypic culture and animal cloning by using genetic engineering techniques to improve animals for human welfare.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	2	2	2	2	3	-	-	2	2	-	-	-	3	1	-
CO2	3	2	2	2	2	2	3	1	-	2	2	3	2	2	3	1	2
CO3	3	2	2	2	2	2	3	2	-	2	2	3	2	2	3	1	2
CO4	3	2	2	3	3	3	3	3	3	2	2	3	2	3	3	1	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability and Skill Development

M. Sc. Biotechnology III semester,

Core Course : BT-C302 :Genetic Engineering

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: The student will understand various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries which is reflected in the contents of this course. The student will able to demonstrate the innovative utilization of manipulating enzymes, various cloning and expression vectors. Student will able to interpret the applications of genetic engineering in biotechnological research and strategic uses of recombinant DNA techniques, PCR techniques, methods for protein-DNA interactions, gene silencing and genome editing technologies.

Topics	Teaching Hrs.
Unit I	
1. Scope of Genetic Engineering. 2. Isolation of enzymes, in-vitro synthesis of DNA and patenting of life forms. 3. Restriction enzymes and modification enzymes. 4. Nucleic acid Purification and Yield Analysis. 5. Nucleic Acid Amplification, PCR and Its application	**15**
Unit II	
1. Gene cloning Vectors Plasmids, bacteriophage, phagemides, cosmids, Artificial Chromosomes. 2. Restriction mapping of DNA fragments and Map construction. 3. cDNA Synthesis - mRNA enrichment, reverse transcription, DNA primers, linkers, Adapters and their chemical synthesis, Library construction and screening. 4. Alternative strategies of Gene Cloning. Cloning interacting genes- Two and three hybrid systems. 5. Nucleic acid microarrays.	**15**
Unit III	
1. Site directed Mutagenesis and Protein Engineering. 2. How to study the Gene Regulation? DNA transfection, Northern blot, Primer extension, SI mapping, Rnase protection assay. 3. Expression Strategies for heterologous genes Expression in bacteria, expression in Yeast, expression in insects and insect cells, expression in mammalian cells. 4. Processing of Recombinant proteins. Purification and stabilization of proteins.	**15**
Unit IV	
1. Phase Display. 2. T-DNA and Transposon Tagging 3. Transgenic and gene Knock out Technologies Targeted gene replacement, chromosome engineering. 4. Gene Therapy. Vector engineering, Strategies of delivery, gene replacement/ augmentation, gene correction, gene editing, regulation and silencing.	**15**

Suggested Reading

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.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
6. Genetic Engineering by Sandhya Mitra
7. Gene Technology by SN Jogdand.

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: Recite key aspects of various enzymes in gene manipulation techniques to explore recombinant DNA techniques and in-vitro synthesis of DNA. The student learns to purify and amplify the nucleic acids by high throughput techniques used in genomics and transcriptomics. Capable to recognize importance of protection of new knowledge and innovations and its role in business.

CO2: Construct plasmid vectors and illustrate them to comprehend more about its structure and functions. The students recall the principles of genetic engineering and the vectors used in cloning, methods of introduction of gene and expression. The students appreciate the different cloning strategies and their expression. Construction and screening of genomic and c DNA libraries. Get an insight into the concept of different vectors (plasmids, cosmids, phagemids, and artificial chromosome vectors) that act as carrier of DNA fragment between cellular organisms during genetic modification.

CO3: Demonstrate the ability of designing recombinant molecules and conducting experiments involving genetic manipulation and purification. Assess methods of transformation and analyses cloned genes for their markers

Understand the different expression strategies for heterologous genes and their processing.

CO4: Employ various gene editing, engineering, tagging and replacement techniques for gene therapy using different vectors and recombinant products.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability, Entrepreneurship and Skill Development

M. Sc. Biotechnology III semester

Core Course : BT-C303: Bioprocess Engineering and Technology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: The student will learn the concepts of screening, optimization and maintenance of cultures and to introduce the students to the various concepts of microbial growth kinetics, fermentation and bioprocess engineering. Course will enable the students to learn basics principles of fermentation techniques, design of fermentors and techniques involved in Upstream and downstream bioprocessing.

