Mahatma Education Society's

Pillai College of Arts, Commerce & Science (Autonomous)

Affiliated to University of Mumbai

'NAAC Accredited 'A' grade (3 cycles)'
'Best College Award' by University of Mumbai
ISO 9001:2015 Certified

SYLLABUS

Program: Master of Science (M. Sc.) in Biotechnology

M.Sc.- Part I Biotechnology

PCACS/MSCBT/SYL/2024-25/PI

As per National Education Policy
Choice Based Credit & Grading System

Academic Year 2024-25

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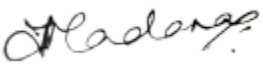
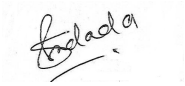
Board of Studies in Department of Biotechnology

1	Mrs. Suparna Deepak Assistant Professor, PCACS	Chairperson (Head of Department of Biotechnology)	
2	Mrs. Meenakshi Johri Assistant Professor, PCACS	Member	
3	Mr. Gopakumar Pillai Assistant Professor, PCACS	Member	
4	Mrs. Bindu Rajaguru Assistant Professor, PCACS	Member	
5	Dr. C. K. Prashant Assistant Professor, PCACS	Member	
6	Dr. D.B. Thakare Former Chairman, BOS of Microbiology, University of Mumbai	Vice Chancellor Nominee	
7	Dr. Mansee Thakur Director, MGM School of Biomedical Sciences, Kamothe, Navi Mumbai	Subject Expert From outside Parent University	
8	Dr.Usha Padmanabhan Senior Scientific Officer & Head, Cell Biology Department, Haffkine Institute of Testing, Training, Research, Parel, Mumbai	Industry Representative (Industry/Corporate/Allied sector)	

9	Dr. Thakamani Marar Dean,Faculty of Science and Technology, Professor, School of Biotechnology, D.Y Patil University, Navi Mumbai	Subject Expert From outside Parent University	
10	Dr. Pankaj Mundada Asistant Production Head, Agri Division Warkem Biotech Pvt Ltd, Mumbai	Post Graduate Meritorious Alumni	
11	Dr. P. S. Goyal Dean, R&D, Pillai College of Engineering	Faculty Specialist	
12	Dr. Gajanan Wader	Principal, PCACS	
13.	Mrs Deepika Sharma	Vice Principal PCACS	

1. Introduction

The Biotechnology sector, now recognized as one of the key priority sectors under the various government initiatives like ‘Make in India’, ‘Skill India’ and ‘Startup India’, is expected to contribute towards invention, innovation and economic growth of the country. It has also highlighted the importance of human resource development and the need for nurturing tailor-made human capital for advanced scientific research and entrepreneurship.

The post-graduate course in biotechnology started by the University of Mumbai in the late 1990’s has gone through various phases of restructuring. The present M.Sc. Biotechnology First Year (Semester I and II) syllabus has been designed with the idea of incorporating outcome-based learning for fruitful engagement of learners. The revised syllabus is an outcome of several rounds of deliberations, discussions, feedback and multiple brainstorming sessions involving various contributors & stakeholders- academicians, industry experts and students. Course Objectives and Course Outcomes have been clearly defined for each paper in the syllabus to guide teachers in order to make the learning process more effective. A lot of focus has been given in the syllabus to cover latest developments in the area of biotechnology and to equip students with necessary knowledge and skills. Relevant papers to make students industry ready have also been included. Attempts have been made to draft a robust, well defined syllabus keeping in view the best learning outcome which shall enable students to pursue high quality research or increase employability of the students. It is hoped that the revised syllabus shall serve its objective of promoting outcome-based learning to meet the changing needs of the biotechnology sector.

2. Program Outcomes

S. No	PO Title	PO in brief
PO1	Advanced Knowledge and Expertise	Demonstrate a systematic, extensive and coherent knowledge and understanding of their academic discipline as a whole and its applications, and links to related disciplinary areas/subjects of study; demonstrate a critical understanding of the latest developments in the subject, and an ability to use established techniques of analysis and enquiry within the subject domain with a global perspective.
PO2	Research and Innovation	Acquire comprehensive knowledge about current research and innovation, and acquire techniques and skills required for identifying problems and issues to produce a well-researched written work that engages with various sources employing a range of disciplinary techniques and scientific methods applicable.
PO3	Interdisciplinary Perspective	Commitment to intellectual openness and developing understanding beyond subject domains; answering questions, solving problems and addressing contemporary social issues by synthesizing knowledge from multiple disciplines.
PO4	Leadership Abilities & Entrepreneurial Mindset	Inculcate Leadership skills, including the ability to lead teams, manage projects, and make strategic decisions. innovation and entrepreneurship, business development, technology commercialization, and startup creation
PO5	Communication Competence	Demonstrate effective oral and written communicative skills to covey disciplinary knowledge and to communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s) of study
PO6	Ethical Conduct and Research Integrity	Understanding and adherence to ethical standards and research integrity by developing commitment towards professional ethics and responsibilities as a social endeavor.
PO7	Career development	Demonstrate subject-related knowledge and skills that are relevant to academic, professional, soft skills and employability required for higher education and placements.
PO8	Commitment to the society and to the Nation	Recognise the importance of social, environmental, human and other critical issues faced by humanity at the local, national and international level; appreciate the pluralistic national culture and the importance of national integration.

3. Program Specific Outcomes

PSO-1	Students will be able to design, conduct experiments, analyze and interpret data for investigating problems in Biotechnology and allied fields.
PSO-2	To equip the students to apply knowledge of molecular mechanisms of cellular processes in living systems including microbes, plants, and higher order organisms to applied aspects.
PSO-3	Understand the potentials, and impact of biotechnological innovations on the environment and their implementation for finding sustainable solutions to issues pertaining to the environment, health sector, agriculture, etc.
PSO-4	Address the increasing need for skilled scientific manpower with an understanding of research ethics involving animals and humans to contribute to application, advancement, and imparting of knowledge in the field of biotechnology globally.

Course Structure

Semester I						
Course Code	**Course Type**	**Course Title**	**Theory/ Practical**	**Marks**	**Credits**	**Lectures /Week**
PMSBT101	**Major**	Biochemistry	Theory	100	4	4
PMSBT102		Immunology	Theory	100	4	4
PMSBT103		Bioinformatics	Theory	100	4	4
PMSBT104	**Major Elective**	a. Emerging Technologies and Molecular Diagnostics	Theory	50	2	3
		b. Aquaculture Biotechnology				
		c. Bio fertilizers and Bio pesticides production				
PMSBT105P	**Major Practical**	Practical (PMSBT101+PMSBT102)	Practical	100	2	6
PMSBT106P	**Major + Major Elective Practical**	Practical (PMSBT103+PMSBT104)	Practical	100	2	6
PMSBT107	**RM**	Research methodology	Theory	50	2	3
PMSBT108P	**RM**	Practical (PMSBT107)	Practical	50	2	2
Total				650	22	32
All Subjects having Field Project as part of Continuous Assessment-2						

Abbreviation:

RM: Research Methodology

Semester II						
Course Code	**Course Type**	**Course Title**	**Theory/ Practical**	**Marks**	**Credits**	**Lectures /Week**
PMSBT201	**Major**	Cell biology	Theory	100	4	4
PMSBT202		Plant and Animal Biotechnology	Theory	100	4	4
PMSBT203		Bioprocess Engineering and technology	Theory	100	4	4
PMSBT204	**Major Elective**	a. Drug Discovery, IPR and Bioethics	Theory	50	2	3
		b. Tissue engineering				
		c. Organic farming and Hydroponics				
PMSBT205P	**Major Practical**	Practical (PMSBT201 + PMSBT202)	Practical	100	2	8
PMSBT206P	**Major + Major Elective Practical**	Practical (PMSBT203 + PMSBT204)	Practical	100	2	8
PMSBT207	**OJT/FP**	Internship (90 hours)	-	100	4	-
Total				650	22	31
All Subjects having Field Project as part of Continuous Assessment-2						

Abbreviations:
OJT : On Job Training: Internship/ Apprenticeship
FP : Field Projects

Evaluation Pattern

Marking Code	Marking Scheme
A	60 Marks Final Exam, 20 Marks Continuous Assessment I, 15 Marks – Field Project/Continuous Assessment II - Review article/ Chapter writing, 05 Marks- Attendance
B	50 marks distributed within Quiz/Project/Case study-based assignment
C	100 Marks Practical Examination. Course 1/3 Practical (50 Marks) + Course 2/4 Practical (50 Marks) =100
D	50 Marks Practical Examination. Course 6 Practical (50 Marks)
E	100 marks within Internship of minimum 90 hours duration/ report/PowerPoint presentation and viva

Semester-I

Course Code	Course Type	Course Title	Evaluation Pattern	Marks
PMSBT101	**Major**	Biochemistry	A	100
PMSBT102		Immunology	A	100
PMSBT103		Bioinformatics	A	100
PMSBT104	**Major Elective**	a. Emerging Technologies and Molecular Diagnostics	B	50
		b. Aquaculture Biotechnology		
		c. Bio fertilizers and Bio pesticides production		
PMSBT105P	**Major**	Practical (Course 1+Course 2)	C	100
PMSBT106P	**Major + Major Elective**	Practical (Course 3+Course 4)	C	100
PMSBT107	**RM**	Research methodology	B	50
PMSBT108P	**RM**	Practical (Course 6)	D	50
Total				650

