आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश
IFTM University, Moradabad, Uttar Pradesh
NAAC ACCREDITED

SCHOOL OF BIOTECHNOLOGY
IFTM UNIVERSITY
www.iftmuniveristy.ac.in

Study & Evaluation Scheme of Master of Science (Biotechnology) Session 2021-2022

Programme:	Master of Science (Biotechnology)
Course Level:	PG Degree
Duration:	Two Years (four semesters) Full Time
Medium of Instruction:	English
Maximum required attendance:	75%
Maximum Credits:	93

Programme Outcomes (POs)

Students completing this programme will be able to:

- Utilize and implement their knowledge and innovative idea base that strongly influence existing archetype of agriculture, industry, healthcare and environment.
- Students will exhibit contemporary knowledge in Biotechnology and they will be eligible to serve in various sectors of pharmaceutical, cosmetic, food, and biotechnological industry.
- Students will be able to design research projects, conduct experiments, analyze and interpret data for investigating problems in Biotechnology and allied fields.
- Higher studies (Ph.D) can be pursued in order to attain faculty/ research positions in State and Central Universities or Government Research Institute.
- Student will be able appear in various competitive examinations such as CSIR-NET, ICAR-JRF, GATE, ICMR-JRF, DBT-JRF and many other opens channels for promising career in research.
- Students can acquire a scientific position in research & development division of biotechnology Industries, pharmaceutical companies, bio fertilizer industry, aquaculture industries, crop production units, food processing industries, national bio-resource development firms etc.
- Entrepreneurship scheme/venture such as consultancy and training centres can be opened.
- Students will be able to understand the potentials, and impact of biotechnological innovations
- Impart their knowledge for finding sustainable solution to issues pertaining to environment, health sector, agriculture, etc.

IFTM UNIVERSITY, MORADABAD
COURSE STRUCTURE
M.Sc. (BIOTECHNOLOGY/MICROBIOLOGY/FOOD TECHNOLOGY)
(Effective from 2021-22)
First Semester

S.N.	Module Code	Module Name	Periods			EVALUATION SCHEME			End Sem Exam	Course Total	Credits
			L	T	P	Mid Sem Exam	AS +AT	Total			
THEORY											
1.	MSB-101	Cell Biology	3	1	0	20	10	30	70	100	4
2.	MSB-102	Biochemistry	3	1	0	20	10	30	70	100	4
3.	MSB-103	Microbiology	3	1	0	20	10	30	70	100	4
4.	MSB-104	Bioinstrumentation	3	1	0	20	10	30	70	100	4
5.	MSB-105	Molecular Biology	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT											
6	MSB-151	Cell Biology & Biochemistry	0	0	4	20	10	30	70	100	2
7	MSB-152	Microbiology & Bioinstrumentation	0	0	4	20	10	30	70	100	2
		Total Credit	**15**	**5**	8			**210**	**490**	**700**	**24**

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)
(Effective from 2021-22)

MSB-101: CELL BIOLOGY

Objective(s): The objectives of this course:

- Will build on the knowledge of cell structure and function gained in the undergraduate course's students knowledge of how eukaryotic cells work at the molecular level.
- Provide an overview of cell structure and function at the molecular level, including the flow of information from genes to proteins, and regulation of cellular processes, signaling and proliferation in eukaryotic cells.
- Introduce some of the major ideas and experimental approaches in cell and molecular biology.

UNIT I: (8 Sessions)

Cell Basics: Discovery of cell; The Cell theory; Ultrastructure and functions of prokaryotic and eukaryotic cells. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Structure and functions of Nucleus, with nuclear pore complex, Nucleolus, Endoplasmic reticulum, Golgi complex, Ribosome; Biogenesis of mitochondria and chloroplast.

UNIT II: (8 Sessions)

Cytoskeleton, Cell Motility and Cellular Interaction: Microtubules, microfilaments and intermediate elements; Cell motility - Amoeboid, ciliary and flagellar movements. Microvilli, Tight Junction, Desmosome; Connexon; Intercellular communication and Gap Junction.

UNIT III: (8 Sessions)

Cell Division and Cell Cycle: Mitosis -Mitotic Apparatus – centromere/kinetochore; Spindle microtubule; Metaphase chromosomal motion; Anaphase chromosomal movement. Meiosis- Meiotic division I and Meiotic division II; Cytokinesis in animal and plant cells; regulation and control of cell cycle.

UNIT IV: (8 Sessions)

Cell signaling: Extracellular Messengers & their receptors, G-protein- Coupled receptors their second messengers and signal transduction pathway-Specificity of G-protein coupled responses, Regulation of Glucose levels, Role of GPCRs in sensory perceptions. Protein Tyrosine Kinases- Receptor tyrosine kinases (RTKs), Dimerization, Protein Kinase activation, RTKs activates downstream signaling pathway, signaling by the insulin receptors; Calcium as an intracellular messenger: IP3 and Voltage-Gated Ca^{2+} Channels, Calcium binding Protein (calmodulin); light induced signal transduction (Plant transduction).

UNIT V: (8 Sessions)

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, apoptosis.

Course Outcomes:

Upon successful completion of the course, students should be able to:

- Understand and utilize the scientific vocabulary used in communicating information in cell and molecular biology
- Understand and apply general concepts of cell and molecular biology to relevant, specific problems

- Describe and discuss the properties and biological significance of the major classes of molecules found in living organisms and the relationship between molecular structure and biological function
- Represent and illustrate the structural organization of genes and the control of gene expression
- Conceptualize and describe protein structure, folding and sorting
- Explain the structure of membranes and intracellular compartments and relate these to function.
- Summarize the processes of energy transduction in cells and explain their significance.
- Relate how cell movement and cell-cell communication occur and discuss mechanisms of signal transduction
- Outline the processes that control eukaryotic cell cycle and cell death.
- Link the rapid advances in cell and molecular biology to a better understanding of diseases, including cancer.