Topics	Teaching Hrs.
Unit I	
1. Introduction to bioprocess Engineering. 2. Bioreactor and fermentor 3. Isolation, Preservation and Maintenance of Industrial Microorganism. 4. Kinetic of Microbial Growth and death.	**15**
Unit II	
1. Media for industrial fermentation. 2. Air and media sterilization. 3. Type of fermentation process; Analysis of batch, fed batch and continuous bioreactors, stability of microbial reactors, specialized bioreactors (pulsed fluidized photo bioreactors etc).	**15**
Unit III	
1. Measurement and control of bioprocess parameters. 2. Downstream Processing: Introduction, Removal of microbial cell and solid matter, foam precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane process Drying and crystallization effluent treatment; D.O.C. and C.O.D. treatment and disposal of effluents. 3. Whole cell immobilization and their industrial applications	**15**
Unit IV	
1. Industrial production of chemical; Alcohol (ethanol), Acids (citric acetic,gluconic) solvents (glycerol, acetone), Antibiotics (penicillin, tetracycline) Amino acids (lysine, glutamic acid) ,Single cell protein. 2. Use of microbes in mineral beneficiation and oil recovery. 3. Introduction to food technology: -Elementary idea of canning and packing. -Sterilization and pasteurization of food products. -Food preservation.	**15**

Suggested Reading

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
4. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
5. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
6. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.

7. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd,UK, 2007.

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: Understand the structure, operation and functions of various bioreactors and fermentors apply the knowledge of isolation and preservation, maintainance of microorganism in industry.

CO2: Able to prepare media and sterilization. Able to apply the kinetics in fermentation process.

CO3: Learn the basic techniques related to downstream processing.

CO4: Critical analysis of the role of microorganisms for the production and preservation of biotechnological products in different industries.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	-	2	3	2	-	2	2	3	2	3	3	1	1	-
CO2	3	3	3	-	2	3	2	2	2	2	3	2	3	3	2	1	3
CO3	3	3	3	-	2	3	2	2	2	2	3	3	3	3	2	1	3
CO4	3	3	3	-	2	3	2	2	2	2	3	3	3	3	2	1	3

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability and Entrepreneurship

M. Sc. Biotechnology III semester

Elective Course : BT-E304: Basic Bioinformatics

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: The major objective of this course is to provide knowledge of bioinformatics tools as well as use of bioinformatics in biological studies.

Topics	Teaching Hrs.
Unit I	
1. Introduction to Bioinformatics - an overview, introduction and scope of bioinformatics. 2. Use of bioinformatics in nucleic acid sequence database, brief knowledge of sequence alignment and its significance 3. Introduction of Biological databases – Primary sequence database (Protein and DNA), Secondary database, composite database. 4. Applications of bioinformatics - Clinical informatics - Cheminformatic resources and pharmacoinformatics	**15**
Unit II	
1. Searching database and locating genes, Alignment of gene sequences, Local and Global. - Nucleic acid sequence databases: GenBank, EMBL - Protein sequence databases: SWISS-PROT, TrEMBL, PIR - Genome Databases at NCBI, EBI - Derived Databases: basic concept of derived databases, PROSITE, Pfam, - Repositories for high throughput genomic sequences: EST, STS 2. Gene structure prediction: CENSOR, RepeatMasker; detection of functional sites in DNA sequences-PromoterScan and GenScan. 3. Biodiversity and ecosystem based databases	**15**
Unit III	
1. Analysis of DNA sequence: Sequence Similarity, Homology and Alignment; BLAST, FASTA, Multiple sequence alignment (ClustalW, Psi BLAST). Statistical significance of alignments score, motifs and pattern analysis. 2. Designing primers of specific gene. 3. Generation of restriction maps, Generating Phylogenetic trees based on DNA sequence and evolutionary relationship. Phylogenetic trees (PHYLIP) 4. Phylogenetic Inference Package, Sites and Centres	**15**
Unit IV	
1. Protein sequence, structures and interacting proteins databases 2. Predicting ORFs, location of transcription start point and end point, getting polypeptide sequence from a nucleotide sequence. 3. Analysis of proteins: Protein classification, homology modeling, 4. Protein Structure Visualization: tools for structure prediction, validation and visualization;Pymol, Protein Data Bank (PDB) and PDB format.	**15**

Suggested Reading

1. N. C. Jones, P. A. Pevzner, An Introduction to Bioinformatics Algorithms, MPI Press 2004.
2. D. W. Mont, Bioinformatics: Sequence and Genome Analysis, CSHL Press.
3. D. Gusfield, Algorithms on Strings, Trees, and Sequences: Computer Science and ComputationalBiology, Cambridge University Press, 1997.
4. Barnes & Gray: Bioinformatics for geneticists (2003, Wiley)
5. Lesk: Bioinformatics (2nd ed 2006, Oxford)
6. Westhead et al: Bioinformatics Instant Notes (Indian ed 2003, Viva Books)
7. Mount, Bioinformatics (2nd ed 2006, CBS)

8. Hunt and Livesey: Functional Genomics (2006, Oxford)
9. Campbel: Discovering Genomics, Proteomics and Bioinformatics (2006, LPE)
10. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).

