

DEPARTMENT OF BIOTECHNOLOGY
SCHOOL OF LIFE SCIENCES
DR. BHIMRAO AMBEDKAR UNIVERSITY, AGRA

MINUTES

The minutes of the meeting of the Academic Committee of Department of Biotechnology held in the Department of Biotechnology of the Dr. Bhimrao Ambedkar University, Agra on 3rd June 2022 at 11:00 AM. The following members were present:

1. Prof. Rajendra Sharma (Redt.) Department of Botany, Dr. Bhimrao Ambedkar University, Agra
2. Dr. Ajayvir Singh, Scientist 'E' NJIL&OMD, Agra
3. Dr. Amita Sarkar, Agra College, Agra
4. Dr. Monika Asthana, Department of Biotechnology, Dr. Bhimrao Ambedkar University, Agra
5. Prof. Bhupendra Swarup Sharma, Dean Life Sciences, Dr. Bhimrao Ambedkar University, Agra

1. The Academic Committee considered and approved of Revised Ordinances of the M.Sc. Biotechnology. (In Faculty of Life Science) course based on Choice Based Credit System (CBCS) as per NEP 2020. (Appendix – 1)
2. The Academic Committee considered and approved the Revised Syllabus of M.Sc. Biotechnology (In Faculty of Life Science) based on Choice Based Credit System (CBCS) as per NEP 2020. (To be implemented from the academic session 2022-2023). (Appendix – 2)
3. The Academic Committee considered and approved the Syllabus for Minor Subject for Post Graduate (M.Sc.) Courses for other Faculty, based on Choice Based Credit System (CBCS) as per NEP 2020. (To be implemented from the academic session 2022-2023). (Appendix – 3)

Prasad
3/6/22

Redt
3/6/22

Stainus
3.6.22

Monika
3/6/22

4. The Academic Committee considered and approved of Ordinances of Post Graduate Diploma in Research (PGDR) in Biotechnology (in Faculty of Life Science) course based on Choice Based Credit System (CBCS) as per NEP 2020. (Appendix – 3)
5. The Academic Committee considered and approved the Syllabus of Post Graduate Diploma in Research (PGDR) in Biotechnology (in Faculty of Life Science) based on Choice Based Credit System (CBCS) as per NEP 2020. (To be implemented from the academic session 2022-2023). (Appendix – 4)
6. The Academic Committee considered and approved the fee structure of Post Graduate Diploma in Research (PGDR) in Biotechnology (in Faculty of Life Science) based on Choice Based Credit System (CBCS) as per NEP 2020 (To be implemented from the academic session 2022-2023. Tuition fees 25000/- per semester and other fees (examination, enrollment, sports and cultural activities etc.) as per University norms.

Prof. Rajendra Sharma (Retd)
Dr. Bhimrao Ambedkar University,
Agra

*Attended & Recommended
virtually - dates attached*

Dr. Ajayvir Singh,
NJIL&OMD

*Recd
3/6/22*

Dr. Amita Sarkar
Agra College,

*Haimis
3.6.22*

Dr. Monika Asthana
Dr. Bhimrao Ambedkar University, Agra

*Monika
3/6/22*

*Monika
3/6/22*

Prof. Bhupendra Swarup Sharma,
Dr. Bhimrao Ambedkar University, Agra

*Recd
3/6/22*

**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

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	Credit	Course Mapping		
		CIE	End	100		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 Courses	Course Title M.Sc. Biotechnology II semester		Marks	Total	Credit	Course Mapping		
		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 Courses	Course Title M.Sc. Biotechnology III semester		Marks	Total	Credit	Course Mapping		
		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 Courses	Course Title		Marks	Total	Credit	Course Mapping		
		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,

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	<u>Teaching Hrs.</u>
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]

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 producing 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 Bioenergetics – 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

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

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	<u>Teaching Hrs.</u>
Unit I	
1. Development of Microbiology in twentieth century 2. General characteristics of prokaryotes, cyanobacteria, Viruses, Virioids 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, Citric acid cycle, Pentose phosphate pathway, Embden 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 – Gluconeogenesis, 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.