Semester-II

Course Code	Course Type	Course Title	Evaluation Pattern	Marks
PMSBT201	**Major**	Cell biology	A	100
PMSBT202		Plant and Animal Biotechnology	A	100
PMSBT203		Bioprocess Engineering and technology	A	100
PMSBT204	**Major Elective**	a. Drug Discovery, IPR and Bioethics	B	50
		b. Tissue engineering		
		c. Organic farming and Hydroponics		
PMSBT205P	**Major**	Practical (Course 1 + Course 2)	C	100
PMSBT206P	**Major + Major Elective**	Practical (Course 3 + Course 4)	C	100
	OJT/FP	Internship (90 hours)	E	100
Total				650

SEMESTER-I

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	I
Course Name	Biochemistry
Course Code	PMSBT101
Course type	Major
Level of Course	Medium
Total Credits for the Course	4 Theory + 1 Practical

Course objectives:

1. Understanding the structural and functional aspects of lipoprotein, glycoproteins, chaperones, amino acid and nucleic acid.
2. The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Glycobiology & Membrane Biochemistry	1.1	Glycosylation of Biomolecules - Synthesis N-linked, O-linked, and GPI linked glycoproteins and role of glycosylation.	15
		1.2	Lipid aggregates: micelles, bilayers and liposomes-structure, types, preparation, characterization, and therapeutic applications of liposomes.	
		1.3	Composition and Architecture of membrane: structural lipids in membranes, membrane bound proteins - structure, properties, and function	
		1.4	Membrane Dynamics: lipid movements, flippase, FRAP, Lipid raft, Membrane fusion. Solubilization of the membrane by using different detergents.	
II	Protein Folding	2.1	Denaturation and Renaturation of proteins; Denaturants and their mode of action; Anfinsen's classical experiments.	15
		2.2	Folding curves and transitions; Types of protein folding and intermediates; Models of protein folding; Assisted protein folding (Chaperones); Misfolding and diseases	
		2.3	Protein degradation: Ubiquitin-proteasome pathway and lysosomal proteolysis.	
III	Biochemistry of Nucleic acids	3.1	Forces stabilizing nucleic acid structures, triple helix. Superhelix topology- linking number, Twist and writhing number, measurement of supercoiling and Topoisomerases.	15

		3.2	Nucleic acid binding protein – Leucine Zipper, Zinc fingers, OB fold, Beta Barrel, Helix-turn-helix, Helix-loop-helix. Biosynthesis of nucleic acids and inborn errors of nucleic acid metabolism.	
		3.3	Methodologies for detection: Protein –Protein and DNA – Protein interactions: Gel retardation assay, DNA footprinting, Yeast-2-Hybrid Method advantages & limitations, yeast split hybrid and reverse two-hybrid systems. Co-Immunoprecipitation (Co-IP) and FarWestern Blot Analysis.	
IV	Bioenergetics and regulation of metabolism	4.1	Biosynthesis of Amino acids; tyrosine, phenylalanine, threonine and methionine.	15
		4.2	Bioenergetics-coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism.	
		4.3	Elucidation of metabolic pathways: Experimental approaches to the study of Metabolism, Integration of central metabolism; entry/ exit of various biomolecules from central pathways, principles of metabolic regulation.	
TOTAL LECTURES				**60**

Course outcomes: By the end of the course the student will be able to -

1. Describe glycosylation of biomolecules and its biological significance.
2. Explain types of lipid aggregates and structural lipids and membrane dynamics, its synthesis and applications.
3. Identify factors causing protein denaturation. Describe the protein structure and function and outline the process of protein purification and summarize the pathway for protein folding – its transitions and the diseases that arise as a result of its misfolding.
4. Examine factors that stabilize nucleic acids and the proteins that interact with nucleic acids and control its expression followed by the protein detection methods
5. Explain biosynthesis of amino acids and assess the bioenergetics of coupled interconnecting reactions in metabolism, elucidation of metabolic pathways and integration of central metabolism.
6. Discuss the energy metabolism in various specific organs and metabolic homeostasis and metabolic adaptation. Explain the correlation upon how the living organisms exchange energy and matter with the surroundings for their survival, and store free energy in the form of energy-rich compounds

References:

1. Stryer, L. (2015). Biochemistry. (8th edition) New York:Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th edition). New York,NY:Worth.

3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th edition). Hoboken, NJ: J. Wiley Sons.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008).
5. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H.Freeman.
6. Lewin's Genes XI. Burlington, MA: Jones & BartlettLearning.

Case study:

1.	Baby Ronny had difficulty feeding ever since he was born. And after 6 months he started showing "orange sand" symptoms in his diaper. Later after two years of age he started showing aggressive behaviors, self-mutilating behaviors such as lip and finger biting and head banging on walls or solid surfaces. He had bulges in elbows, ears on his skin. And he had never learned to speak fluently, he had difficulty in forming words. When he was shown to the doctor, they warned Ronny's parents if not treated early could develop gout.
2.	A six-year-old boy was referred to Hospital in January 1990 with the problem of aggressive behavior and developmental delay. He was born after an uneventful pregnancy. His mother noticed at the age of three months that her child was rather quiet and could not hold his head up. The child shows slower growth than the normal. The parents were first cousins and one of the maternal grandfathers was mentally retarded. Clinical examination revealed a stunted child with height and weight below the 3rd centile and with light brown hair. He was very playful, hyperactive and very destructive and aggressive towards other children. He could not follow simple instructions and was unable to read, write alphabetical letters or even perform simple arithmetic. Laboratory investigations revealed normal blood counts, blood glucose and electrolytes. The urine ferric chloride test was positive (blue-green) and dinitro-phenyl hydrazine test (ANPH) was also positive. The cyanide nitroprusside test was negative. Urine amino-acid thin layer chromatography (T.L.C) revealed a band of increased staining intensity which corresponded to the chromatogram of phenylalanine (Band 2 = phenylalanine). Plasma amino-acid chromatography (TLC) revealed the phenylalanine band (Band 2) was increased. These two tests were repeated again which showed similar conclusions. The other siblings and the parents were screened but did not reveal any abnormality.

PRACTICALS

1	To prepare Acetate and Phosphate buffers using the Henderson-Hasselbalch equation.
2	To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3	Protein gel staining techniques: silver staining, Activity staining: LDH, glycoprotein staining
4	Viscosity studies of proteins.
5	Identification of sugars in fruit juices using thin layer chromatography.
6	Isolation of starch from potato and its estimation by anthrone method.
7	Estimation of Sugar by GOD-POD method.

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	I
Course Name	Immunology
Course Code	PMSBT102
Course type	Major
Level of Course	Medium
Total Credits for the Course	4 Theory + 1 Practical

Course Objectives:

1. The objective of this course is to learn about structural features of components of the immune system as well as their function. The major emphasis of this course will be on development of the immune system and mechanisms by which our body elicits immune response.
2. This will be imperative for students as it will help them to predict the nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Vaccinology	1.1	Active and passive immunization; live, killed, attenuated, Subunit vaccines; vaccine technology: role and properties of adjuvants.	15
		1.2	Recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies	
		1.3	Catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral- like particles (VLPs), dendritic cell-based vaccines, vaccine against cancer, T cell-based vaccine, edible antibodies and therapeutic vaccine	
II	Immune effector Mechanism	2.1	Immunity to infection: bacteria, viral, fungal and parasitic infections (with examples from each group)	15
		2.2	Hypersensitivity Reactions: Type I –IV.	
		2.3	Autoimmunity: types of autoimmune diseases; mechanism for Induction of Autoimmunity; treatment of autoimmune diseases.	

III	Clinical Immunology	3.1	Immunodeficiency: Primary immunodeficiency, acquired or secondary immunodeficiency.	15
		3.2	Tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy.	
		3.3	Transplantation and Transfusion immunology: immunological basis of graft rejection; clinical transplantation and: clinical transplantation and immunosuppressive therapy, Blood transfusion- ABO and Rh Blood groups, Potential transfusion hazards, Transfusion alternatives.	
IV	Immuno-diagnostics and Animal Models	4.1	Immunodiagnostics: Hemagglutination and Blood typing; Phage Display libraries; Microscopy and Imaging; TUNEL Assay; Assay for cytotoxic T–Cell.	15
		4.2	Detection of Immunity in Vivo: Tuberculin Test, Testing of allergic responses, Arthus Reaction and adoptive transfer of Lymphocyte and Hematopoietic Stem Cell.	
		4.3	Animal models: Inbred-strain, Adoptive transfer technique, Congenic-strain, Transgenic animals, and their use in immunological studies, Knockout Mice.	
Total Lectures				**60**

Course outcomes: By the end of the course the student will be able to-

1. Identify the modes of immunization
2. Illustrate the principle strategies available for developing a vaccine and explain the significance of critical antigens, immunogens and adjuvants in developing effective vaccines
3. Correlate the causes, principles involved, examples, control and treatment of immunodeficiency disorders, hypersensitivity reactions, autoimmune diseases and cancer.
4. Comment on the organs, tissue transplantation and blood transfusion-principle involved, types of transfusion reactions and their control, tests to be performed for safe transplantation.
5. Summarize immunity to infection: bacteria, viral, fungal and parasitic infections
6. Discuss the usefulness of various immunological techniques and explain the variants of animal models used in immunological research.