Course Outcomes : **After completing this course, student is expected to learn the following:**

CO1: Understand the role of computer science in predicting structure and function of biomolecules. Ability to apply existing softwares and online tools effectively to extract information from large databases and to use this information in computer based modeling.

CO2: Know about variety of databases information available for alignment various aspects of macromolecules structure and function. Role of bioinformatics tools in gene analysis.

CO3: Understand the similarities and differences among living organisms on the basis of genetic information

CO 4 Interpret correctly the outputs from tools used to analyze biological data and make meaningful predictions from these outputs

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	3	3	1	-	2	2	3	2	2	3	2	1	3
CO2	3	3	3	3	3	3	1	-	2	2	3	2	2	3	2	1	3
CO3	3	3	3	3	3	3	1	-	2	2	3	2	2	3	2	1	3
CO4	3	3	3	3	3	3	-	-	2	2	3	2	2	3	2	1	3

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability

M. Sc. Biotechnology III semester

Elective Course : BT-E305: Basic Genomics and Proteomics

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives : This course enables students to learn basic of genomics, transcriptomics and microarray, applications of genomics, proteomics, types of proteomics, techniques in proteomics, applications of proteomics.

Topics	Teaching Hrs.
Unit I	
Genome 1. Brief overview of prokaryotic and eukaryotic genome organization; 2. Extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. 3. Human Genome Project	**15**
Unit II	
Genome Mapping : 1. Genetic and physical maps; 2. Markers for genetic mapping; 3. Methods and techniques used for gene mapping, physical mapping, 4. Linkage analysis, cytogenetic techniques, FISH technique in gene mapping, Somatic cell hybridization, in situ hybridization, comparative gene mapping. **Comparative Genomics** : 5. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; 6. Use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; 7. Determining gene location in genome sequence	**20**
Unit III	
1. **Proteome and Proteomics**: - Aims, strategies and challenges in proteomics; - Proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.	**10**
Unit IV	
Functional Genomics and Proteomics : 1. Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, 2. Gene function- forward and reverse genetics, gene ethics; 3. Protein-protein and protein-DNA interactions; 4. Protein chips and functional proteomics; 5. Clinical and biomedical applications of proteomics; 6. Introduction to metabolomics, lipidomics, metagenomics and systems biology.	**15**

Suggested Readings

1. Concepts and Techniques in Genomics and Proteomics by N Saraswathy, P Ramalingam Elsevier.
2. Genomics and Proteomics: Principles, Technologies, and Applications. byDevarajanThangadurai (Editor), JeyabalanSangeetha (Editor). Apple Academic Press; 1st edition (2015)
3. Principles of Gene Manipulation and Genomics by Sandy Primrose and Richard Twyman Blackwell Publishers Edition 7 (2006)

4. Recombinant DNA : Genes and Genomics : Short Course, By JD Watson, Publisher W.H. Edition 3 (2607)
5. Chapter 8 Basics of proteomics by Saurabh Bhatia In : Introduction to Pharmaceutical Biotechnology, Volume 2 Enzymes, proteins and bioinformatics IOP Publishing Ltd (2018)
6. S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Plenum Publication, 1999.
7. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1 st edition, Academic Press, San Diego, 1996.
8. Introduction to proteomics: Tools for new biology by Daniel C. Liebler, Humana Press.

Course Outcomes : **After completing this course, student is expected to learn the following:**

CO1 Understand the molecular characterization of human genome and human genome project.

CO2 Recognize and interpret the techniques involved in genomics and proteomics. Administer the principles to discover novel drug.

CO3 Learn the techniques involved in structural and functional proteomics

CO4 Apply protein- protein and protein-DNA interaction to make protein / DNA chips for clinical and medical diagnostics.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	-	1	-	-	2	-	3	2	2	3	1	1	-
CO2	3	3	3	3	-	1	-	-	2	-	3	2	2	3	1	1	2
CO3	3	3	3	3	-	1	-	-	2	-	3	2	2	3	1	1	2
CO4	3	3	3	3	-	1	-	1	2	-	3	2	2	3	1	1	1

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Skill Development

M. Sc. Biotechnology III semester

Core Course : BT-C306: Practical

[Total Credits : 04; Total Marks= 100; End Semester Exam= 100]

Course objectives: This course enables the students to learn basic practical knowledge of biotechnology lab and principles associated with experimentation.