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	<u>Teaching Hrs.</u>
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 deviation, variance. 3. Simple linear regression and correlation. 4. Probability, Theorems of probability and probability distribution – Binomial, Poisson 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, EBCDIC, 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

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

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

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 <u>post transcriptional gene silencing</u> . 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 secretory 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]

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	<u>Teaching Hrs.</u>
Unit I	
1. <u>Photometry – Basic principles, Instrumentation and applications of UV-Visible spectrophotometry</u> 2. <u>Infrared (IR) spectroscopy and its applications</u> 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. <u>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</u> . 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

- Biochemical Techniques : Theory and Practice by Robyt and White
- Principles of Instrumental Analysis by Skoog and West
- Analytical Biochemistry by Holme and Peck
- Biological Spectroscopy by Campbell and Dwek
- Organic Spectroscopy by Kemp
- A Biologist's Guide to Principles 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 (Wiley Eastern limited).
13. Biochemistry - a laboratory course by J.M. Becker (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

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	<u>Teaching Hrs.</u>
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: <ul style="list-style-type: none"> - 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

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	<u>Teaching</u> <u>Hrs.</u>
<u>UNIT –I</u>	
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
<u>UNIT-II</u>	
1. Methods of genetic analysis and genetic mapping, Pedigree analysis, lod score for linkage testing. 2. Recombination - Homologous 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
<u>UNIT- III</u>	
1. Bacterial genetic system: transformation, conjugation and transduction. Bacterial genetics map with reference to <i>E.coli</i> . 2. Complementation analysis, cir-trans test, deletion mapping, Benzer’s concept of cistron, concept of overlapping genes.	15
<u>UNIT- IV</u>	
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]

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 Polyacrylamide gel electrophoresis (PAGE).	
10. To separate subunits of protein by sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE).	
11. To perform FISH for detection the expression of gene.	
12. To perform ABO blood group typing by using Haemagglutination 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

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, pluripotency, 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 and primary culture; 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 Balasubrahmanian et. 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.

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	<u>Teaching Hrs.</u>
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

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.

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 <ul style="list-style-type: none"> - Clinical informatics - Cheminformatic resources and pharmacoinformatics 	15
Unit II	
1. Searching database and locating genes, Alignment of gene sequences, Local and Global. <ul style="list-style-type: none"> - 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 Computational Biology, 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)

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. by Devarajan Thangadurai (Editor), Jeyabalan Sangeetha (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)

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	<u>Teaching</u> <u>Hrs.</u>
<ol style="list-style-type: none">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

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	
<ol style="list-style-type: none"> 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	
<ol style="list-style-type: none"> 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	
<ol style="list-style-type: none"> 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	
<ol style="list-style-type: none"> 1. Application of plant transformation for productivity and performance <ul style="list-style-type: none"> Herbicide resistance -phosphinothricin, 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 –polyhydroxybutyrate, Therapeutic proteins, lysosomal enzyme antibodies, edible vaccines, 3. Green House. 	15

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	<u>Teaching Hrs.</u>
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.

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	
<p>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 .</p> <p>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;</p> <p>3.</p> <p>4. Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis.</p>	15
Unit II	
<p>1. Diagnostic metabolomics: Metabolite profile for biomarker detection the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms .</p> <p>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 .</p>	15
Unit III	
<p>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 .</p>	15
Unit IV	
<p>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.</p> <p>2. Quality assurance and control: Quality oversight; regulations and approved testing .</p>	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.

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

**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 learn 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 – <i>Brucella</i> , <i>Bacillus</i> , <i>Clostridium</i> , <i>Escherichia</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Staphylococcus</i> , <i>Vibrio</i> , <i>Yersinia</i> , <i>Nematodes</i> , <i>protozoa</i> , <i>algae</i> , <i>fungi</i> and <i>viruses</i> .	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.

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. <u>Somatic hybridization, haploid production and cryopreservation</u> 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. <u>Production of bio-fertilizers and applications of rhizobium, azotobacter, azolla and myconrrhiza</u> 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. <u>Techniques of some plant tissue culture techniques for bio-resource production :</u> 2. <u>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)</u> . 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
4. Agricultural Biotechnology Challenges and Prospects Elite by Mahesh K. Bhalga, William P- Ridley, Allan. Felst, and James N, Seiber.