References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. NewYork: W.H. Freeman.
2. Murphy,K.,Travers,P.,Walport,M.,& Janeway,C.(2012). Janeway's Immunobiology. New York: Garland Science.
3. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic

Press.
4. Immunology essential and fundamental, Second edition S Pathak & U Palan Parveen Publishing House
5. Immunology, An introduction, fourth edition. Ian R Tizard Thomson
6. Immunology, sixth Ed Roitt, Brostoff, Male Mosby, An imprint of Elsevier science Ltd

Case Study:

1.	John, a 28-year-old male, presented with seasonal allergic rhinitis symptoms including nasal congestion, sneezing, and itchy eyes. Diagnosis with skin prick testing confirmed sensitization to pollen allergens. Treatment-line suggested to him were allergen avoidance, intranasal corticosteroids, and antihistamines for symptom relief. Immunotherapy is an option for refractory cases. With adherence to treatment, John experienced significant symptom improvement, enhancing his quality of life during allergy seasons.
2.	Sarah, 25 years old female, presented with joint pain, fatigue, and a sun-induced facial rash. Tests confirmed SLE with positive autoantibodies. She receives NSAIDs, corticosteroids, and hydroxychloroquine for symptom management. With treatment, Sarah experienced symptom relief and improved disease control.

PRACTICALS

1	Perform serum electrophoresis(horizontal)
2	Perform the Dot blot assays.
3	Latex bead agglutination / precipitation test for detection of rheumatoid factor
4	Separation of lymphocytes on Ficol Histopaque and viability count.
5	Video Demonstration of tuberculin test
6	Determination of Isoagglutinin titre.

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	I
Course Name	Bioinformatics
Course Code	PMSBT103
Course type	Major
Level of Course	Medium
Total Credits for the Course	4 Theory + 1 Practical

Course Objectives:

1. To provide an overview of the application areas of bioinformatics with a focus on extraction of data from key bioinformatics databases and selection of simple tools for data analysis.
2. To analyze and interpret various types of data including nucleotide and amino acid sequences, protein domains, and protein structures.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Basics of Bioinformatics and DNA sequence analysis	1.1	Bioinformatics basics: Introduction to Unix and Linux systems and basic commands.	15
		1.2	Database concepts; Organization of biological data, databases (raw and processed).	
		1.3	NCBI; publicly available tools; resources at EBI; resources on web; database mining tools. Information retrieval systems. Resource for restriction enzyme (REBASE), Primer designing for PCR.	
II	Bioinformatics Resources and Structural databases	2.1	Bioinformatics Resources – NCBI, EBI, ExPASy, RCSB, DDBJ: The knowledge of databases and bioinformatics tools available at these resources, organization of databases: data contents, purpose and utility.	15
		2.2	Open access bibliographic resources and literature databases: PubMed, BioMed Central, Public Library of Sciences (PloS), CiteXplore	
		2.3	Structural databases:- Protein Data bank (PDB), Nucleic Acid Data Bank (NDB), Molecular modeling Data Bank (MMDB).	
III	Sequence analysis	3.1	Sequence File formats. Sequence Similarity Basics: Similarity, Identity, Homology, Scoring, selectivity/Sensitivity, Gap penalty, Linear and Affine	15

			Gap Penalty, Basic of scoring system and matrices (PAM, BIOSUM)	
		3.2	Similarity Searching Tools: Pairwise Sequences Alignment: Brute Force method, Dot matrix method, Global (NeedlemanWunsch) and Local Alignment (Smith-Waterman) using Dynamic programming. BLAST and FASTA, Theory and Algorithms, variants of BLAST and FASTA, PSI-BLAST, Statistical Significance. Sequence Pattern and Profiles: Concepts of motif, pattern and profile.	
		3.3	Submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences.	
IV	Multiple sequence alignments and protein modeling	4.1	Multiple sequence analysis; methods of phylogenetic analysis.	15
		4.2	Secondary structure prediction methods: Ab initio methods: Chou Fasman and GOR methods, Homology Based Methods Prediction based on Neural Networks.	
		4.3	Tertiary structure prediction methods: Homology Modelling, Threading and Ab initio methods, Docking – rigid and flexible, protein-protein and protein-ligand.	
TOTAL LECTURES				**60**

Course outcomes: By the end of the course the student will be able to -

1. Appreciate the importance of bioinformatics and apply the knowledge gained in a variety of applications of bioinformatics.
2. Extract information from large databases and apply pairwise sequence and multiple sequence alignment of protein and DNA sequences techniques.
3. Utilize various computational methods and tools used for protein secondary structure prediction and genome analysis.
4. Apply and integrate their knowledge of bioinformatics to other areas of their studies and to their everyday life
5. Engage in laboratory investigations that focus on Bioinformatics.
6. Construct testable hypotheses and design scientific investigations that contribute to Bioinformatics.

References:

1. Bioinformatics : Sequence and Genome Analysis (Second Edition 2004) David W. Mount Cold spring Harbor Laboratory Press
2. Bioinformatics and Functional Genomics (2003) Jonathan Pevsner John Wiley & Sons Publications
3. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.

4. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
5. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
6. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.

Case Study:

1.	Protein sequencing is a technique to determine the amino acid sequence of a protein, as well as which conformation the protein adopts and the extent to which it is complexed with any nonpeptide molecules. Discovering the structures and functions of proteins in living organisms is an important tool for understanding cellular processes, and allows drugs that target specific metabolic pathways to be invented more easily.Methods of secondary structure prediction fall into two broad Classes: Ab-initio methods– predict secondary structure based solely on protein sequence; these methods compute statistics for the residues that occur in different secondary structural elements in proteins with known structures, these in order to identify "patterns" in the types of residues that occur in a given type of secondary structure. Homology-based methods– make use of multiple sequence alignments of homologous proteins to predict secondary structure; methods are able to locate conserved patterns that are characteristic of particular secondary structural elements across the aligned family members.
2.	The 2020 pandemic of COVID-19 has had a devastating impact on human health, economies, cultural practices, and higher education, but it has also provided a unique opportunity to teach about microbes in a highly relevant context . Modern technology has allowed a robust and rapid research response to this virus that has not been seen in viral outbreaks in the past. Data has been made publicly available at a record rate, allowing open access to the latest results and helping to direct public health decisions. The genome for SARSCoV2 (causative agent for COVID-19) was sequenced and made publicly available before most of the general public even knew it existed. Professors and instructors teaching microbiology and other biology courses can capture the enthusiasm and true curiosity surrounding COVID-19 by providing engagement with scientific literature and helping students find answers for themselves . Free online databases make it possible for students to access cutting-edge genomic data for the virus causing COVID-19, SARS-CoV-2. With a basic introduction to genomics and bioinformatics, students can generate alignments, search for related ancestors, and discover unique mutations and sequences that make COVID-19 different from other coronaviruses.

PRACTICALS

1	Similarity searches using tools like BLAST and interpretation of results.
2	Multiple sequence alignment using ClustalW.
3	Phylogenetic analysis of protein and nucleotide sequences.
4	Use of genetic prediction methods (GRAIL, Genscan, Glimmer)
5	Using RNA prediction tools
6	Finding orthologs and paralogs using KEGG.
7	Using RASMOL for visualization of protein structures.
8	Use of different protein structure classification databases (SCOP, CATH).

9	Finding Motifs using Prosite.
10	Homology modeling using SPDBV (swiss PDB Viewer)
11	Finding genes by ORF finder
12	Restriction digestion tool (NEB cutter)
13	Designing PCR primer using NCBI BLAST tool
14	Restriction site prediction tools.