Topics	Teaching Hrs.
1. To prepare balanced salt solution for animal cell culture. 2. To prepare tissue culture media for animal cell culture. 3. To perform cell viability assay for detection of viable cells. 4. To perform test for detection of cell death in sample. 5. To perform cell-cell fusion by using polyethylene glycol (PEG). 6. To screen transformed bacterial cells by using Blue- white selection method. 7. Digestion of λ DNA by restriction enzyme and their sample analysis using RFLP. 8. To synthesize C-DNA from different RNA samples for analysis of genes expression/amplification. 9. To design primers for testing genomic DNA contamination in C- DNA samples. 10. To design primers for site-directed mutagenesis (SDM) to change in codon sequence. 11. To amplify desire gene sequence by using polymerase chain reaction (PCR). 12. To perform DNA sequencing for amplify gene sequence/clone sequence. 13. To prepare competent cell for transformation a clone/construct. 14. To study bacterial growth kinetics, doubling time and different phases. 15. To prepare media for industrial/fermentation process and its sterilization. 16. To perform different method cell disruption – mechanical and chemical methods. 17. To sterilize laboratory fermentor and other instrument. 18. To perform ethanol production in laboratory at small scale. 19. To check DO, BOD, salt and ammonia in a given water sample. 20. To retrieve genomic and protein sequences from NCBI databases. 21. To compare different protein sequences for homology analysis by using Clustal W alignment. 22. To construct phylogenic tree by using different protein sequences for analysis of evolutionary study.	

Suggested reading

1. Biotechnology Department Practical Manual
2. Wilson Walker Practical Biochemistry
3. Laboratory Manual for Biotechnology by Ashish Verma et al, S chand Publication

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: To impart knowledge on handling and the culture of animal cell culture media and animal cell line.

CO2: To develop knowledge for analysis expression of a gene and to introduce mutation.

CO 3: To identify and analyze the environmental waste water sample

CO4: To learn the bioinformatics tools for solving the molecular biological problems

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	3	3	-	-	2	2	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	2	-	2	2	3	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	-	2	2	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	2	-	2	2	3	3	3	3	3	2	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability, Entrepreneurship and Skill Development

M. Sc. Biotechnology IV semester

Core Course : BT-C401:Plant Biotechnology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives : In this course students will learn the basic concepts and principles of in vitro propagation methods, cryopreservation, genetic transformation methods, genetic manipulation, marker assisted plant breeding and QTL mapping. To provide knowledge on genetic engineering in the improvement of plants for human welfare.

Topics	Teaching Hrs
Unit I	
1. Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids. 2. Tissue culture media (composition and preparation). 3. Initiation and maintenance of callus and suspension culture, single cell clones. 4. Organogenesis, somatic embryogenesis; transfer and establishment of whole plant in soil.	**15**
Unit II	
1. Shoot tip culture, rapid clonal propagation and production of virus free plants. 2. Embryo culture and embryo rescue. 3. Protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants; symmetric or asymmetric hybrids cybrids. 4. Anther, pollen and ovary culture for production of haploid plants and homozygous lines . 5. Cryopreservation, slow growth and DNA banking for germplasm conservation.	**15**
Unit III	
1. Plant Transformation technology – basis of tumor formation, hairy root, feature of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes. 2. Use of Ti and Ri as vectors - binary vectors and co integrate vector. 3. Genetic markers – reporter gene, selectable marker genes. 4. Transgenic stability – use of 30S promoter, reporter gene with introns, use of scaffold attachment regions. 5. Methods of nuclear transformation - viral vectors and their applications, vector less or direct DNA transfer. 6. Chloroplast transformation.	**15**
Unit IV	
1. Application of plant transformation for productivity and performance Herbicide resistance -phosphoinothricin, glyphosate, sulfonyl urea, atrazine. Insect resistance - bt genes Non bt like protease inhibitors. Alpha amylase inhibitor. Virus resistance - coat protein mediated, nucleocapsid gene. Disease resistance - chitinase, 1-3 beta glucanase, RIP, antifungal proteins thionins, PR proteins. Nematode resistance. Abiotic stress post-harvest losses - long a shelf life of fruits and flowers, uses of ACC synthase, polygalacturonase, ACCoxidase. Male-sterile lines - bar and barnase system. Carbohydrate composition and storage - ADP glucose pyrophosphorylase. 2. Plant secondary metabolites - control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloids, industrial enzymes, biodegradable plastic –polyhyroxybutyrate, Therapeutic proteins, lysosomal enzyme antibodies, edible vaccines, 3. Green House.	**15**

Suggested Reading

1. Introduction to Plant Biotechnology, H S Chawala 2009, 3rd Edition, Science Publishers
2. Agricultural Biotechnology, 1st edition, (2008) Rawat H, Oxford Book Co, India.
3. Agrobiotechnology and plant tissue culture, Bhojwani SS, Soh WY, Oxford & IBH Publ, India
4. Agricultural Biotechnology, (2005), Kumar HD, DayaPubl House, India
5.Plant tissue culture and molecular markers: Their role in improving crop productivity Ashwani Kumar, Shekhawat NS (2009) (IK International)
6. Plant Biotechnology by A. Slater, N.W. Scott and M.R. Fowler (Oxford University press).
7. Biotechnology in Agriculture by Swaminathan, M.S (Mc. Milllan India Ltd).
8. Biotechnology and its applications to Agriculture, by Copping LG and P.Rodgers (British Crop Projection).
9. Plant Biotechnology, by Kung, S.andC.J.Arntzen (Butterworths).
10. Biotechnology By U Satyanarayana.