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.
<ol style="list-style-type: none">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

DEPARTMENT OF BIOTECHNOLOGY
M SC. BIOTECHNOLOGY SEMESTER IV; CENTRE CODE: 913
PROJECT WORK 2021-22

Roll No.	Student Name	Supervisor Name	Topic of Research Project	Project Work Place
200913637 1001	Ajay Kumar	DR. AVNISH KUMAR & Dr. MONIKA ASTHANA	Evaluation of Antidiabetic activity of Terminalia chebula fruits Extracts and its Molecular characterization using RAPD markers	School of Life Science, DBRAU, Agra
200913637 1002	Anjali Singh	DR. HARPREET SINGH PAWAR	Clinical profile and laboratory diagnosis of new leprosy patients and their sociodemographic characteristics : A prospective study.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1003	Anoop Saraswat	DR. DEEPA BISHT	Analysis of cytosolic proteins of aminoglycosides resistant <i>Mycobacterium tuberculosis</i> isolate by two – dimensional gel electrophoresis.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1004	Ayushi Verma	DR. HIRAWATI DEVAL	Detection of Respiratory viruses etiology in ARI & SARI cases below 5 year children in BRD medical college, Gorakhpur	ICMR- Regional Medical Research Centre, Gorakhpur, UP
200913637 1005	Dinesh Kumar	DR. K.K. MOHANTY	Comparative Evaluation of Anti-ceramide-1- Phosphate Antibodies in people Affected with Leprosy and Healthy Control	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1006	Divya Sagar	DR. HIRAWATI DEVAL	To determine the extent of disability among pediatric Japanese Encephalitis and scrub patients and predictors of outcome	ICMR- Regional Medical Research Centre, Gorakhpur, UP
200913637 1007	Gaurav Kumar	DR. DEEPA BISHT	Proteomic analysis of contacts of lepromatous leprosy cases for early diagnosis of leprosy	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1008	Himani Lawania	DR. K.K. MOHANTY	Comparative Analysis of the Antibody Response against Soluble Extract of Mycobactirium tuberculosis (H37Rv) antigen in Confirmed and Suspected Tuberculosis Individuals	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1009	Honey Sharma	DR. AMIT KUMAR SINGH	In vitro investigation of therapeutic impact of L-serine supplementation on Mycobacterium tuberculosis growth.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1010	Humera Hussain	DR. VIVEK KUMAR GUPTA	Anti-tuberculosis activity of selected medicinal plants against mycobacterium tuberculosis H37Rv with their immunomodulatory efficacy.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1011	Jennifer Lawrence	DR. MADAN KUMAR MURTHY	Exploring the utility of exhaustion marker PD 1 and KLRG 1 for their role in treatment monitoring of extra pulmonary Tuberculosis.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1012	Jolly Yadav	DR. AMIT KUMAR SINGH	In vitro evaluation of Quercitin against the Non-tuberculous Mycobacterium.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases

				Tajganj Agra
200913637 1013	Kalyanee Sharma	DR. H.B. SINGH	Clinical Outcome among Presumptive TB patients who are clinically suggestive / X-ray suggestive and whose sputum samples have not detected result on CBNAAT and negative on AFB smear examination.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1014	Km Rehnuma Mirza	DR. SHUBBIR AHMED	Techniques Related to Recombinant protein Production and characterization	THSTI, Gurugram
200913637 1015	Mahima Varshney	DR. DHARMENDRA SINGH	Comparative Evaluation of diagnostic role of multiplex PCR and RLEP PCR in borderline tuberculoid leprosy	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1016	Poonam Yadav	DR. H.B. SINGH	Discordance Observed Between Molecular Techniques used for Rifampicin Resistant for Tuberculosis	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1017	Raj Kamal Singh	DR. VIKRANT GUPTA	In silico analysis of strigolactone receptors in medicinal and aromatic plants and cloning of CRT/ DRE gene homolog from Ocimum sanctum	CSIR- CIMAP, Lucknow
200913637 1018	Salvi Garg	DR. A.M. KHAN	Anti biofilm activity of plant extract against Mycobacterium smegmatis.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1019	Shivani Garg	DR. ASHOK KUMAR PANDEY	Clinical and epidemiological profiling of scrub and non-scrub acute febrile cases of eastern UP	ICMR- Regional Medical Research Centre, Gorakhpur, UP
200913637 1020	Shrishti Yadav	DR. AVNISH KUMAR & Dr. MONIKA ASTHANA	Analysis of antioxidant, antibacterial activity of Emblica officinalis extract and their AgNPs including their characterization, using HPTLC, UV spectroscopy, FE-SEM and XRD	School Of Life Science, DBRAU, Agra
200913637 1021	Somya Goyal	DR. BHAWNA SHARMA	Exploring the role of Activation of Signal transducers and Activator of Transcription (STAT) molecules in leprosy reactions.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1022	Subhangi Sharma	DR. HARPREET SINGH PAWAR	Exploration of co-transmission of free living amoeba and mycobacterium leprae using nasopharyngeal swabs of leprosy patients.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1024	Vaishali Goyal	DR. MAMTA ARORA	Detection of Mycobacterium leprosy in skin smear and nasal smear by microscopy in comparison to molecular detection by RLEP PCR.	National Jalma Institute For Leprosy And Other Mycobacterial Diseases Tajganj Agra
200913637 1025	Vaishnavi Mishra	DR. HIRAWATI DEVAL	Molecular characterization of enterovirus isolated from the respiratory infection of pediatric patients in Gorakhpur region in U.P., India	ICMR- Regional Medical Research Centre, Gorakhpur, UP