Suggested Readings:

1. Buchanan et al. Biochemistry & Molecular Biology of plants (2004)
2. Nelson & Cox Lehninger Principles of Biochemistry, (2005)
3. Karp,G.. Cell and Molecular Biology; Concepts & Experiments (2004).
4. Cooper,G.M. The Cell: A molecular Approach (2004)
5. deRobertis&dfRobertis. Cell & Molecular biology
6. Hughes &Mehnet. Cell proliferation and apoptosis (2003)
7. Albert's et al Molecular Biology of Cells, (2002), 4th Edition
8. Lodish et al. Molecular Cell Biology (2004)

Website Sources:

- https://www.edx.org/learn/cellular-biology
- https://www.coursera.org/courses?query=cell%20biology
- https://bscb.org/learning-resources/softcell-e-learning/
- https://www.mooc-list.com/tags/cell-biology
- https://nptel.ac.in/courses/102/103/102103012/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)
(Effective from 2021-22)

MSB-102: BIOCHEMISTRY

Objective(s): The objectives of this course:

- Is designed to introduce the students to the study of biological phenomena at the molecular level.
- Aims to make the students understand the fundamental chemical principles that govern complex biological systems.
- Have major focuses on disciplines within biology and chemistry to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis.
- Enable students to acquire a specialized knowledge of the biological molecules and their structure.

UNIT I: (8 Sessions)

Carbohydrates: Composition; basic structure and function of carbohydrates, Mono-, di- ,oligo-saccharides, Glycosidic bonds; glycoproteins (O- linked and N- linked), glycolipids; Polysaccharides- Classification, Homopolysaccharides; Heteropolysaccharides; Metabolism- Glycolysis, TCA cycle, Gluconeogenesis, HMP pathway, Glycogenesis, Glycogenolysis.

UNIT II: (8 Sessions)

Proteins: Primary, Secondary, Tertiary and Quaternary structure of Proteins; Globular protein- Hemoglobin and Myoglobin; Fibrous protein- Collagen and Membrane Protein; ATP synthetase; Protein sequencing; Evolutionary divergence of organisms and its relationship to protein structure and function; Ramachandran plot; Protein folding.

UNIT III: (8 Sessions)

Fatty acids: General formula, nomenclature and chemical properties; Lipid classification- simple, complex; General structure and functions of major lipid subclasses - acyl glycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins & free fatty acids; Fatty acid oxidation (β oxidation of fatty acid); Regulation of fatty acid metabolism; Ketone bodies; Circulating lipids - chylomicrons. LDL, HDL and VLDL.

UNIT IV: (8 Sessions)

Fat soluble and water soluble vitamins: structure and function, Cofactors and coenzymes: structure and function; Coenzymes and their functions - NAD, $NADP^+$, FAD, FMN, lipoic acid, TPP, pyridoxal phosphate, biotin and cyanocobalamin; Hormones**:** Classification; site of formation, target organs; Mechanism of action of peptide and steroid hormones: Insulin, Glucagon, Epinephrine, Norepinephrin, Thyroid hormones, Testosterone, Estrogen, Progesterone, Pheromones; Hormonal regulation of metabolism by mineralocorticoids.

UNIT V: (8 Sessions)

Nucleic Acids: Structure of purines, pyrimidines, nucleosides and nucleotides; Physical & biochemical properties of DNA; Types of DNA- A, B and Z DNA, their structure and significance; Physical & biochemical properties of RNA- tRNA, rRNA, mRNA and hnRNA; Primary, secondary, and tertiary structures of RNA; metabolism of Purines and Pyrimidines (*De-novo* and Salvage pathway).

Course Outcomes:

Students completing this course will be able to:

- Demonstrate knowledge and understanding of the molecular machinery of living cells.

- Demonstrate knowledge and understanding of the principles that govern the structures of macromolecules and their participation in molecular recognition.
- Demonstrate knowledge and understanding of the principles of the basic composition of the genetic material that ultimately leads to the formation of complex system.

Suggested Readings:

1. D. Papachristodoulou, A. Snape, W. H. Elliott, Daphne C. Elliott. Biochemistry and Molecular Biology, V Ed.,Oxford University Press, 2014.
2. K. Trehan. Biochemistry, II Edition, New Age International, 2007.
3. D.L. Nelson, M. M. Cox. Lehninger Principles of Biochemistry, V Ed., CBS Publication, 2016.
4. D. Voet, C. W. Pratt, J.G. Voet, Principles of Biochemistry: International StudentVersion, IV Ed., Wiley, New York.
5. J.M. Berg, J.L., Tymoczko, L. Stryer. Biochemistry: VII Ed., W.H. Freeman Int. Edition, 2010.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)
(Effective from 2021-22)

MSB-103: MICROBIOLOGY

Objective: The objective of this course:

- Provides knowledge about the microbial world their morphology, difference from other living organisms, distribution and their specific roles in various fields of human life and industry.

UNIT I: **(8 Sessions)**

Introduction to Microbiology: Definition, Historical background & scope; Prokaryotes and eukaryotes, Difference between prokaryotic and eukaryotic organisms; Method of Microbiology- Pure culture techniques, sterilization techniques, Culture media and its types; microbial nutrition; Microbial growth and kinetics.

UNIT II: **(8 Sessions)**

Bacteria: General characteristics; Morphology and structure of bacteria; Gram positive and gram negative bacteria; Basic principle and techniques used in bacterial Classification; Types of vegetative, asexual and sexual reproduction in bacteria.