Course Outcomes : **After completing this course, student is expected to learn the following:**

CO1: Establish different types of plant cultures.

CO2: Develop skill in raising transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement

CO3: Apply the practical skills for entrepreneurial development.

CO4: Design and implement experimental procedures using relevant techniques. Apply the concepts of Biotechnology in Environmental Management.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	1	1	1	3	3	3	-	2	2	3	3	3	3	3	1	2
CO2	3	1	2	3	3	3	3	-	2	2	3	3	3	3	3	1	2
CO3	3	3	3	2	3	3	3	-	2	2	3	3	3	3	3	1	2
CO4	3	3	3	3	3	3	3	-	2	2	3	3	3	3	3	1	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability and Entrepreneurship

M. Sc. Biotechnology IV semester

Core Course : BT-C402:Environmental Biotechnology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: This course will orient students to various aspects of environment and life forms that includes energy and environment, pollution and environment, waste management, bioremediation removing pollutants from environments, environment monitoring and informatics.

Topics	Teaching Hrs.
Unit I	
1. Environment: basic concepts and issues. 2. Environmental pollution: types of pollution, Methods for the measurement of pollution, Methodology of environment management the problem solving approach, its limitation. 3. Air pollution and its control through biotechnology.	**15**
Unit II	
1. Need for water managements, Measurement and water pollution, sources of water pollution, Waste water collection 2. Waste water treatment – physical and chemical processes. 3. Microbiology of Waste water Treatment, Aerobic Process: Activated sludge, Oxidation ditches, trickling, towers, rotation dises, rotating drums, oxidation ponds. 4. Anaerobic Processes: Anaerobic digestion, anaerobic filters, Upflow anaerobic blanket reactors.	**15**
Unit III	
1. Treatment schemes of wastewater of dairy, distillery, tannery, sugar, antibiotic industries. 2. Solid wastes: Sources and managements (composting, worm culture and methane production) 3. Microbiology of degradation of Xenobiotic in Environment- degradative plasmids; hydrocarbons. Substituted hydrocarbons, oil pollution and pesticides.	**15**
Unit IV	
1. Bioremediation of contaminated soil and wasteland. 2. Bio pesticides and integrated pest management. 3. Global Environment Problems: Ozone depletion, UV-B, greenhouse effect and acid rain, their impact and biotechnological approaches for management. 4. Environmental Monitoring – environmental impacts and their assessments using bio-indicators, biomarkers and biosensors.	**15**

Suggested Reading

1. Biotechnology by B.D.Singh (Kalyani).
2. Ecology and Environment by PD Sharma.
3. Fundamentals of Ecology, by Odum, EP (McGraw Hill)
4. Environmental Biotechnology by Forster, C.F. and Wase D.A.J. (Ellis Horwood).
5. Biotechnological innovations in environmental management by Leach, CK and Van DamMieras, MCE (Butterworth-Herinemann, Oxford (Biotol Series).
6. Molecular Biology and Biotechnology by Meyers, RA, A comprehensive Desk reference (VCH Publishers).
7. Biotechnology by U. Satyanarayana (Books & Allied (P) Ltd).
8. Environmental Biotechnology by JN Jogdand.
9. Principles and Applications of Environmental Biotechnology for a Sustainable Future,by Ram Lakhan Singh. Springer Singapore.

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: Learn the source, issue and mechanism of environmental pollution.

CO2: Apply the microbes and plants in remediation and management of environmental pollution.

CO3: Understand the replacement/options available for non-degradable pollutants. Concept building in alternate energy sources: Biomass as source of energy; Biocomposting; Biofertilizers; Vermiculture; Organic farming; Bio-mineralization; Biofuel etc.

CO4: Apply the knowledge in Environmental monitoring and solve the global environment problems through biotechnology.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	2	3	3	-	3	-	3	-	2	2	3	3	3	3	3	1	-
CO2	2	3	3	-	3	-	3	-	2	2	3	3	3	3	3	1	-
CO3	2	3	3	-	3	3	3	1	2	2	3	3	3	3	3	1	2
CO4	2	3	3	1	3	3	3	-	2	2	3	3	3	3	3	1	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability and Skill Development

M. Sc. Biotechnology IV semester

Elective Course : BT-E403: Molecular Diagnostics

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: After completing the course student will able to use critical thinking skills to trouble shoot problems as they occur and determine possible causes. Identify the important parameters in the design of a laboratory to conduct the most commonly-used molecular diagnostics protocols. Perform quality control (QC) procedures according to established protocol and evaluate the results.