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INSTITUTE FOR LEPROSY & OTHER
MYCOBACTERIAL DISEASES, AGRA



आई सी एम आर - राष्ट्रीय जलमा कुष्ठ एवं अन्य
माइकोबैक्टीरियल रोग संस्थान, अजगरा
संस्थान अनुसंधान विभाग, स्वास्थ्य और परिवार
कल्याण विभाग, भारत सरकार

ICMR - National JALMA Institute for Leprosy
& Other Mycobacterial Diseases, Agra
Department of Health Research, Ministry of Health
& Family Welfare, Government of India

Ref. ICMR-NJIL/DB/HRD/2022/02

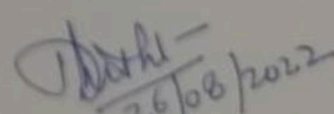
Date: 26/08/2022

CERTIFICATE

This is to certify that Mr Anoop Saraswat (Roll No: 2009136371003) has completed the project work entitled 'Analysis of cytosolic proteins of aminoglycosides resistant *Mycobacterium tuberculosis* isolate by two-dimensional gel electrophoresis' under my supervision from 08.03.2022 to 23.08.2022. The project report is submitted here with for the partial fulfillment of requirement for the award of degree of M.Sc. Biotechnology.

During the project work he has undergone hands on working on various methods/procedures/techniques such as Isoelectric focusing, SDS-Polyacrylamide Gel Electrophoresis, Two-dimensional Gel Electrophoresis, Centrifugation, Ultracentrifugation, Protein estimation, Sonication etc. at the Department of Biochemistry, ICMR-National JALMA Institute for Leprosy and Other Mycobacterial Diseases, Agra.

This report has not been submitted in full or part for the award of any other degree or diploma to this or any other University. The study has all necessary approval including Institutional Human Ethics Committee.


(Dr Deepa Bisht)

दीपा बिष्ट / Deepa Bisht

वैज्ञानिक - एफ / Scientist - F

जीव विज्ञान / BIOCHEMISTRY

आई सी एम आर - राष्ट्रीय जलमा कुष्ठ एवं अन्य माइकोबैक्टीरियल रोग संस्थान

ICMR-National JALMA Institute for Leprosy & Other Mycobacterial Diseases

सजयगंज, अजगरा - 282004 / Tajganj, Agra - 282004



आई सी एम आर – क्षेत्रीय आयुर्विज्ञान अनुसंधान केंद्र, गोरखपुर
स्वास्थ्य अनुसंधान विभाग, स्वास्थ्य एवं
परिवार कल्याण मंत्रालय, भारत सरकार

ICMR – Regional Medical Research Centre, Gorakhpur
Department of Health Research, Ministry of Health &
Family Welfare, Government of India

Ref. ICMR-RMRC/DIR/HRD/2022/

Date: 17/09/2022

CERTIFICATE

This is to certify that Ms. **Vaishnavi Mishra**, Roll No: (2009136371025) Enrollment No. A-17256216 has undergone training for her project work from January 2022 to July 2022 on the project entitled “**Molecular characterization of enterovirus isolated from the respiratory infection of pediatric patients in Gorakhpur region U.P. India**” under my supervision. The project work is submitted here with for the partial fulfillment of requirement for the award of degree of M.Sc. Biotechnology. During the course of the project she has undergone hands-on experience on various techniques which includes RNA isolation, PCR and gel electrophoresis at molecular biology division of ICMR-Regional Medical Research Center, Gorakhpur, Uttar Pradesh. This project report has not been submitted in full or part for the award of any other degree or diploma to this or any other University.