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	I
Course Name	Emerging technologies and molecular diagnostics
Course Code	PMSBT104(a)
Course type	Major Elective
Level of Course	Medium
Total Credits for the Course	2 Theory + 1 Practical

Course Objectives:

1. The objectives of this course are to provide introductory knowledge concerning genomics, proteomics and their applications in molecular diagnostics.
2. This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life- sciences.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Functional genomics and proteomics	1.1	Genomics Gene expression by SAGE and Microarrays- Construction of microarrays – genomic arrays, cDNA arrays and oligo arrays and its applications, NGS platforms, high and low read sequences	15
		1.2	Proteomics; Separation and Identification of Proteins 2D-PAGE, isoelectric focusing, Edman reaction Protein tryptic digestion and peptide mass fingerprinting mass spectrometry, MALDI-TOF Protein Expression Profiling; Protein Microarrays/ Protein chips: Types and applications	
		1.3	Gel-based quantitative proteomics: DIGE (Difference in Gel electrophoresis); Gel-free based quantitative proteomic: Surface plasmon resonance, MS based used with stable-isotope tagging, In-vivo labeling- SILAC, In-vitro labeling- ICAT.	
II	CRISPR CAS and Molecular cytogenetics	2.1	CRISPR CAS: History of its discovery, elucidation of the mechanism including introduction to all the molecular players development of applications for in vivo genome engineering for genetic studies, promise of the technology as a next generation	15
		2.2	Advanced Cytogenetic techniques and applications - FISH, M-FISH, SKY, CGH. Molecular Approaches for Delineating, Marker Chromosomes, Prenatal Diagnosis of Common Aneuploidies,	

			Pre-implantation FISH, Diagnosis of Aneuploidies	
		2.3	Cytogenetic changes in different tumor types. Cytogenetics of Leukemias.	
III	Diagnostic Techniques	3.1	Fluorescence microscopy and Confocal microscopy. Advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET) Fluorescence Correlation Spectroscopy (FCS).	15
		3.2	PCR Technique Molecular amplification techniques •Target amplification systems •Probe amplification systems •Signal amplification	
		3.3	Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing Detection and identity of microbial diseases Direct detection and identification of pathogenic- organisms/ viruses E.g. TB and HIV Clinical utility of molecular diagnostics tests (NAAT) for Hepatitis and AIDS. Molecular identification of fungal pathogens Pharmacogenetics	
TOTAL LECTURES				**45**

Course outcomes: By the end of the course the student will be able to -

1. Describe the workflows in the different techniques used for study of transcriptomics and proteomics and also different NGS technologies in the market.
2. Appreciate the application of Crispr Cas system for gene editing and the role of advanced cytogenetic techniques in identifying chromosomal abnormalities.
3. Determine an appropriate sample preparation and instrumentation selection based on the nature of the research inquiry being pursued.
4. Identify the important parameters to conduct the most commonly-used molecular diagnostics protocols.
5. Apply the knowledge to acquire hands-on skills in handling advanced instruments and techniques and understand the data generated.
6. Manage necessary experimental protocols and documentation to ensure accurate interpretation, publication and reproducibility.

References:

1. Campbell, I. D. (2012). *Biophysical Techniques*. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). *Methods in Molecular Biophysics: Structure, Dynamics, Function*. Cambridge: Cambridge UniversityPress.
3. Huang, B., Bates, M., & Zhuang, X. (2009). *Super-Resolution Fluorescence Microscopy.* Annual Review of Biochemistry, 78(1), 993-1016.doi:10.1146/annurev.biochem.77.061906.092014.

4. Ledford,H. (2016). *The Unsung Heroes of CRISPR*. Nature, 535(7612), 342-344. doi:10.1038/535342a.
5. *Molecular Imaging* Theranostics, 4(4), 386-398. doi:10.7150/thno.8006 Coleman, W. B., & Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: HumanaPress.

PRACTICALS

1	Antibiotic sensitivity test using paper disc method.
2	Demonstration of drug resistance.
3	Operation and maintenance of light microscope – Write up
4	Microscopy types Confocal, Fluorescence, STORM – Demonstrations/videos and pictures – Write up
5	Photo album of chromosomal abnormalities in normal and disease condition ● Numerical detected by using different probes centromeric, locus specific, telomeric Structural - Translocations and fusion genes ● Detection of inversions and interstitial deletions by SKY ● CGH for a disease or cancer
6	Purification of antibodies using Affinity chromatography.
7	Quantification of purified antibodies using Lowry's method
8	Video demonstration of 2-D PAGE
9	To resolve soluble proteins by Native PAGE followed by staining with Coomassie Brilliant Blue R-250

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	I
Course Name	Aquaculture Biotechnology
Course Code	PMSBT104 (b)
Type of Course	Major Elective
Level of the Course	Advanced
Total Credits for the Course	2 Theory + 1 Practical

Course Objectives-

1. This course is aimed to teach sustainable use of aquatic resources with various approaches in biotechnology.
2. To empower students to understand the recent trends and challenges of farming society in the field of Aquaculture and get confidence to work on different kinds of aquaculture practices.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Introduction to Aquaculture	1.1	Overview-History, definition and significance of aquaculture, Comparison of aquaculture with agriculture and commercial fisheries; Aquaculture-Present status, problems and scope of fish farming in global and Indian Perspective	15
		1.2	General characteristics of Commercially important cultivable finfishes, shellfish criteria for selection of candidate species, Freshwater and marine cultivable fishes and their biology.	
		1.3	Classification of Algae by F.E. Fritsch and Modern Classification of Algae. Ecology – Diversity, distribution and Salient features of Chlorophyceae, Phaeophyceae, Rhodophyceae and Cyanophyceae.	
II	Systems of aqua- culture	2.1	Concept of different systems of aquaculture - Monoculture, Polyculture-pond, raceway and rope culture, Composite culture, Monosex culture, Mixed culture; Pen, Cage and raft culture.	15
		2.2	Aqua-farming systems-traditional, extensive, semi-intensive, intensive. Integrated fish farming; Shellfish – culture of prawns and molluscs. Aqua farm construction and pond preparation	
		2.3	Culture of commercial important species i.e. Seaweeds- (Gracilaria, Gelidiella, Kappaphycus) Finfishes (seabass, grouper, pearl spot, mullet, milkfish, cobia, silver pompano and ornamental fishes). Shellfishes (shrimps, crabs, lobsters, mussels, edible oysters, pearl oysters, clams).	

III	Industrial aquaculture technology	3.1	Fish Feed Technology: Types of feed, conventional feed vs functional feeds; Principles of feed formulation and manufacturing, feed ingredients, Diets suitable for application in different aquaculture systems - micro diets, nutritional quality of compounded feeds, culture of live feeds-microalgae, rotifer, Artemia, cladoceran, copepods and polychaetes, nutritional composition of live feeds, bioenrichment.	15
		3.2	Fish handling and transportation, fish spoilage, methods of prevention of spoilage, Post-harvest Biotechnology: Fundamental aspects and methods of freezing, canning, drying, salt curing, smoking and ionizing irradiation, quality control and factory sanitation.	
		3.3	Use of natural and synthetic carotenoids; feed additives; Role of additives; Feed processing: Gelatinization, extrusion Technology, pellet dressing with heat labile nutrients; Fish by products-fish oil-methods of production, fish meal, fish ensilage Fish Protein Concentrate etc.	
TOTAL LECTURES				**45**

Course Outcomes: On completion of this course, students should be able to:

1. Describe the classification, general characteristics of commercially important fishes and status of world and Indian fisheries.
2. Outline the principles and application of biotechnology in aquaculture.
3. Explain the types and practices of aquaculture along with integrated farming.
4. Investigate the aspects of fish spoilage and the role of preservation in quality management of fish.
5. Summarize the techniques involved in the preparation of feed formulation and its processing for cultivable aquatic organisms.
6. Develop the concept and application of aquaculture as a means of employment, entrepreneurship and environmental management.

Reference:

1. Amrik singh Ahluwalia. 2003. Phycology, Principles, processes and Applications. Daya publishing house 481pp.
2. Ashok Pandey., DJ Lee; Yusuf chisti; Carlos Ricardo. 2013. Biofuels from algae. Amsterdam : Elesevier.
3. Christiaan Hoek. 1995. Algae - An Introduction to Phycology. Cambridge University Press, Science
   - 623 pp.
4. T. V. R. Pillay and M. N. Kutty. 2005. Aquaculture Principles and Practices. Wiely Black-Well
5. Chen F and Jian Y. (Eds) 2001. Algae and their biotechnological Potential. Kluwer Academic Publishers.
6. Navid Reza Moheimani et al., 2015. Biomass and Biofuels from Microalgae: Advances in Engineering and Biology. Springer

PRACTICALS

1	Identification of commercially important freshwater finfish/shellfish
2	Components of indoor fish farming system
3	Aquarium making and maintenance
4	Hatching of Artemia cysts and harvesting
5	Breeding of freshwater fishes
6	Estimation of fish fecundity
7	Study of different stages embryonic development
8	Chlorophyll estimation from seaweeds
9	FRAP assay for antioxidant extracted from marine algae
10	Synthesis of silver nanoparticles using algae.
11	Production and analysis of Single cell protein.
12	Visit hatcheries and grow out farms.