Topics	Teaching Hrs.
Unit I	
1. **Genome biology in health and disease:** An overview; - Chromosomal structure & mutations; - DNA polymorphism: human identity; - Clinical variability and genetically determined adverse reactions to drugs. **2. Genome: resolution, detection & analysis:** - PCR: Real-time; ARMS; Multiplex; ISH; FISH; RFLP; SSCP; - Nucleic acid sequencing: new generations of automated sequencers; - Microarray chips; Microarray data normalization & analysis; 3. 4. **Diagnostic proteomics:** SELDI-TOF-MS; Bioinformatics data acquisition & analysis.	**15**
Unit II	
1. **Diagnostic metabolomics:** Metabolite profile for biomarker detection the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms. 2. **Detection and identity of microbial diseases:** Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of in vitro cultivation as well as genotypic markers of microbial resistance to specific antibiotics.	**15**
Unit III	
1. **Detection of inherited diseases:** Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: - Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, - von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes.	**15**
Unit IV	
1. **Molecular oncology:** - Detection of recognized genetic aberrations in clinical samples from cancer patients; - Types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; - Predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies. 2. **Quality assurance and control:** Quality oversight; regulations and approved testing.	**15**

Suggested Reading:

1. Campbell, A. M., &Heyer, L. J. (2006). Discovering Genomics, Proteomics,and Bioinformatics. San Francisco: Benjamin Cummings.
2. Brooker, R. J. (2009). Genetics: Analysis & Principles. New York, NY: McGraw-Hill.

3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.
4. Coleman, W. B., &Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press.

Course Outcomes : **After completing this course, student is expected to learn the following:**

CO1: Understand the various molecular techniques used in diagnostics. Identify the important parameters in the design of a molecular diagnostic test.

CO2: Apply the knowledge to detect and identify the diseases

CO3 : Learn to detect the inheritable diseases

CO4: Learn to detect the various types of cancers causing alteration by next generation sequencing and use biomarkers for oncotherapy

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	2	2	-	-	1	-	3	3	3	3	2	1	2
CO2	3	3	3	3	2	2	-	-	1	-	3	3	3	3	2	1	2
CO3	3	3	3	3	2	2	-	-	1	-	3	3	3	3	2	1	2
CO4	3	3	3	3	2	2	-	-	1	-	3	3	3	3	2	1	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability

M. Sc. Biotechnology IV semester

Elective Course : BT-E404: Stem Cell Biology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objective: To explore the biomedical research involving tissue engineering that aims to grow and replace tissue *in-vitro* using stem cell technology.

Topics	Teaching Hrs.
Unit I	
1. Introduction to Stem Cells, 2. Definition, Classification and Sources.	**15**
Unit II	
1. Embryonic Stem Cells 2. Blastocyst and inner cell mass cells, Organogenesis, 3. Mammalian Nuclear Transfer Technology, 4. Stem cell differentiation, stem cells cryopreservation.	**15**
Unit III	
1. Application of stem Cells 2. Overview of embryonic and adult stem cells for therapy Neurodegenerative diseases; Parkinson's, Alzheimer, 3. Tissue system Failures: Diabetes, Cardiomyopathy, Kidney failure, Liver failure, Hemophilia.	**15**
Unit IV	
1. Human Embryonic Stem Cells and Society 2.Human stem cells research: Ethical consideration; Stem cell religion consideration; 3. Stem cell based therapies: Pre clinical regulatory consideration and Patient advocacy.	**15**

Suggested Reading

1. Ann A. Kiessling, Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential, Jones and Bartett, 2003.
2. Peter J. Quesenberry, Stem Cell Biology and Gene Therapy, 1st Edition, Willy-Less, 1998.
3. Robert Lanja, Essential of Stem Cell Biology, 2nd Edition, academic Press, 2006.
4. A.D.Ho., R.Hoffiman, Stem cell Transplantation Biology Processes Therapy, Willy-VCH, 2006.
5. C. S. Potten, Stem Cells, Elsevier, 2006.
6. Essentials of Stem Cell Biology, 2nd edition, (2009) Robert Lanza, et al. Elsevier Academic Press, USA
7. Stem cells and the future of regenerative medicine, 1st edition, (2002), National research council and Institute of medicine, National Academic press, Washington DC
8. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: Understand the stem cell classification and sources.

CO2: Learn the nuclear transfer technology stem cell differentiation and cryopreservation.

CO3: Apply stem cell therapy for neurodegenerative diseases and tissue system failure.