Dr. Hirawati Deval

M.Sc. Ph.D

Scientist 'D'

**ICMR-RMRC, Gorakhpur
(Ministry of Health and Family
Welfare, Govt. of India)**



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आय सी एम आर - राष्ट्रीय जालमा कुष्ठ एवं अन्य
माइकोबैक्टीरियल रोग संस्थान, अजमेरा
संस्थान अनुसंधान विभाग, स्वास्थ्य और परिवार
कल्याण विभाग, भारत सरकार

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Department of Health Research, Ministry of Health
& Family Welfare, Government of India

Ref. ICMR-NJIL/BIOCHEM./HRD/2022/04

Date: 30/08/22

CERTIFICATE

This is to certify that Ms. Humera Hussain (Roll No: 2009136371010) has completed the project work entitled 'Anti-tuberculosis activity of selected medicinal plants against *Mycobacterium tuberculosis* (H37Rv) with their immunomodulatory efficacy' under my supervision from 08.03.2022 to 22.08.2022. The project work is submitted herewith for the partial fulfillment of requirement for the award of degree of M.Sc. Biotechnology.

During the project work she has undergone hands on working experience on various methods/procedures/techniques such as maintenance and cultivation of *Mycobacterium tuberculosis*, REMA, Cell Culture, ELISA (Sandwich), Drug susceptibility test, Extraction of plant metabolites, TLC etc. at the Department of Biochemistry, ICMR-National JALMA Institute for Leprosy and Other Mycobacterial Diseases, Agra.

This project report has not been submitted in full or part for the award of any other degree or diploma to this or any other University. The study has all necessary approval including Institutional Human Ethics Committee.

Vivek Kumar Gupta

Dr. Vivek Kumar Gupta

Scientist-E

Department of Biochemistry

Supervisor

डॉ. वी. के. गुप्ता

वैज्ञानिक-ई

ICMR-NATIONAL JALMA - राष्ट्रीय जालमा कुष्ठ एवं
अन्य माइकोबैक्टीरियल रोग संस्थान
ताजगंज, अजमेरा-282004



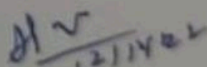
Dr. Avnish Kumar
Assistant Professor
Department of Biotechnology

School of Life Sciences,
Dr. Bhimrao Ambedkar University,
Khandari Campus Agra-282004
Mobile No. 9410410378; 8630405764
mail-akbiotech81@gmail.com

CERTIFICATE

It is my pleasure to certify that **Ms. Shrishti Yadav** (Roll No: 2009136371020, Enrollment No. **A-13217542**) has been completed her project work entitled “**Analysis of antioxidant, antibacterial activity of *Embllica officinulis* extract and their AgNPs including their characterization, using HPTLC, UV spectroscopy, FE-SEM and XRD**” under my supervision and co-supervision of **Dr. Monika Asthana (In-charge)** for partial fulfillment of degree of M.Sc. (Biotechnology) to be submitted at Department of Biotechnology, School of Life Sciences, Dr. Bhimrao Ambedkar University, Khandari Campus Agra 12th March 2022 to 30th September 2022. This project work has not been submitted elsewhere for any other Degree or Diploma.

I wish all the success in her career and life.


(Dr. Avnish Kumar)



CSIR-CIMAP

केन्द्रीय औषधीय एवं सगंध पौधा संस्थान

CSIR-CENTRAL INSTITUTE OF MEDICINAL AND AROMATIC PLANTS
Human Resource Development Programme

CERTIFICATE

This certificate is issued to the candidate by **CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow** on successful completion of his **M.Sc. Project Work** for more than 90 working days.

Name of the Candidate : Mr. Raj Kamal Singh
Institution : Department of Biotechnology, School of Life Sciences, Dr. B R Ambedkar University, Khandari Campus, Agra (U.P.)
Category of Training : Graduate Training
Training Department : Plant Biotechnology Division, CSIR-CIMAP, Lucknow
Title of Training : *In Silico* Analysis of Strigolactone Receptors in Medicinal & Aromatic Plants, and, Cloning of CRT/DRE Gene Homolog from *Ocimum sanctum*
Duration of Training : 02 February 2022 to 15 July 2022

The institute wishes the candidate success in his future endeavors.

Supervisor

(Dr. Vikrant Gupta)

Sr. Principal Scientist

Biotechnology Division

Central Institute of Medicinal and Aromatic Plants

(CSIR, Ministry of Science & Tech., Govt. of India)

P.O. CIMAP, Lucknow-226015, INDIA

Head of the Department/Division

Dr. Laiq ur Rahman

Senior Principal Scientist

CSIR-Central Institute of Medicinal & Aromatic Plants

P.O.-CIMAP, Lucknow-226015



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आइ सी एम आर - राष्ट्रीय जालमा कुल एवं अन्य
माइकोबैक्टीरियल रोग संस्थान, आगरा
स्वास्थ्य अनुसंधान विभाग, स्वास्थ्य और परिवार
कल्याण मंत्रालय, भारत सरकार