UNIT III: **(8 Sessions)**

Viruses: General characteristics; Morphology, Classification and structure of plant, animal and bacterial viruses; Cultivation of viruses, a brief account of Adenoviruses, Herpes, Retrovirus, Viroids and prions; Reproductive cycles: lytic and lysogenic.

UNIT IV: **(8 Sessions)**

Control of Microorganism: Antimicrobial Agents; Sulfa drugs, Antibiotics (penicillin and cephalosporin); Broad Spectrum Antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance of antibiotics.

UNIT V: **(8 Sessions)**

Microbial Ecology: Microbial flora of soil; Interaction among soil microorganisms; Nitrogen fixation; Symbiotic association-types, functions and establishment of symbiosis; *A. niger*, yeast, *Pseudomonades putida*.

Course Outcomes:

At the end of this course:

- The students get trained in all aspects of microbiology as it is required in the field of biotechnology, microbiology and food technology.
- The students can recognize and compare the structure and function of microbes.
- Imparts advanced training in microbiology for the students.

Suggested Readings:

1. Pelczar Jr. M.J., Chan E.C.S. and Krieg R., Microbiology, McGraw Hill (1998).
2. Stainer R.Y., Ingraham J.L., Wheelis M.L. and Pamler P.R., General Microbiology, MacMillan (2003).
3. Powar&Dagniwala. Microbiology, Volume 1, Himalaya Publishing House Pvt. Ltd, 2012.
4. Tortora G.J., Funke B.R., and Case C.L., Microbiology, An Introduction, Pearson Education (2009).
5. Madigan, M., Martinko, J., Dunlap, P. and Clark, D., Biology of Microorganisms, Pearson Education (2015).

Website Sources:

- https://www.khanacademy.org/
- https://www.britannica.com/
- https://www.wikipedia.org/
- https://www.researchgate.net

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MSB-104: BIOINSTRUMENTATION

Objective(s): The objectives of this course:

- Is to provide principle of the various analytical techniques, which will be helpful in various applications in the field of life science like Molecular Genetics, Cell Biology, Genetic Engineering, Environmental Science and other fields.
- The student will learn to technical aspect of functioning of these bio instruments.

UNIT I: **(8 Sessions)**

Microscopic Techniques: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy; Scanning and Transmission Electron Microscopy; Confocal Microscopy; Advances of microscopy.

UNIT II: **(8 Sessions)**

Chromatography Techniques & Centrifugation Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GLC and HPLC; Density & Ultra Centrifugation.

UNIT III: **(8 Sessions)**

Electrophoresis Techniques: Theory and Application of PAGE, Agarose Gel Electrophoresis, Iso-electric Focusing, Immuno diffusion, Southern, Northern and Western Blotting.

UNIT IV: **(8 Sessions)**

Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, NMR, Atomic Absorption Spectroscopy, Raman Spectroscopy

UNIT V: **(8 Sessions)**

Radio-isotopic Techniques: Introduction to Radioisotopes and their Biological Applications; Radioactive Decay – Types and Measurement; Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter; Autoradiography, Radiation Dosimetry.

Course Outcomes:

Students completing this course will be able to:

- Define and explain various fundamentals of spectroscopy, qualitative and quantitative analysis.
- Discuss the terms, principle, instrumentation, operation and applications of Molecular spectroscopic techniques.
- Differentiate between principle, instrumentation and operation of Atomic absorption and emission Spectroscopy.
- Explain the various Separation techniques and its instrumentation.

Suggested Readings:

1. Skoog & West Principle of Instrumental Analysis 4th Edn 1992.
2. Freilder. Physical Biochemistry: Application to Biochemistry and Molecular Biology, 2nd Edn 1983.

3. Keith Wilson & John Walker Principles and Techniques of Biochemistry and Molecular Biology:, 7th E Cambridge University Press.
4. S. K. Sawhney & Randhir Singh., Introductory Practical Biochemistry 5th Edn, 2014.
5. G. R. Chatwal & S. K. Anand, Instrumental Methods of Chemical Analysis, Oscar publication, 2015.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://library.nitrkl.ac.in/

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Master of Science (M.Sc.), Programme
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(Effective from 2021-22)

MSB-105: MOLECULAR BIOLOGY

Objective(s): The objectives of this course:

- Is to provide core principles of molecular biology and to impart knowledge to students about the importance of molecular genetics.
- Will help learners to understand the organization and structure of DNA and its properties.
- Will let the student have an in-depth knowledge on molecular mechanisms like Replication, Transcription, Translation, regulation of genetic expression and cancer biology.

UNIT I: **(8 Sessions)**

Nuclear organization: Nuclear membrane, chromosome structure. Proteins associated with nuclei. nucleosome model. Nuclear DNA content, C-Value paradox, Cot value and its significance in situ hybridization, Structural alteration in chromosome: Deletion, Duplication, Inversion & Translocation, heterozygote. Special types of chromosomes; Salivary gland and Lamp-brush chromosomes. Gene mutation: Types of mutations, Molecular mechanism of mutations. Polyploidy (aneuploids, autopolyploids and allopolyploids).

UNIT II: **(8 Sessions)**

DNA Replication: Mechanism of DNA replication (Prokaryotic and Eukaryotic), Enzymes involved in DNA replication (Helicases, DNA polymerase, Topoisomerase etc). Type of DNA repair. Regulation of telomere length. DNA recombination; site specific recombination.

UNIT III: **(8 Sessions)**

Transcription: Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerase, Promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences, Initiation and termination of transcription factor, RNA processing in Prokaryotes *Vs* Eukaryotes.