CO4: Lean the ethical and religion consideration of stem cell based therapy.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	-	-	2	-	-	-	-	-	3	3	1	-	3	1	2
CO2	3	3	2	-	2	-	-	-	-	-	3	3	1	-	2	1	2
CO3	3	3	2	1	2	-	-	1	1	-	3	3	1	1	3	1	2
CO4	3	3	-	-	2	-	-	3	1	-	3	3	1	1	3	1	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability, Entrepreneurship and Skill Development

M. Sc. Biotechnology IV semester

Elective Course : BT-E405: Food Biotechnology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives: In this course students will learns various aspects of biotechnology in food industry and processing that includes microbial biotechnology, enzyme in food technology, nanobiotechnology, prebiotics and probiotics, nutraceuticals, QC and QA quality, quality improvement, and food laws.

Topics	Teaching Hrs.
Unit I	
1. Introduction and history of food microbiology, General characteristics, classification and importance of microorganisms important in food microbiology, 2. Principles of food preservation. Asepsis–Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying, canning, food irradiation). 3. Factors influencing microbial growth in food – Extrinsic and intrinsic factors; 4. Chemical preservatives.	**15**
Unit II	
1. Contamination and spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products, Fish and sea foods, poultry food, spoilage of canned foods. 2. Detection of spoilage and characterization. 3. Food-borne infections and intoxications: Bacterial and nonbacterial toxins with examples of infective and toxic types – *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia, Nematodes, protozoa, algae, fungi* and *viruses*.	**15**
Unit III	
1. Food fermentations: Industrial production method for microbial starters, bread, cheese, vinegar, fermented vegetables, fermented dairy products; 2. Fermented beverages: beer and wine. 3. Microbial cells as food (single cell proteins, mushrooms), 4. Amino acid production: glutamic acid and lysine. 5. Production of probiotics and prebiotics, nutraceuticals, low calorie sweetener, food coloring and naturally occurring flavor modifiers.	**15**
Unit IV	
1. Food quality standards, Monitoring and control, 2. Food Adulteration, R&D innovations in food microbiology, 3. Genetically modified foods, 4. Need and requirements of food packaging; Containers for packaging, Dispensing devices, 5. Food Regulations/Safety & Quality Standards & Food Laws	**15**

Suggested readings

1. Food microbiology- Royal society of chemistry: MR Adams and MO Moss.
2. Principles of fermentation technology: PF Stanbury, A Whitekar and SJ Hall, Pergamon Press.
3. Basic Food Microbiology: GJ Banwart, CBS Publishers.

Course Outcomes : **After completing this course, student is expected to learn the following:**

CO1 Ability to acquire knowledge about the food microbiology, food preservation and chemical preservatives.

CO2 Understand the sources of food contamination, able to specify food spoilage – its types, causative agents and changes associated with it; enumerate factors affecting the rate of spoilage.

CO3 Apply the knowledge in fermentation industry for the production of beverages, amino acids, prebiotics, probiotics and dairy products.

CO4 Knowledge building over public acceptance of genetically modified crops and government regulations of GM crops will help them engage in solving social problems and understand social concerns about new technology

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	3	1	3	1	2	1	2	2	3	2	3	3	3	1	2
CO2	3	2	3	1	3	1	2	1	2	2	3	3	3	3	3	1	2
CO3	3	3	3	2	3	3	3	1	2	2	3	3	3	3	3	1	3
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	1	3

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Employability, Entrepreneurship and Skill Development

M. Sc. Biotechnology IV semester

Elective Course : BT-E406: Agriculture Biotechnology

[Total Credits : 04; Total Marks= 100; CIE= 25; End Semester Exam= 75]

Course Objectives : This course enables students to learn basic of agricultural biotechnology, crop improvement, development and formulation (with various carrier materials) of bioinoculants, for better agricultural productivity.

Topics	Teaching Hrs.
Unit I	
1. Introduction to Agricultural biotechnology: Concepts and scope of Agricultural Biotechnology 2. Crop improvement hybridization and plant breeding techniques. 3. Micropropagation and plant tissue culture technique and its application in agriculture. 4. Somatic hybridization, haploid production and cryopreservation 5. Study of biopesticides used in agriculture (neem as example)	**15**
Unit II	
1. Mechanism of biological nitrogen fixation process. Study of NIF, NOD and HUP genes nitrogen fixation process. 2. Production of bio-fertilizers and applications of rhizobium, azotobacter, azolla and myconrrhiza 3. Use of plant growth regulators in agriculture and horticulture.	**15**
Unit III	
Biotechnology for quality crop development 1. Technological change in agriculture, Green Revolution: traditional and non-traditional methods of crop improvement. Molecular genetics of Photosynthesis, theory and techiques for the development of transgenic plants-conferting resistance to herbicide (Glyphosate und BASTA) 2. Pesticide (Bt-Gene) Technological change in agriculture- for biotic, abiotic stress: Improvement of crop yield and quality fruit ripening	**15**
Unit IV	
Agro-industrial biotechnology 1. Techniques of some plant tissue culture techniques for bio-resource production: 2. Micropropagation; Somaclonal variation, Artificial seed production; Androgenesis and its applications in genetics and plant breeding: Cell cultures for secondary metabolite production: (Gemplasm conservation and cryopreservation). 3. Agro-industry: Microbes in agriculture, Bio-fertilizer, Microbial enzymes and their applications in agro-chemical industries, Biocatalyst; Agro-waste utilization; Mycorrhiza in agriculture and forestry	**15**