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	I
Course Name	Bio fertilizers and Bio pesticides production
Course Code	PMSBT104 (c)
Type of Course	Major Elective
Level of the Course	Advanced
Total Credits for the Course	2 Theory + 1 Practical

Course Objectives-

1. Realize the importance of eco-friendly fertilizers and pesticides.
2. Demonstrate skills on culture and mass production of biofertilizers and biopesticides.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Introduction to Biofertilizers	1.1	Different Agriculturally important beneficial Microorganisms. Introduction and scope of Biofertilizers, Types and classification of Biofertilizers. Total Biofertilizer production in India	15
		1.2	Different Nitrogen Biofertilizers. Symbiotic & Non-Symbiotic Nitrogen fixation. Nodule formation, Competitiveness, Quantification of Nitrogen fixed. Associative and Free-living Nitrogen fixation. Cyanobacterial Biofertilizers.	
		1.3	Phosphate solubilizing Bacteria and Fungi. Mechanism and solubilization of Phosphorus. Phosphate mobilizing microorganisms. VAM in detail, Potassium and Zinc Biofertilizers. Plant Growth Promoting Biofertilizers (PGPR).	
II	Production and Application of Biofertilizers	2.1	Production technology; Strain selection, Sterilization, Growth and Fermentation. Mass scale production of different carrier and liquid based biofertilizers	15
		2.2	FCO specifications and quality control of biofertilizers.	
		2.3	Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers – Storage, shelf life and marketing. Factors influencing the efficacy of Biofertilizers.	
III	Biopesticide Production	3.1	Introduction, importance, scope and potential of Bio Pesticides, Definitions, concepts and classification of Bio Pesticides viz. pathogens, botanical pesticides, and bio rationals.	15

		3.2	Microbial Biopesticides viz. Viruses, Bacteria, Fungi etc. Role of Bio Pesticides in Organic farming and ecofriendly agriculture.	
		3.3	Mass production and scaling up of production of different categories of Bio Pesticides, Methods of applications of Bio Pesticides. Precautionary approaches in application and usage of Bio Pesticides, Methods of quality control and Techniques of Bio Pesticides.	
TOTAL LECTURES				**45**

Course Outcome: By the end of the course the student will be able to:

1. Describe the types and significance of plant growth promoting microorganisms and Biopesticides.
2. Classify Biopesticide viz. pathogens, botanical pesticides, and bio rationals.
3. Understand the role of bio-fertilizers in quality parameters of various agricultural products and the key role of biofertilizers in maintaining soil health.
4. Isolate and characterize biofertilizer and biopesticide formulation.
5. Analyze the effects of biofertilizers and biopesticides on crop growth and development.
6. Carry out Mass scale production of biofertilizers and biopesticides.

Reference:

1. Subrata Datta. 2012. Bio Pesticides and Fertilizers: Novel Substitutes of their Chemical Alternates.Journal of Environmental Research and Development, 6 (3A), 773-777 pp.
2. Biofertilizers in Agriculture by N. S. Subba Rao.
3. Handbook of Microbial Biofertilisers by Mahendra Rai. Published in 2006 by CRC Press.
4. Biofertilizers in Sustainable Agriculture by A. C. Guar. Published by ICAR.
5. Leo, M.L. Nollet, Hamirsingh Rathore. Bio Pesticide Handbook. CRC Press Tayler & Francis group, New York. 1-29 pp.
6. Dwijendra Singh.2014. Advances in Plant Bio Pesticides. Publisher Springer 1-401 pp.

PRACTICALS

1	Isolation of Nitrogen fixing organisms Rhizobium, Azotobacter.
2	Isolation of Phosphate solubilizing mobilizing microbes from soil samples.
3	Isolation of Potassium solubilizing mobilizing microbes from soil samples.
4	Production of Indole Acetic Acid (IAA).
5	Preparation of different Carrier based Biofertilizers- Bacterial and Fungal.
6	Isolation and purification of important Bio Pesticides: Bacterial organisms and their production.
7	Visit to the Biopesticides production unit in a nearby area.

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	I
Course Name	Research Methodology
Course Code	PMSBT105
Type of Course	RM
Level of the Course	Advance
Total Credits for the Course	2 Theory + 2 Practical

Course objectives:

1. To be able to conduct research with an understanding of all the latest theories.
2. To develop the ability to explore research techniques used for solving any real world or innovative problems.

Unit No.	Name of Unit	Topic No.	Content	Hours
I	Introduction to Research	1.1	Meaning, Characteristics of Research, Objectives of research	15
		1.2	Types of research: Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical research	
		1.3	Ethical issues and Problems in research, Meaning of research methodology, Stages in Scientific Research Process	
		1.4	Measurement concepts: Scales of measurement - nominal, ordinal, ratio and interval, Types of measurement scales: comparative scales-Paired Comparison Scale,Rank Order Scale,Q-Sort Scale and non comparative scales- Continuous Rating Scale, Itemised Rating Scale, Likert Scale, Stapel Scale, Semantic Differential Scale.	
II	Sampling Design and Questionnaire Design	2.1	Sampling design- meaning and significance, Essentials of good sampling, Stages in sampling design, Sampling errors	15
		2.2	Types of Probability sampling- simple random sampling, stratified random sampling, systematic random sampling, & cluster random sampling. Types of non-probability sampling-Convenience sampling, Quota sampling, Self-selection (volunteer) sampling, Snowball sampling, Purposive (judgmental) sampling.	

		2.3	Types of data- Primary data and secondary data meaning, significance and limitations, Collection of primary and secondary data	
		2.4	Designing of a questionnaire- meaning, stages in questionnaire designing, Essentials of a good questionnaire.	
III	Data Analysis and Presentation	3.1	Determination of sample size, Editing and Coding	15
		3.2	Basic Data Analysis Arithmetic Mean, Median, mode, Standard deviation, Correlation, Regression analysis	
		3.3	Hypothesis testing for significance, Types of errors in Hypothesis testing	
		3.4	Hypothesis testing for significance for mean/s and proportion for large samples, t test for single mean, paired and unpaired means, Chi-Square test. ANOVA-One way & Two way.	
TOTAL LECTURES				**45**

Course Outcome: By the end of the course the student will be able to

1. Describe sampling methods
2. Explain ethical issues and Problems in research
3. Apply appropriate methods to the research in hand
4. Interpret secondary sources for research
5. Analyze the quantitative and qualitative data
6. Summarize statistical tools and techniques

Reference:

1. Business Research Methods William G.Zikmund, B.J Babin, J.C. Carr, Cengage 8e 2016 Atanu Adhikari, M.Griffin
2. Business Analytics Albright Winston Cengage 5e 2015
3. Research Methodology-Method and Techniques 3e 2014
4. Research Methodology: Methods & Techniques, C.R. Kothari
5. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and Other Related Fields-Pradeep Kumar
6. Research Methodology: A Step-by-Step Guide for Beginners- Ranjit Kumar

PRACTICALS

1	Using R execute the basic commands
2	Import the data from Excel / .CSV find mean median mode,standard deviation variance
3	Perform R program for making Diagrams(Bar Diagram, Multiple Bar Diagram, Pie Chart)
4	Perform R program for making Graphs(Histogram, Frequency Polygon, Ogive)
5	Import the data from Excel / .CSV and perform the Chi-square Test, goodness of fit, Independence of attributes
6	Perform an R program on z-test- one population mean, Two population means.One population proportion,two population proportion.
7	Perform an R program on t test- one sample, paired and unpaired
8	Perform an R program on Non ParametricTest -Sign test, wilcoxon signed rank test
9	Perform an R program on One way ANOVAand Two way ANOVA
10	Perform an R program on Friedman Test and Kruskal Wallis test

SEMESTER-II

BOS	Biotechnology
Class	M. Sc Part-I
Semester	I
Course Name	Cell Biology
Course Code	PMSBT201
Course type	Major
Level of Course	Advanced
Total Credits for the Course	4 Theory + 1 Practical

Course Objectives:

1. The paper aims to provide an understanding of the functions of cells at molecular level.
2. The course will give a thorough knowledge about structure and function of cells, cellular energetics, protein trafficking, bio molecules and cellular development.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Dynamics and organization of cell	1.1	Universal features of cells; internal organization of the cell - cell membranes and cell organelle;	15
		1.2	Dynamics of DNA and mechanisms based on central dogma; chromatin control: gene transcription and silencing by chromatin Writers,- Readers and – Erasers	
		1.3	Replication, transcription and translation machineries, post translational modifications, mitochondrial genetic code translation product cleavage, modification and activation.	
II	Cellular signaling, transport and trafficking	2.1	Cellular signaling Molecular mechanisms of membrane transport	15
		2.2	Nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.	
		2.3	Cell signaling- intercellular communications- nerve impulses, neurotransmitters; agonist and antagonist reactions	
III	Cellular processes – manipulations	3.1	Cell cycle and its regulation; cell divisions and related machineries; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues;	15

		3.2	Cell-ECM and cell-cell interactions;cell motility and migration; cell death: different modes of cell death and their regulation.	
		3.3	Isolation of cells and basics of cell culture; observing cells under microscope, analyzing and manipulating DNA, RNA and proteins.	
IV	Genome instability and cell transformation	4.1	Mutations, proto-oncogenes, oncogenes and tumor suppressor genes, physical, chemical and biological mutagens; types of mutations	15
		4.2	Epigenetic mutations intra- genic and inter-genic suppression; transpositions-transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome	
		4.3	Viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.	
Total Lectures				**60**

Course outcomes: By the end of the course the student will be able to:

1. Describe cellular organization, characteristic features and molecular processes like replication, transcription and translation.
2. Outline the concept of cell cycle regulation, cellular signaling, transport and trafficking.
3. Determine the role of Cell ECM and cell -cell interactions in maintenance of cellular integrity and functions; develop methods for isolation of cells, cell culture and laboratory techniques for analyzing macromolecules.
4. Analyze genes and genetic changes affecting cycle regulation and mechanisms that lead to apoptosis and development of cancer.
5. Justify the role of chromatin remodeling in facilitating gene expression.
6. Identify, formulate, and solve problems that arise due to the inefficient functioning of the various cellular processes like cell-to-cell communication, cellular transport and trafficking, cell cycle regulation, gene expression processes of a cell or system.