UNIT IV: **(8 Sessions)**

Translation: Prokaryotic and Eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation. Post-translational modifications and intracellular proteins transport. Control of gene expression in prokaryotes and eukaryotes, operon model- lac and trp operon, Autogenous regulation, Feedback inhibition, Lytic cascades and lysogenic repression.

UNIT V: **(8 Sessions)**

Genetic disease and diagnostics: Sex linked and autosomal diseases. Molecular Biology of Cancer- causes and genetics of cancer, Tumor suppressor genes and onco genes, anticancer agent (p53 and pRB). Tools in molecular biology- Fluorescent In-situ Hybridisation (FISH), DNA microarrays, Advantages and disadvantages of DNA microarrays.

Course Outcomes:

By the end of this course, students will be able to:

- Describe the nuclear organization of DNA and various models of nuclear organization
- Describe types of mutations and various levels of ploidy
- Explain the different types of molecular mechanisms like Replication, Transcription and translation
- Explain the role of p53 and pRB in the development of cancer and molecular tools like FISH and microarrays.

Suggested Readings:

1. Miglani G.S. Advance Genetics by Narosa Publishing House.
2. S.B. Primrose, R.Twyman. Principles of Gene Manipulation and Genomics, VII Ed., Wiley-Blackwell, 2006.
3. D.L. Nelson, M.M. Cox. LehningerPrinciples of Biochemistry, . V Ed., 2016.
4. J.D. Watson. A Passion for DNA: Genes, Genome &Society, Cold Spring Harbor Laboratory Press, 2000
5. Albert's et al. Molecular Biology of Cells, IVth Edition, 2002.
6. Lewin B. , Genes VII, 7th edition, Oxford University Press; 2000

Website Sources:

- https://ocw.mit.edu/courses/health-sciences-and-technology/
- https://thebiologynotes.com/microbial-genetics/
- https://www.sparknotes.com/biology/
- https://www.cliffsnotes.com/study-guides/biology/biochemistry-i/
- biological-information-flow/the-central-dogma-of-molecular-biology

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology/Food Technology) I Year (I Semester)
(Effective from 2021-22)

MSB-151: Cell Biology and Biochemistry

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3.	Do and Don't	
4.	About Equipment and Accessories and Working	
5.	To study of the properties of carbohydrates. Experiment: I A Molish Test Experiment: 1 B. Benedict's Test;	Experiment 1
6.	2A: To estimate given amount of protein by Folin-Lowry method. 2B: To estimate the protein content in the given sample by Biurret methods.	Experiment 2
7.	3A: Qualitative test for the presence of fatty acid by titrametric methods. 3B: Estimation of cholesterol by Liebermann-Buchard reaction.	Experiment 3
8.	To learn technique SDS-PAGE and to separate protein according to their molecular size.	Experiment 4
9.	To understand the process and different stages of mitosis.	Experiment 5
10.	To determine the concentration of cells in a given sample using hemocytometer.	Experiment 6
11.	To detect the presence of amino acid from a given sample by Ninhydrin Test or Xanthoproteic acid Test.	Experiment 7
12.	To stain lignin of the plant section and observe under the microscope.	Experiment 8

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
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(Effective from 2021-22)

MSB-152: Bioinstrumentation and Microbiology

1.	Introduction of Laboratory Practices	
2.	Safety Measures	
3.	Do and Don't	
4.	About Equipment and Accessories and Working	
5.	Working Principle and structural components of simple microscope.	Experiment 1
6.	Working Principle and structural components of compound microscope.	Experiment 2
7.	Basics Working and Principle of Autoclave	Experiment 3
8.	Basics Working and Principle of Biological Safety Cabinet (Laminar Air Flow Chamber)	Experiment 4
9.	Study of Sterilization methods and equipments.	Experiment 5
10.	To prepare and sterilize the nutrient broth media.	Experiment 6
11.	To prepare and sterilize the nutrient agar media (NAM) and to prepare nutrient agar slants.	Experiment 7
12.	To isolate and enumerate microorganisms from soil sample by spread and streak plate methods.	Experiment 8
13.	To isolate and enumerate microorganisms from soil sample by serial dilution method.	Experiment 9
14.	To isolate the microorganisms from mixed culture by sub-culturing technique.	Experiment 10
15.	To stain bacterial cell by simple staining method.	Experiment 11

IFTM UNIVERSITY, MORADABAD
COURSE STRUCTURE
M.Sc. (BIOTECHNOLOGY)
(Effective from 2021-22)
Second Semester

S.N.	Module Code	Module Name	Periods			EVALUATION SCHEME				Course Total	Credits
			L	T	P	Mid Sem Exam	AS +AT	Total	End Sem Exam		
THEORY											
1.	MSB-201	Enzymology & Enzyme Technology	3	1	0	20	10	30	70	100	4
2.	MSB-202	Plant Biotechnology	3	1	0	20	10	30	70	100	4
3.	MSB-203	Immunology & Immunotechnology	3	1	0	20	10	30	70	100	4
4.	MSB-204	Microbial Technology	3	1	0	20	10	30	70	100	4
5.	MSB-205	Advanced Proteomics and Genomics	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT											
7.	MSB-251	Immunology & Immunotechnology; Plant Biotechnology	0	0	4	20	10	30	70	100	2
8.	MSB-252	Microbial Technology; Advanced Proteomics & Genomics	0	0	4	20	10	30	70	100	2
		Total Credit	**15**	**5**	**8**			**250**	**450**	**700**	**24**

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Food Technology) I Year (II Semester)
(Effective from 2021-22)

MSB -201: ENZYMOLOGY & ENZYME TECHNOLOGY

Objective(s): The objectives of the course:

- Provide a deeper insight into the fundamentals of enzyme structure, function and kinetics of enzymes and techniques employed in enzymes purification and characterizations are also emphasized in this course.
- Will introduce students to the theory as well as applications of enzyme technology in various industries.
- Serves to provide an awareness of the current and possible future applications of enzyme technologies.