Suggested Reading

1. Plant Biotechnology and Genetics: Principles, Techniques and Applications C. Neal Stewart, J. Editor) Wiley, 2008
2. Agricultural biotechnology by. S. Prot - Second Enlarged ation, Agrobios, 2007
3 Agricultural Biotechnology, HD. Kumar Daya Publishing House, 2005,
4. Agricultural Biotechnology Challenges and Prospects Elite by Mahesh K. Bhalga, William P- Ridley, Allan. Felst, and James N, Seiber.

Course Outcomes : After completing this course, student is expected to learn the following:

CO1 Ability to acquire knowledge about the range of approaches to manipulate and improve plants. Develop bio-pesticides based on knowledge acquired.

CO2 Understand the production of bio-fertilizers and use of plant growth regulator in agriculture.

CO3 Apply the knowledge for quality crop development.

CO4 Able to produce the biofertilizers, biocatalysts, artificial seeds, etc.

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	3	2	1	-	3	1	3	3	2	1	3	1	2
CO2	3	3	3	3	3	2	2	-	3	1	3	3	2	3	3	1	2
CO3	3	3	3	3	3	2	1	-	3	1	3	3	2	2	3	1	2
CO4	3	3	3	3	3	2	1	-	3	1	3	3	2	3	3	1	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3

Skill Development

M. Sc. Biotechnology IV semester

Core Course : BT-C407: Practical

[Total Credits : 04; Total Marks= 100; End Semester Exam= 100]

Course objectives: This course enables the students to learn basic practical knowledge of biotechnology lab and principles associated with experimentation.

Topics	Teaching Hrs.
1. To understand different methods for maintaining aseptic condition in plant tissues culture laboratory. 2. To prepare plant tissue culture medium (MS medium) and its sterilization. 3. To induce of callus from given explants sample. 4. To generate virus free plants from explants through callus induction. 5. To prepare artificial seeds through somatic embryogenesis. 6. To isolate protoplast for generation of hybrid, transformation with Ti/Ri plasmid/ reporter genes. 7. To grow Single cell culture/ cell suspension culture from plant tissues in laboratory. 8. To detect and measure different pollutants in the given soil and water samples. 9. To culture earthworms for solid waste treatment and produce vermin-composite. 10. To perform real time PCR for detection the expression of gene. 11. To grow Stem cells of plants from given single cell/tissues by using plant tissue culture. 12. To preservations of food, milk, vegetables, meat, etc. by using different methods. 13. To produce beverages (ethanol) by using Yeast from molasses/ C - source. 14. To produce single cell protein from different C/N sources. 15. To learn the packaging and storage of different foods and other dairy products. 16. To isolate nitrogen fixation bacteria from root nodules/ rhizospheric soil. 17. To cultivate microbes as bio-fertilizes for agriculture. 18. To test drought/saline resistant in plants- Arabidopsis.	

Suggested reading

1. Biotechnology Department Practical Manual
2. Wilson Walker Practical Biochemistry
3. Laboratory Manual for Biotechnology by Ashish Verma et al, S chand Publication

Course Outcomes : After completing this course, student is expected to learn the following:

CO1: To know the importance of biofertilizers and biopesticides

CO2: To acquire hands-on training for the production of fermented products, organic acid, enzymes

CO 3: To provide practical knowledge and skill in the isolation of organisms from contaminated foods

CO4: To understand the quality of water using BOD and COD and to determine the potability of water sample

Course Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	2	1	2	3	1	2	1	3	3	3	2	3	1	2
CO2	3	3	3	2	1	2	2	1	2	1	3	3	3	2	3	1	2
CO3	3	3	3	2	1	2	2	1	2	1	3	3	3	2	3	1	2
CO4	3	3	3	2	1	2	3	1	2	1	3	3	3	2	3	1	2

Matching: * 0 to 30% = 1; *30% to 60% = 2; * 60% to 100% =3