References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). Molecular Biology of the Cell. New York: GarlandScience.
2. Lodish, H. F. (2000). Molecular Cell Biology. New York: W.H.Freeman.
3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & BartlettLearning.
4. Cooper, G. M., & Hausman, R. E. (2009). The Cell: a Molecular Approach. Washington: ASM; Sunderland.
5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston: BenjaminCummings.

6. Watson, J. D. (1987). Molecular Biology of the Gene (7th ed.). Menlo Park, CA:Benjamin/Cummings.

Case Studies:

1.	John, a 65-year-old man, presented with symptoms of memory loss, confusion, and difficulty in performing daily tasks. His family reported noticing these symptoms gradually worsening over the past few months. Concerned about the possibility of dementia, John's doctor decided to investigate the role of neurotransmitters in his condition.
2.	Sarah, a 40-year-old woman, presented with symptoms of chronic fatigue, muscle weakness, and difficulty concentrating. Her symptoms had been progressively worsening over the past few months, despite adequate rest and nutrition. Suspecting a mitochondrial disorder, Sarah's physician decided to investigate the transport processes across mitochondria to understand the underlying cause of her symptoms. Sarah underwent a series of tests, including blood work, muscle biopsies, and genetic analysis. Results revealed abnormalities in mitochondrial function, including impaired ATP production and disrupted electron transport chain activity. Further investigation using electron microscopy confirmed structural abnormalities in Sarah's mitochondria, indicating dysfunction at the molecular level.

PRACTICALS

1	Isolation of chloroplast by density gradient centrifugation techniques from plant sources
2	Isolation of chloroplast DNA
3	Study of Hill’s reaction using chloroplast.
4	Restriction Enzyme digestion of plasmid DNA
5	Ligation Reaction
6	Cell motility studies (bacteria, algae, cyanobacteria, protozoans,)
7	Cell death /apoptosis studies using flow-cytometry- demonstration

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	II
Course Name	Plant and Animal Biotechnology
Course Code	PMSBT202
Course type	Major
Level of Course	Advanced
Total Credits for the Course	4 Theory + 1 Practical

Course Objectives:

1. To provide an insight into an interdisciplinary research program on plant and animal cell and tissue cultures, its applications and transgenic technology.
2. To understand the principles of artificial reproductive techniques in livestock, its applications in animal biotechnology and the concept of molecular markers, molecular diagnostics of pathogens in plants and animals.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Plant tissue culture	1.1	Plant tissue culture: historical perspective; totipotency; organogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques	15
		1.2	Applications of tissue culture: micropropagation; Somatic embryogenesis; somaclonal variation; androgenesis, and its applications in genetics and plant breeding; synthetic seed production	
		1.3	Protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids	
		1.4	Plant cell cultures for secondary metabolite production, Hairy root culture, elicitation, Molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.	
II	Animal Tissue Culture	2.1	Animal cell culture: brief history of animal cell culture; Cell Culture Laboratory Design and Equipments	15
		2.2	Cell culture media and reagents: Types of cell	

			culture media, its ingredients and significance; Preparation and sterilization of cell culture media, culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures.	
		2.2	Cell culture media and reagents: Types of cell culture media, its ingredients and significance; Preparation and sterilization of cell culture media, culture of mammalian cells, tissues and organs	
		2.3	Different tissue culture techniques; Types of primary culture; Secondary culture; Cell separation; Trypsinization; Continuous cell lines; Suspension culture; Organ culture etc.; Behaviour of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Common cell culture contaminants.	
		2.4	Application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.	
III	Animal reproductive biotechnology and Vaccinology	3.1	Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock artificial insemination; superovulation, embryo recovery and *in vitro* fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology	15
		3.2	Animal cloning - basic concept, cloning for conservation of endangered species	
		3.3	Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines	
IV	Molecular mapping and marker assisted selection	4.1	Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and	15

			applications; introduction to mapping of genes/QTLs	
		4.2	Marker-assisted selection-strategies for Introducing genes of biotic and abiotic stress resistance in plants	
		4.3	Genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.	
TOTAL LECTURES				**60**

Course outcomes: By the end of the course the student will be able to-

1. Describe the fundamental principles and types of cell cultures in animal and plant biotechnology
2. Outlining the concept of vaccination, the conventional methods of animal vaccine production followed by recombinant approaches to vaccine production
3. Demonstrate genetic approaches used in production of transgenic plants and the use of animal cloning techniques for protection of endangered species.
4. Explaining artificial insemination, collection and cryopreservation of gametes and embryos and the assisted reproduction techniques more frequently used for embryo production and manipulation in vivo and in vitro.
5. Summarize the applications of plant and animal biotechnology for the benefit of society
6. Elaborate the concept of molecular markers for marker assisted selection and use of molecular techniques for disease diagnosis and disease resistance in plants and animals.

References:

1. Biology of plant metabolomics, Robert Hall, Annual Plant Reviews, 43,Chichester, West Sussex; Ames, Iowa : Wiley-Blackwell, 2011
2. Plant Biotechnology. Umesha, S. (2013).
3. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
4. Brown, T. A. (2006). Gene Cloning and DNA Analysis: An Introduction. Oxford: Blackwell Publishers.
5. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.

Case Studies:

1.	The lack of immunization in developing countries is undoubtedly the most serious consequence of the difficulty in accessing traditional vaccination systems. The World Health Organization (WHO) has aimed to find low-cost vaccines, which are accessible to the population and are easy to store and distribute without the need for refrigeration. There is literature support that orally administered edible vaccines are promising agents to reduce the incidence of diseases such as hepatitis and diarrhea, especially in the developing world. Research is done for studying the suitability of edible vaccines as biopharmaceuticals in the context of the 2030 Agenda for Sustainable Development, allowing to comprehensively address both malnutrition and the degree of immunization, mainly in the child population in developing countries. UNand FAO

	called it ‘Therapeutic Food’ or ‘Ready to Use Therapeutic Food’.
2.	Animal husbandry refers to livestock raising and selective breeding. It is the management and care of animals in which the genetic qualities and behavior of animals are further developed for profit. A large number of farmers depend upon animal husbandry for their livelihood. Animals provide us with a variety of food products which have high nutritional values. Therefore, they require a lot of care and attention. Animals are bred commercially in order to meet the high demand for food. Dairy products from animals like cows, buffaloes, goats, are rich sources of protein. These animals are called milch animals as they provide us with milk. Several decades ago, embryo transfer (ET) methods were established in cattle. Since embryos recovered from females with valuable economical traits can be utilized, this technology facilitates the selection of females. However, cattle produce only a single oocyte per estrous cycle; therefore, the number of embryos that can be recovered from the genetically superior individuals is limited. To solve this problem, superovulation (SOV) methods were developed. A leading dairy company in India wanted to have an Australian Holstein Friesian for the dairy product. Due to transportation hindrances the embryo of the animal was transported instead.

PRACTICALS

1	Prepare culture media with various supplements for plant tissue culture.
2	Prepare explants of *Valleriana wallichii* for inoculation under aseptic conditions.
3	Isolation and induction of anther cultures using hibiscus.
4	Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG (available material).
5	Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species.
6	Undertake plant genomic DNA isolation by CTAB method and its quantization by visual as well as spectrophotometric methods.
7	Restriction Fragment Length Polymorphism (RFLP) Technique (Demonstration)
8	Prepare karyotypes and study the morphology of somatic chromosomes of *Allium cepa, A. sativum, A. tuberosum* and compare them on the basis of karyotype.
9	Count cells of an animal tissue and check their viability.
10	Preparation of culture media with various supplements for animals
11	Prepare single cell suspension from spleen and thymus.
12	Peripheral Blood Monocyte to Macrophage Conversion by Adherence Based Method.
13	NBT Assay for Oxidative Stress.
14	MTT Assay for Viability.
15	Chromosome preparations from cultured animal cells
16	Isolate DNA from animal tissue by SDS method.