UNIT I: (8 Sessions)

Introduction to Enzymes: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate – lock and key model, induced fit model; Features of active site, activation energy, enzyme specificity and types.IUB system of classification and nomenclature of enzymes. Isolation and purification of enzymes from plants, animals and microbes; Enzyme activity; Unit of enzyme activity- definition and importance.

UNIT II: (8 Sessions)

Enzyme Kinetics: Kinetics of single substrate reactions; Derivation of Michaelis-Menten equation, turnover number; Determination of Km and Vmax (LB plot, ED plot), Importance of Km & Vmax; Multi-Substrate reaction mechanisms. Deactivation Kinetics. Specific activity.

UNIT III: (8 Sessions)

Factor Affecting Enzyme Activity, Catalysis and Regulation: Factors affecting the velocity of enzyme catalyzed reaction: enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators, Acid-base and nucleophilic catalysis, Role of metal ions in enzyme catalysis; Enzyme Inhibition: irreversible; reversible (competitive, uncompetitive and non-competitive inhibition); Allosteric regulation of enzymes, concerted and sequential model.

UNIT IV: (8 Sessions)

Structure and Function of Enzymes: Lysozyme, chymotrypsin, DNA polymerase, RNase, proteases; Lipases, papain, ribonuclease, trypsin, carboxypeptidase, phosphorylase; Multi enzyme complexes- pyruvate dehydrogenase and fatty acid synthetase.

UNIT V: (8 Sessions)

Enzyme Immobilization, Reactors and Biosensors: Adsorption, Matrix entrapment, Cross linking, Encapsulation, Covalent binding and their examples; Advantages and disadvantages of different immobilization techniques; Enzyme Reactors – Stirred tank reactors (STR), Continuous Flow Stirred Tank Reactors (CSTR), Packed-bed reactors (PBR), Fluidized-bed Reactor (FBR); Membrane reactors. Biosensors – glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors.

Course Outcomes:

Students will be able to:

- State the enzyme kinetics, various factors regulating catalysis, different models for analyzing the enzyme kinetics, Immobilization and large-scale production of enzyme.
- Apply biochemical calculation for enzyme kinetics. Plot graphs based on kinetics data
- Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.

Suggested Readings:

1. Alan Fersht: Structure and Mechanism in Protein Science, 2nd ed. W.H. Freeman & Co.
2. Nicolas Price & Lewis Stevens: Fundamentals of Enymology, 2nd edition, Oxford Univ. Press, New York, NY.
3. Trevor Palmer: Understanding Enzymes, Second Edition, J. Wiley & Sons, New York.
4. Donald Voet& Judith Voet: Biochemistry, J. Wiley & Sons, New York
5. Geoffrey Zubay (1993): Biochemistry, 3rd edition, Wm. C. Brown, Oxford
6. Berg, Tymoczo and Stryer: Biochemistry, 7th Edition., W.H.Freeman,2010
7. Nicolas Price & Lewis Stevens: Fundamentals of Enymology, 2nd edition, Oxford Univ. Press, New York, NY.

Website Sources:

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- https://www.britannica.com/science/enzyme
- https://www.sciencedirect.com/book/9780444641144/advances-in-enzyme-technology
- http://www.biologydiscussion.com/enzymes/enzyme-technology/enzyme-technology-application-and-commercial-production-of-enzymes/10185
- http://www.biologymad.com/studentswork/12%20-%20etnotes.pdf
- https://www.kth.se/dib/enzyme-technology-1.783173
- http://www1.lsbu.ac.uk/water/enztech/whither.html
- https://bmcbiotechnol.biomedcentral.com/articles/sections/protein-and-enzyme-technology
- http://www.odofin.com/enzyme%20technology.htm
- https://www.thesciencenotes.com/enzyme-technology/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology I Year (II Semester)
(Effective from 2021-22)

MSB-202: PLANT BIOTECHNOLOGY

Objective(s): The objectives of this course:

- Designed to impart knowledge of various modern tools and techniques used to adapt plants for specific needs or opportunities.
- To combat situations that combine multiple needs and opportunities are common for example, a single crop may be required to provide sustainable food and healthful nutrition, protection of the environment, and opportunities for jobs and income.
- Finding or developing suitable plants is typically a highly complex challenge.

UNIT I: **(8 Sessions)**

Plant Tissue Culture: Cleaning, sterilization, sterile handling of tissue culture of Plant; Nutritional requirement for in vitro culture; Concept of cellular totipotency, single cell culture, micro propagation, somoclonal variation and its application for plant improvement; Somatic embryogenesis; Anther and ovule culture; Haploid and double-haploid production:

UNIT II: **(8 Sessions)**

Protoplast Culture: Isolation, fusion and culture; Somatic hybridization; Selection system for hybrids; Cybrid production and their application in crop improvement; Cryobiology of plant cell culture and establishment of gene banks; Production of virus free plants using meristem culture:

UNIT III: **(8 Sessions)**

Genetic Engineering in Plant: Ti and Ri plasmid and viral vectors (CaMV based vectors, Gemini virus, TMV based vectors); Mechanism of DNA transfer; Role of virulence Genes; Use of 35S promoters; Genetic markers; Use of reporter genes; Methods of nuclear transfer, particle bombardment, electroporation, microinjection, transformation of monocots, transgene stability and gene silencing; Herbicide , insect and salt resistance , Plant DNA fingerprinting - Hybridization and PCR based markers (RFLP, SSRs, RAPD, QTLS , SCARS , AFLP etc.):

UNIT IV: **(8 Sessions)**

Transgenic plants: Commercial status and public acceptance; Bio-safety guidelines for research involving GMO's, benefits and risks; Socio economic impact and ecological consideration of GMO's; Gene flow; IPR and IPP; Patenting of biological material.