ICMR - National JALMA Institute for Leprosy
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Department of Health Research, Ministry of Health
& Family Welfare, Government of India

Ref. ICMR-NJIL/CLINICAL/HRD/2022/MS-002

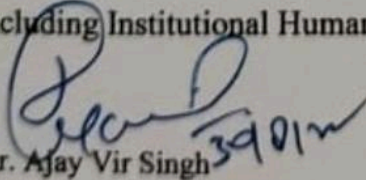
Date: 30-AUG-2022

CERTIFICATE

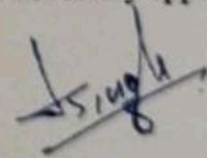
This is to certify that Ms. Subhangi Sharma (Roll No: 2009136371022) has completed the project work entitled "Exploration of co-transmission of Free-Living Amoebae and *Mycobacterium leprae* using nasopharyngeal swabs of leprosy patients" under my supervision from 08-03-2022 to 17-08-2022. The project report is submitted herewith for the partial fulfillment of requirement for the award of degree of M.Sc. Biotechnology.

During the project work she has undergone hands on experience on various methods/procedures/techniques such as Clinical Sample Collection, AFB/ ZN-Staining (Slit Skin Smear), Microscopy, DNA Isolation, PCR, Gel-Electrophoresis etc. at Clinical-Division & Department of Microbiology and Molecular Biology, ICMR-National JALMA Institute for Leprosy and Other Mycobacterial Diseases, Agra.

This project report has not been submitted in full or part for the award of any other degree or diploma to this or any other University. This study has all necessary approval including Institutional Human Ethics Committee.


Dr. Ajay Vir Singh

Scientist 'E'
Co-Supervisor



Dr. Harpreet Singh Pawar
Scientist 'C' (Medical)
Supervisor

Dr Ajay Vir Singh / डॉ अजय वीर सिंह

Scientist-E / वैज्ञानिक-ई

Department of Microbiology & Molecular Biology

माइक्रोबायोलॉजी एवं मॉलिक्यूलर बायोलॉजी विभाग

ICMR-National JALMA Institute for Leprosy & Other Mycobacterial
Diseases (Ministry of Health & Family Welfare, Govt. of India), Agra

आइ सी एम आर - राष्ट्रीय जालमा कुल एवं अन्य माइकोबैक्टीरियल रोग संस्थान

Dr. Harpreet Singh Pawar

Scientist - C (Medical)

National Jalma Institute for Leprosy

& Other Mycobacterial Diseases (ICMR)

Tajganj, AGRA - 282004



ट्रांसलेशनल स्वास्थ्य विज्ञान
एवं प्रौद्योगिकी संस्थान
TRANSLATIONAL HEALTH SCIENCE
AND TECHNOLOGY INSTITUTE

An autonomous institute of the Deptt. of Biotechnology, Ministry of Science & Technology, Govt of India

NCR Biotech Science Cluster
3rd Milestone, Faridabad-Gurugram Expressway,
P O Box No. 04, Faridabad-121001
Haryana, India

Date: 03.06.2022

TO WHOMSOEVER IT MAY CONCERN

This is to certified that the project work entitled *"Techniques related to Recombinant Protein Production and Characterization"* submitted in partial fulfillment of requirement of the degree of M. Sc. Biotechnology at Department of Biotechnology, School of Life Sciences, DR. Bhim Rao Ambedkar University, Agra is a record of Bonafide research work carried out by **Ms. Rehnuma Mirza** (Roll no-2009136371014). The work has been carried out under my supervision and guidance. To the best of my knowledge and belief this is an original piece of work, satisfactory for the award of Master of Science and has not been submitted to any other university or institute for any degree and diploma.

Moreover, the results contained in this record have not been submitted in part or full to any other university or institute for the award of any degree or diploma.

SK-AJ
03/06/22

Dr. Shubbir Ahmad

External Supervisor

Infection and Immunology

Translational health science

Faridabad-Gurugram expressway

Faridabad, Haryana, India

Dr. Shubbir Ahmad, Ph.D.
Senior Research Scientist
विज्ञान और प्रौद्योगिकी संस्थान
Translational Health Science and Technology Institute
विज्ञान और प्रौद्योगिकी विभाग का एक स्वायत्त संस्थान
An autonomous institute of the Dept of Biotechnology Govt of India
3rd Milestone, Faridabad-Gurugram Expressway,
Faridabad-121001, Haryana, India