BOS	Biotechnology
Class	M. Sc. Part-I
Semester	II
Course Name	Bioprocess Engineering and technology
Course Code	PMSBT203
Course type	Major
Level of Course	Advanced
Total Credits for the Course	4 Theory + 1 Practical

Course Objectives:

1. To empower the students with various designs of fermenter, the growth kinetics and process kinetics of the fermentation process enable the students to manipulate for improvement.
2. To provide an international peer-reviewed forum to facilitate the discussion between engineering and biological science to find efficient solutions in the development and improvement of bioprocesses.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Basic principles of biochemical engineering	1.1	Sources of Microorganisms Used in Biotechnology- Literature search and culture collection supply, Isolation de novo of organisms producing metabolites of economic importance.	15
		1.2	Strain Improvement- Selection from naturally occurring variants, Manipulation of the genome of industrial organisms in strain improvement	
		1.3	Bioreactor design and analysis-Media formulation and optimization methods; sterilization of bioreactors, aeration and agitation in bioreactors KLa value (factors affecting and methods of determination), heat transfer in bioprocess measurement and control of bioprocess parameters.	
		1.4	Bioprocess economics	
II	Production of proteins from recombinant microorganisms	2.1	Principles of Microbial Growth- Batch Fermentation, Fed-Batch Fermentation, Continuous Fermentation	15
		2.2	Maximizing the Efficiency of the Fermentation, Process- High-Density Cell Cultures, Increasing Plasmid Stability, Quiescent *E. coli* Cells, Protein Secretion and Reducing Acetate	
		2.3	Bioreactors Typical Large-Scale, Fermentation Systems Two-Stage, Fermentation in Tandem Airlift Reactors, Two-Stage Fermentation in a Single Stirred-Tank Reactor, Batch versus Fed-Batch Fermentation Harvesting Microbial	

			Cells, Disrupting Microbial Cells, Downstream Processing, Protein Solubilization, Large-Scale Production of plasmid DNA	
III	Applications of enzyme technology in food processing	3.1	Introduction and scope 1.Enzymes sourced from animals and plants used in food manufacturing technology 2.Enzyme usage in food applications.	15
		3.2	Mechanism of enzyme function and reactions in food processes 1. Starch-processing and related carbohydrates. 2. Lipases for the production of food components:interesterified fat 3. Enzymes in protein modification: hydrolyzed protein 4. Enzymes in bread making - flavour, texture and keeping quality 5. Enzymes in dairy product manufacture 6. Enzymes in fruit and vegetable processing and juice extraction 7. Enzymes in fish and meat processing Beer Production using Immobilized Cell Technology.	
IV	Applications of Enzyme and microbial technology in food process operations and production	4.1	Microbial biomass production- mushrooms, SCP Fermented foods and beverages: Sauerkraut production, soya bean fermentations, apple cider	15
		4.2	Food additives and supplements- a) Lipids, Nucleosides, nucleotides and related compounds- Vitamins b) Natural food preservatives- bacteriocins from lactic acid bacteria – production and applications e.g. Nisin c) Microbial production of colours and flavours. d) Polyhydric alcohols: low-calorie sweetener particularly useful for sweetening food products for diabetics Microbial exopolysaccharides - Xanthan gum	
		4.3	Rationale for immobilizing enzymes, Methods for enzyme immobilization, Properties of immobilized enzymes, applications of immobilized enzymes.	
TOTAL LECTURES				**60**

Course outcomes: By the end of the course the student will be able to:

1. Recognize the relevance of microorganisms from an industrial context.
2. Describe the design and operations of various fermenters.
3. Explain important microbial/enzymatic industrial processes in the food and fuel industry.

4. Identify the aspects involved in the fermentation process for production of proteins.
5. Differentiate between the staired tank and pneumatic fermenters which will be used in the production process.
6. Summarize types of enzymes and mechanisms of enzyme reaction used in food processing industries.

References:

1. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology.Oxford: Pergamon Press.
2. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor &Francis.
3. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: WorldScientific.
4. Michael Waites and Morgan, Rockney and Highton -Industrial microbiology: AnIntroduction
5. Robert Whitehurst and Maarten Van Oort - Enzymes in food technology 2nd ed
6. Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield.

Case Studies:

1.	Municipal solid waste generation and disposal is a problem not only in India but all over the world. Presently majority of such waste is being dumped indiscriminately over vacant lands causing problems of odor, methane generation leading to air pollution, leaching effect polluting groundwater and runoff polluting water bodies. Technological options are available to treat this solid waste and convert it into usable products but the biggest problem is its segregation preferably at the source of generation or even at the disposal area. Municipal solid waste generated in India consists of 15 percent non-biodegradable which has high calorific contents and can be converted into power generation. Remaining 85 percent is degradable which can either be converted into compost or bio fuels. Under the present context, sustainable municipal waste management strategy needs to be evolved and put in place with effective implementation to address the issue of environmental pollution. An effort has to be made as to how much compost, bio fuel and power can be generated along with economic value to make it sustainable on a time scale.
2.	One of the most important processes in fuel ethanol production is yeast fermentation of glucose into ethanol. When fermentation is running well, downstream operations run well. Unfortunately, if fermentation does not run well, downstream processes become fouled and low quality byproducts are produced. Also, fuel ethanol output is compromised, reducing facility profits.Commercial products are synthesized by using genetically engineered organisms in the bioreactors. Many parameters are playing an important role in the production of the product. Whatever the conditions were effective in small scale production should be equally effective in large scale production. Various types of fermenters have been used for the growth of microbial cells for its production and the major objective of fermentation is to maximize the volumetric productivity. There are two types of enzymes which are produced by microorganisms that are intracellular and extracellular.

PRACTICALS

1	Use of microorganisms to produce a product. Detects utilization of substrate and formation of product at time intervals. Attempt purification of product e.g. Alcohol.
2	Immobilize an organism / enzyme and detect the conversion of substrate to product.
3	Production and extraction of microbial pigment.
4	Demonstration of media optimization by Placket Burman test-demonstration
5	Methods for measurement of cell mass: a. Direct physical measurement of dry weight, wet weight, or volume of cells after centrifugation. b. Indirect measurement of chemical activity such as nutrient utilization and product synthesized. c. Turbidity measurements employ a variety of instruments to determine the amount of light scattered by a suspension of cells.
6	Detection of different food enzymes by simple tests (amylase, catalase, invertase, papain, pectinase, pepsin)
7	Study of the pickling process (sauerkraut / pickled cucumbers) with respect to physical, chemical / biochemical and biological changes occurring during the pickling process.

BOS	Biotechnology
Class	M. Sc. I
Semester	II
Course Name	Drug discovery, IPR and Bioethics
Course Code	PMSBT204 (a)
Course type	Major Elective
Level of Course	Advanced

Total Credits for the Course	2 Theory + 1 Practical

Course Objectives:

1. To gain knowledge on the process of drug discovery and pharmacovigilance
2. To acquaint the students with basics of types of intellectual property rights with special reference to laws and its practices.

Unit No.	Name of Unit	Topic No.	Contents	Hours
I	Clinical Research Informatics in Drug Discovery	1.1	Introduction to the drug discovery & development ● Source of drugs ● Structural effects on drug action ● Drugs derived from natural products ● General principles of pharmacology Drug development and testing process	15
		1.2	Approaches to new drug discovery ● Computer-aided drug design ● Identification of novel drug candidates and drug targets ● Construction the signalling network of a drug using integer linear programming Identification for druggable targets of a disease	
		1.3	Generative AI and its application ● Generative AI and pivotal role in drug discovery. ● Milestones in AI-Enabled Drug Discovery - How AI and ML are transforming drug discovery. ● Applications of AI-based methods at different stages of a drug discovery pipeline AI-based software tools for drug development process: Alphafold by Deepmind, MoLFormer by IBM, FrameDiff by MIT, RosettaFold2, RFdiffusion	
II	Pharmaco- vigilance	2.1	Scope and purposes of pharmacovigilance ● Adverse Drug Reactions (ADR) ● ADR classification ● Nature and mechanism of ADR ● Concept of safety Phases and types of DATA	15
		2.2	The process of Pharmacovigilance Signal detection, evaluation and investigation, Communication	
		2.3	Methods of evaluating effectiveness of action	
III	Intellectual Property Rights & Bioethics	3.1	Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional	15

			Knowledge, Geographical Indications. Basics of Patents and Concept of Prior Art: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees;	
		3.2	Patent databases; Searching International Databases; Country- wise patent searches (USPTO, esp@cenet (EPO), PATENT Scope (WIPO), IPO, etc.) Patent filing procedures: National & PCT filing procedure; Time frame and cost; Precautions while patenting– disclosure/ non-disclosure; Patent licensing and agreement, Patent infringement-meaning, scope, litigation, case studies.	
		3.3	Introduction, bioethics in health care- euthanasia, artificial reproductive technologies, cloning and stem cell research, gene therapy, organ transplantation.	
		3.4	Ethics of clinical research, Human and animal experimentation, Guidelines and format for preparing research proposals for ethical review. Agricultural biotechnology- Genetically engineered food, environmental risk, labeling and public opinion, bioterrorism.	
TOTAL LECTURES				**45**

Course outcomes: By the end of the course the student will be able to:

1. Relate the various ways for discovering new drugs.
2. Describe the discovery of new drugs through CADD.
3. Illustrate key regulatory and compliance elements and plan prediction model development.
4. Prepare required documentation for the regulatory affairs and propose technical aspects pertaining to the marketing authorization application (MAA)
5. Describe the various types of IPR.
6. Discuss the different types of patents and the procedures to obtain them and examine in detail inventions that can be patented.

