DR. BHIMRAO AMBEDKAR UNIVERSITY
AGRA SCHOOL OF LIFE SCIENCES

Master in Faculty (Life Science)
(Bachelor Research)

Semester Wise Syllabus of the Papers for M.Sc. Biotechnology

DEPARTMENT OF BIOTECHNOLOGY

SUBJECT: BIOTECHNOLOGY
FACULTY OF LIFE SCIENCE

PROPOSED PAPERS AND SYLLABUS FOR CORE/ELECTIVE COURSES
(Based on Choice Based Credit System)
Under NEP-2020

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

Core	**Course Title M.Sc. Biotechnology I semester**		**Marks**	**Total**	**Credit**	**Course Mapping**		
Courses				**100**				
		CIE	**End**			**EC**	**EPC**	**SDC**
			Semester					
			Examination					
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	**Course Title M.Sc. Biotechnology II semester**		**Marks**	**Total**	**Credit**	**Course Mapping**		
Courses		**CIE**	**End**			**EC**	**EPC**	**SDC**
			Semester					
			Examination					
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	**Course TitleM.Sc. Biotechnology III semester**		**Marks**	**Total**	**Credit**	**Course Mapping**		
Courses		**CIE**	**End**			**EC**	**EPC**	**SDC**
			Semester					
			Examination					
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	**Course Title**		**Marks**	**Total**	**Credit**	**Course Mapping**		
Courses		**CIE**	**End**			**EC**	**EPC**	**SDC**
			Semester					
			Examination					
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,

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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]

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

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]

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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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]

Topics	Teaching Hrs.
Unit I	
1. Development of Microbiology in twentieth century 2. General characteristics of Prokaryotes, Cyanobacteria, 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 , 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 5.	**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.

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]

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

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M. Sc. Biotechnology I semester

Core Course : BT-C105: Practical

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

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

M. Sc. Biotechnology II semester

Core Course : BT-C201: Molecular Biology

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

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.

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]

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**

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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. 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. 16 Practical Biochemistry, by Wilson Walker

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]

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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**

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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).

M. Sc. Biotechnology II semester

Core Course : BT-C204 : Genetics

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

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

M. Sc. Biotechnology II semester

Core Course : BT-C205: Practical

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

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

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]

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.

M. Sc. Biotechnology III semester,

Core Course : BT-C302 :Genetic Engineering

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

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.
8.

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]

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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.

M. Sc. Biotechnology III semester

Elective Course : BT-E304: Basic Bioinformatics

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

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**
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**

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)

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]

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**

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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.

M. Sc. Biotechnology III semester

Core Course : BT-C306: Practical

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

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

M. Sc. Biotechnology IV semester

Core Course : BT-C401:Plant Biotechnology

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

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**

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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.

M. Sc. Biotechnology IV semester

Core Course : BT-C402:Environmental Biotechnology

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

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.

M. Sc. Biotechnology IV semester

Elective Course : BT-E403: Molecular Diagnostics

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

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 ; - Predictivebiomarkers 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.

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M. Sc. Biotechnology IV semester

Elective Course : BT-E404: Stem Cell Biology

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

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

M. Sc. Biotechnology IV semester

Elective Course : BT-E405: Food Biotechnology

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

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.

M. Sc. Biotechnology IV semester

Elective Course : BT-E406: Agriculture Biotechnology

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

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 Challenges and Prospects Elite by Mahesh K. Bhalga, William P- Ridley, Allan. Felst, and James N, Seiber.

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M. Sc. Biotechnology IV semester

Core Course: BT-C407: Practical

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

Topics	Teaching Hr

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

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