UNIT V: **(8 Sessions)**

Biological nitrogen fixation and biofertilizers: Molecular mechanism of nitrogen fixation, genetics of nif gene; Plant diseases- general account, biological control of pests and disease; Biopesticides; Seed production technique; Plant cell culture for the production of useful secondary metabolites pigments, perfumes, flavor, pharmacologically significant compounds, biodegradable plastics.

Course Outcomes:

Students completing this course will be able to:

- Understand basics of plant tissue culture and application of plant tissue culture in crop improvement.
- Understand Basic Knowledge of genetic engineering of plants using several genetic engineering tools.
- Ethics and government regulations that are there for the safe introduction of GMOs.

Suggested Readings:

1. Hammond, John, Peter McGarvey, and Vidadi Yusibov, eds. Plant biotechnology: new products and applications. Vol. 240. Springer Science & Business Media, 2012.
2. Stewart Jr, C. Neal, ed. Plant biotechnology and genetics: principles, techniques and applications. John Wiley & Sons, 2012.
3. Bhojwani, Sant Saran, and Maharaj K. Razdan. Plant tissue culture: theory and practice. Vol. 5. Elsevier, 1986.
4. HS Chawla. Introduction to plant biotechnology. Science Publishers, 2002.

Website Sources:

- https://onlinecourses.nptel.ac.in/
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IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology I Year (II Semester)
(Effective from 2021-22)

MSB-203: IMMUNOLOGY & IMMUNOTECHNOLOGY

Objective(s): The objectives of this course:

- Is to learn the structure and function of the immune system both at the molecular and cellular level.
- To understand the cause and mechanism of immune system pathologies and dysfunctions.
- To learn immunological techniques and their applications in basic & clinical research, and in Immunodiagnosis.

UNIT I: **(8 Sessions)**

Introduction to Immunology: Brief history of immunology, Innate and Acquired immunity, Organization & structure of Lymphoid organs. Hematopoiesis, Cells of immune system, Characteristic of T & B lymphocytes, lymphocyte trafficking, humoral and cell mediated immune response, Inflammation.

UNIT II: **(8 Sessions)**

Antigen and antigenicity: Types of Antigens, Super antigens, Factors affecting the immunogenicity, Haptens and adjuvant, ABO blood group antigens, Epitopes. Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins.

UNIT III: **(8 Sessions)**

Immune response: Structure and function of Major histocompatibility complex (MHC), Exogenous and Endogenous pathways of antigen processing and presentation, Complement system, Structure, function and application of Cytokines, regulation of immune response, Immunological tolerance.

UNIT IV: **(8 Sessions)**

Antigen and antibody interactions: Cross reactivity, precipitation reactions, agglutination; serological techniques – ELISA, RIA, compliment fixation and western blotting; Immunoprecipitation; FACS; Production of monoclonal antibodies (Hybridoma Technology) and its scope; Vaccines.

UNIT V: **(8 Sessions)**

Cell mediated cytotoxicity: Mechanism of T-cell & NK cells mediated lysis. Immunity against infectious agents-Influenza, Mycobacterium tuberculosis, Plasmodium; Hyper-sensitivity, Autoimmunity, Tumor immunology, AIDS, Transplantation immunology.

Course Outcomes:

Students completing this course will be able to:

- Outline the molecular and cellular mechanisms involved in the development and regulation of the immune response,
- Describe the cause, challenges and treatment for Immune System Pathologies and Dysfunctions.
- To demonstrate a capacity for problem-solving about immune responsiveness.
- To describe the roles of the immune system in both maintaining health and contributing to disease.
- To learn the application of major immunological laboratory techniques and their application to both clinical analysis and experimental research.

Suggested Readings:

1. Abul K. Abbas, Andrew H. H. Lichtman, Shiv Pillai, Basic Immunology (Function and Disorder of Immune System), 4th Edition; Elsevier Publisher.
2. Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, Kuby Immunology, 6th Edition; Publisher: W H Freeman & Co.
3. Roitt's Immunology, P.J. Delves, S. J. Martine, D.R. Burton, I.M. Roitt, 12th Edition. Wiley-Blackwell.
4. C.Verman Roa, Immunology. II Edition. Narosa Publishing House-2006
5. Fahim Halim Khan. The Element of Immunology. Pearson Eduction. 2009.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books
- https://www.springer.com/gp/biomedical-sciences/immunology
- https://onlinelibrary.wiley.com/doi/book/10.1002/9781119998648

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology/Microbiology I Year (II Semester)
(Effective from 2021-22)

MSB-204: MICROBIAL TECHNOLOGY

Objective: The objective of this course:

- Is designed to impart knowledge of various modern tools and techniques used to adapt microorganism for specific needs or opportunities, finding or developing suitable microorganism with highly complex challenge.

UNIT I: **(8 Sessions)**

Microbial Fermentation: Introduction to submerged and solid-state fermentation, Component parts of fermentation processes, Range of fermentation processes, Industrial important microbial product- Primary and secondary metabolites.

UNIT II: **8 Sessions)**

Fermentation media: Synthetic and complex media; Media components- Carbon sources, Nitrogen sources, Inducers, Minerals, Antifoam; Raw material availability-agricultural and industrial waste; pretreatment of raw materials- physical, chemical and biological.