References:

1. Basic & Clinical Pharmacology (14th Edition, 2017) - Bertram G. Katzung - McGraw-Hill Education.
2. Software based approaches for drug designing and development: A systematic review on commonly used software and its applications - Prasad G. Jamkhande, Mahavir H. Ghante, Balaji R. Bulletin of Faculty of Pharmacy.
3. Bioinformatics and Drug Discovery (3rd Edition, 2019) - Richard S. Larson, Tudor I. Oprea A- Humana Press, New York, NY 5. An Introduction to Pharmacovigilance (2nd Edition, 2017) - Patrick Waller and Mira Harrison-Wiley Blackwell.
4. Regulatory environment for clinical research: Recent past and expected future - Bhave A, Menon S - Perspect Clin Res 2017;8:11-6. DOI: 10.4103/2229-3485.198551

5. Regulatory requirements for clinical trials in India: What academicians need to know? - Gogtay N, Ravi R, Thatte U - Indian J Anaesth. 2017 Mar; 61(3): 192–199. DOI: 10.4103/ija.IJA_143_17
6. Good Pharmaceutical Manufacturing practice, Rational and compliance by John Sharp, CRC Press

PRACTICALS

1	A finding of a drug-gene interaction or potentially druggable category using The Drug Gene Interaction Database (DGIdb)
2	Recognition of binding patterns common to set of protein structures using ProBiS
3	Recognition of common spatial chemical binding patterns to a Set of Protein Structures using **Multi**ple Alignment of Protein **Bind**ing Sites (MultiBind) tool and analysis using RasMol/Jmol
4	Computational protein-ligand docking using AutoDock (DEMO)
5	Case report on clinical trials (Groupwise project)

BOS	Biotechnology
Class	M. Sc. I
Semester	II
Course Name	Tissue Engineering
Course Code	PMSBT204 (b)
Course type	Major Elective

Level of Course	Advanced
Total Credits for the Course	2 Theory + 1 Practical

Course Objectives:

1. To introduce principles and applications of tissue engineering.
2. To understand how engineering and life science principles come together in tissue engineering.

Unit No.	Name of Unit	Topic No.	Name of the topic	Hours
I	Fundamental Of Tissue Engineering	1.1	Fundamentals Of Stem Cell Tissue Engineering; Growth Factors; Extracellular Matrix: Structure, Function And Tissue	15
		1.2	Engineering Application; Mechanical Forces On Cells; Cell Adhesion; Cell Migration.	
II	Tissue Engineering Enabling Technologies	2.1	Polymer Scaffold For Tissue Engineering Applications; Biomimetic Materials; Nanocomposite Scaffolds Tissue Engineering	15
		2.2	Bioreactors; Regulatory Issues In Tissue Engineering	
III	Tissue Engineering Application	3.1	Bioengineering Of Human Skin Substitute; Nerve Tissue Engineering; Musculoskeletal Tissue Engineering; Bone Tissue Engineering; Cartilage Tissue Engineering	15
		3.2	Temporomandibular Tissue Engineering; Smooth Muscle Tissue Engineering; Esophagus Tissue Engineering.	
TOTAL LECTURES				**45**

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

1. Understand the components of the tissue architecture.
2. Explain the basic concept behind tissue engineering focusing on the stem cells, biomaterials and its applications.
3. Demonstrate proficiency with several fundamental experimental techniques in tissue engineering.
4. Describes the combined use of cells, materials, and biochemical factors to induce the growth of functional tissues for medical applications.
5. Evaluate the ethical implications of different tissue engineering strategies
6. Summarize Clinical applications of bioengineering and cell/tissue engineering pertinent to the health care setting.

References:

1. Clemens van Blitterswijk (2008), Tissue Engineering, Academic Press.
2. Lanza, R., Langer, R., Vacanti, J. P., & Atala, A. (Eds.). (2020). Principles of tissue engineering. Academic press.
3. Palsson, B., Hubbell, J. A., Plonsey, R., & Bronzino, J. D. (2003). Principles and applications in engineering series. Tissue Engineering, CRC Press, Boca Raton, FL.
4. Bernhard O. Palsson, Sangeetha N. Bhatia, Tissue Engineering, 2004, Pearson
5. Robert A Brown, Extreme Tissue Engineering: Concepts and Strategies for Tissue Fabrication, 2013, Wiley Blackwell
6. John P Fisher, Antonios G Mikos, Joseph D Bronzino, Tissue Engineering, 2006, CRC Press

PRACTICALS

1	Synthesis Of Graphene Oxide.
2	Synthesis Of Tio2 Nano-Tubes For Tissue Engineering
3	Hemocompatibility Study Of Biomaterials
4	Synthesis Of Polyelectrolyte Complex Of Non-Mulberry Silk Fibroin
5	Synthesis Of Hydroxyapatite

BOS	Biotechnology
Class	M. Sc. I
Semester	II
Course Name	Organic Farming and Hydroponics
Course Code	PMSBT204 (c)
Course type	Major Elective
Level of Course	Advanced

Total Credits for the Course	2 Theory + 1 Practical

Course Objectives:

1. To provide knowledge and expertise of various aspects of hydroponics, organic cultivation to the students.
2. To equip learners with the knowledge and skills necessary to practice sustainable agriculture & introduce the concept of organic cultivation.

Unit No.	Name of Unit	Topic No.	Content	Hours
I	Principle of Organic Farming	1.1	Organic farming – definition – need – scope – principles – characteristics - relevance to modern agriculture. Initiatives taken by the central governments, NGOs and other organizations for promotion of organic agriculture in India.	15
		1.2	Types of Organic Farming Approach; Traditional, Sustainable, Biodynamic, Natural, Permaculture.	
		1.3	Organic nutrient sources and their fortification – organic manures- methods of composting. Green manure, Microbial Fertilizer, Mineral Fertilizer	
II	Nutrient, Pest & Weed Management	2.1	Nutrient use in organic farming-scope and limitations; Nutrient management in organic farming	15
		2.2	Pest and Disease Management in Organic Farming: Prevention practices, curative methods.	
		2.3	Weed Management in Organic Farming: Preventive Practices, Biological Control, Mechanical Control.	
		2.4	Crop agronomy in organic farming: Crop Rotation, Designing Rotation Cultural strategies used in organics	
III	Hydroponics	3.1	Macronutrients, Micronutrients, Formulating, monitoring, and analyzing, Plant Nutrition, pH adjustment,nutrient monitoring	15
		3.2	Media used for Hydroponics: Ex-clay, Rock wool, Coir, Perlite, Pumice, Vermiculite, Sand, Gravel, Brick shards, Polystyrene packing peanuts, wood fiber;	
		3.3	Techniques in Hydroponics – Static solution culture, Continuous – flow Solution culture, Aeroponics, Passive sub-irrigation, Ebb and flow or flood and drain	

			irrigation, Deep water culture	
TOTAL LECTURES				**45**

Course outcome: By the end of the course the student will be able to:

1. Demonstrate the fundamentals of organic farming and hydroponics.
2. Apply and explain different approaches to organic farming.
3. Discuss various ways of nutrient, pest and weed management..
4. Determine the role of crop agronomy in organic farming.
5. Describe the principles and concepts of hydroponic systems, including nutrient solutions, water management, and environmental control.
6. Develop the proficiency in designing and implementing various types of hydroponic systems suitable for different crops and environments.

References:

1. Keith Roberto. How to Hydroponics. The future garden press New York. 4th Edition.
2. Howard M. Resh. Hobby Hydroponics. CRC Press USA.
3. Prasad S and Kumar U. Green House Management for Horticultural Crops. Agrobios India
4. Dahama A K. Organic Farming for Sustainable Agriculture. Agrobios India.
5. Subbarao N.S. (1995). Biofertilizers in Agriculture and Forestry. Oxford and IBH publishing Company Pvt. LTd. New Delhi
6. B. A. Kratky. A Suspended Net-Pot, Non-Circulating Hydroponic Method for Commercial Production of Leafy, Romaine, and Semi-Head Lettuce. UH–CTAHR

PRACTICALS

1	Growing the following in Hydroponic solution formulated by you:-A leafy vegetable/a fruity vegetable.
2	Growing the following in Hydroponic solution formulated by you:-A medicinal herb/aromatic plant.
3	Comparative study of plants grown in organic/inorganic fertilizer(morphological parameters)
4	Identification of exotic vegetables and their commercial importance.
5	Study of Indigenous technology knowledge for nutrient, insect, disease and weed management
6	Study of Biofertilisers and Bioinoculants

BOS	Biotechnology
Class	M. Sc. I
Semester	II
Course Name	On Job Training: Internship/ Apprenticeship
Course Code	PMSBT205
Type of course	OJT/FP

Level of the Subject	Advanced
Credit points	4

The syllabus proposes an internship for about 7 weeks to 8 weeks (min. 90 Hrs) to be done by a student. It is expected that a student chooses a Biotechnology/ Pharma/ Life Science industry and formally works as a full time/ part time intern during the period. The student should subject oneself with an internship evaluation with proper documentation of the attendance and the type of work he or she has done in the chosen organization. Proper certification (as per the guidelines given in Appendix 1 and 2) by the person, to whom the student was reporting, with the Organization's seal should be attached as part of the documentation.

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