UNIT III: **8 Sessions)**

Isolation and preservation of industrially important microbes: Isolation of different types of mutants for production of primary and secondary metabolites- Auxotrophic mutants, resistant mutants, revertant mutants, recombinant microorganisms; preservation techniques- cryopreservation, lyophilization.

UNIT IV: **(8 Sessions)**

Concept of overproduction of metabolites: Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes: Induction, catabolite repression, crab tree effect, feedback inhibition and feedback repression.

UNIT V: **(8 Sessions)**

Production of industrially important products: Ethanol, Citric acid, Penicillin, Baker's yeast, High fructose corn syrup (HFCS).

Course Outcomes:

Upon completing this course students will be able to:

- Understand how industrially useful strain is isolated preserved, maintained and improved.
- Explain fermenters and its types and application in industry
- Understand and apply that understanding in several commercially important production process.

Suggested Readings:

1. Cruger and ACruger; A text of Industrial microbiology, Sinaeur Associates, 1990.

2. PF STANBURY, S. Hall, A Whitaker and Stephen J Hall. Principle of Fermentation Technology. Elsevier, 2013
3. Y.H Hui et al.Handbook of Food and Beverages Fermentation Technology, 2003
4. Fermentation Microbiology and Biotechnology, A.R. Allman, Mansi E1-Mansi, C.F.A. Bryce, Arnold L. Demain.
5. Linda Harvey. Practical Fermentation Technology Brain McNeil (Editor), 2008.
6. Greed, Prescott and Dunn's, Industrial Microbilogy, 4th Edition, CBS Publishers, 1987.

Website Sources:

- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology, I Year (II Semester)
(Effective from 2021-22)

MSB-205 - ADVANCE PROTEOMICS AND GENOMICS

Objective(s): The objectives of this course:

- Is to appraise students with basic concepts of protein structure and function, protein characterization and purification, functional and structural genomics.
- To build up expertise in students with modern techniques of proteomics and genomics so that they can apply it in basic and applied science research.

UNIT I: (8 Sessions)

Introduction and scope of proteomics: Site Directed Mutagenesis- Subtilizin, Advance Protein Folding Methods, Molecular Chaperons, Post Translational Modifications, Glycosylation Vs protein confirmation, protein separation techniques; Polyacrylamide gel electrophoresis & isoelectric focusing (IEF); 2D Gel Electrophoresis, PAGE for protein analysis and identification.

UNIT II: (8 Sessions)

Gene variation and Genome mapping methods: Physical, genetic and molecular markers in mapping (RFLP, RAPD and AFLP,); single nucleotide polymorphisms (SNPs), Expressed sequence Tags (ESTs): Gene Annotation & Gene disease association.

UNIT III: (8 Sessions)

Protein engineering: Protein chips and functional proteomics; clinical and biomedical application of proteomics; proteomics industry, SCP (Single Cell Protein).

UNIT IV: (8 Sessions)

General introduction and scope of Genomics: Types of PCRs and its applications, DNA sequence analysis methods: Sanger's Dideoxy method and Fluorescence methods, DNA footprinting and DNA fingerprinting.

UNIT V: (8 Sessions)

Gene prediction and annotation: Comparative Genomics; DNA microarrays and DNA chips, DASH, Molecular Becons; Genome databases; Structural Genomics; Principles, tools and applications of gene manipulation for modern food (GM Food) production; Significance of GM foods

Course Outcomes:

Students completing this course will be able to:

- Have an understanding of concepts such as gene expression, proteomics, transcriptomics, metabolomics, and their relationships.
- Describe advanced genomics and proteomics technologies and their application for advancement of research in basic and applied science.
- Explore cellular and molecular targets and able to design research studies for various diseases pathologies.

Suggested Reading:

1 Cantor and Smith, Genomics, john Wiley & Sons, 1999.
2 Introduction to Genomics- Arthur M Lesk, Oxford University Press, 2007.

3 R M Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004
4 L. Stryer, Biochemistry, W. H. Freeman and Co., New York, 2007
5 NPTEL- Phase-II, Proteomics and Genomics by Dr.Vikas Kumar Dubey, IIT, Guwahati

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology, I Year (II Semester)
(Effective from 2021-22)

MSB-251: Immunology & Immunotechnology; Plant Biotechnology

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	Identification of blood group by simple agglutination method.	Experiment 1
6	To enumerate the total number of RBCs and WBCs in the blood sample.	Experiment 2
7	To Perform Ouchterlony double diffusion.	Experiment 3
8	To perform Sandwich ELISA by using microtiter plate reader.	Experiment 4
9	To perform Counter current immunoelectrophoresis.	Experiment 5
10	Preparation of stock solutions of MS (Murashige & Skoog, 1962) basal medium and plant growth regulator stocks.	Experiment 6
11	Establishment and Maintenance of Carrot Callus.	Experiment 7
12	To perform shoot tip culture for virus free plant production	Experiment 8
13	To Culture Excised Tomato Roots.	Experiment 9
14	To extract and analyze genomic DNA from leaves by CTAB method.	Experiment 10

IFTM University, Moradabad

Master of Science (M.Sc.), Programme

M.Sc. Biotechnology, I Year (II Semester)

(Effective from 2021-22)

MSB-252: Microbial Technology; Advanced Proteomics & Genomics

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	To study different growth phases of bacterial population and plot a bacterial growth curve.	Experiment 1
6	To produce ethanol under submerged conditions using *Saccharomyces cerevisiae.*	Experiment 2
7	To purify ethanol produced under submerged conditions.	Experiment 3
8	To immobilize microbial cells using sodium- alginate gel entrapment method.	Experiment 4
9	To produce amylase enzyme under solid state fermentation and submerged state fermentation.	Experiment 5
10	Extraction of protein and estimation of its concentration by Lowry's method	Experiment 6
11	To perform western blotting technique to detect specific protein.	Experiment 7
12	To extract and analyze genomic DNA from leaves by CTAB method.	Experiment 8
13	To perform southern blotting for the detection of a specific DNA fragment.	Experiment 9

IFTM UNIVERSITY, MORADABAD
COURSE STRUCTURE
M.Sc. (BIOTECHNOLOGY)
(Effective from 2021-22)
Third Semester

S.N.	Module Code	Module Name	Periods			EVALUATION SCHEME				Course Total	Credits
			L	T	P	Mid Sem Exam	AS +AT	Total	End Sem Exam		
THEORY											
1.	MSB-301	Animal Cell Culture	3	1	0	20	10	30	70	100	4
2.	MSB-303	Genetic Engineering	3	1	0	20	10	30	70	100	4
3.	MSB-307	Biostatistics	3	1	0	20	10	30	70	100	4
4.	MSB-308	Bioinformatics	3	1	0	20	10	30	70	100	4
5.	MSB-304-306	Departmental Elective	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT											
6.	MSB-351	Biostatistics and Bioinformatics	0	0	4	20	10	30	70	100	2
7.	MSB-355	Genetic Engineering	0	0	4	20	10	30	70	100	2
8.	MSB-354	Seminar	0	0	2	-	-	100	-	100	1
		Total Credit	**15**	**5**	**10**			**310**	**490**	**800**	**25**

IFTM UNIVERSITY, MORADABAD
M. Sc. Biotechnology
Course Structure
(Effective from 2021-22)
Third Semester

LIST OF DEPARTMENT ELECTIVES		
S.No.	**Course Code**	**Course Name**
1	MSB-304/305/306	Environmental Biotechnology/ IPR and Biosafety/ Principles of Nanobiotechnology

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)
(Effective from 2021-22)

MSB-301: ANIMAL CELL CULTURE

Objective(s): The objectives of this course:

- Is to acquire the necessary practical skills for the isolation, maintenance, propagation and manipulation of mammalian cells for *in vitro* studies.
- To educate the specific skills for cells/tissue culture laboratory work, and to provide the student with information on the applications of tissue culture in modern laboratory settings.

UNIT I: **(8 Sessions)**

Requirement of Tissue Culture Laboratory: An introduction; Concept of aseptic technique; Safety consideration in cell culture laboratory; Detection of contamination and remedy.

UNIT II: **(8 Sessions)**

Culture of Animal Cell: Media requirement for mammalian cell culture; Primary Cell Culture - Disruption and dispersion of tissue, Cell propagation; Growth cycle; Development of cell lines; Culture of Stem cells; Preservation and storage of cells;

UNIT III: **(8 Sessions)**

General Cell Culture Techniques: Monolayer culture techniques; Suspension cell culture technique; Concept of Bioreactors for mass culture of mammalian cells; Harvesting and purification for end product recovery.

UNIT IV: **(8 Sessions)**

Measurement of growth and viability of Animal Cells: Cytotoxicity – In vitro limitation; Determination of IC_{50} value; Assay based on cell proliferation- Microtitration Assays (MTT assay) and its application.

UNIT V: **(8 Sessions)**

Application of Animal Cell Culture: Requirement for mammalian expression system-Commonly used cell lines, Vectors, Methods of transfection in animal cells. Application of mammalian expression system - Cells based vaccines.

Course Outcomes:

Students completing this course will be able to:

- Understand that how to isolate and purify cells from primary cell culture/ explant.
- Transition/propagation of primary culture into secondary culture/cell lines.
- Learn to maintain animal cells for routine culture work or cryopreservation.
- To culture cells in bulk for production, isolation and purification of by-products of cells

Suggested Readings:

1. R. Ian Freshney. Culture of Animal Cells: A Manual of basic Technique and Applied Applications, VI Ed., Published Online, ISBN: 9780470649367, 2011.
2. J.P Mather, P.E Roberts. Introduction to Cell and Tissue Culture (Theory and Technique), Springer Science & Business Media, 2007.

3. M. Butler. Animal Cell Culture &Technology: The Basic from background to bench, II Ed., BIOS Scientific Publishers, 2004.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)
(Effective from 2021-22)

MSB-303: GENETIC ENGINEERING

Objective(s): The objectives of this course:

- Is to introduce students to basic molecular biological concepts and techniques used in the fields of biotechnology and genetic engineering.
- This course will give students the insight into the so called recombinant DNA technology which includes group of techniques used for controlling gene expression, manipulating gene structure and gene containment.
- Is to make learners understand designing and engineer novel life forms with such techniques.

UNIT I: **(8 Sessions)**

Introduction: Historical background; Restriction enzymes and modifying enzymes; Restriction mapping; Construction of chimaeric DNA- staggered cleavage, Addition of poly dA and dT tails; Blunt end ligation; Gene cloning.

UNIT II: **(8 Sessions)**

Cloning and Expression Vectors: Vehicles for gene cloning- Plasmids; Bacteriophages, Cosmids, Phagemids, shuttle vectors; Plant and animal viruses as vector- Ti plasmid, TMV, adeno virus vector, vaccinia vector, retroviral vector; High capacity cloning vectors- YAC, BAC, PAC, MAC, Baculoviruses vectors; Promoters and expression cassettes.

UNIT III: **(8 Sessions)**

Concept of Genomics: Whole genome sequencing and functional genomics; Applications of genomics and Proteomics with special reference to Arabidopsis and Rice; Molecular probes; Labeling of probes; Radioactive vs. Non-radioactive labeling; Uses of molecular probes; Polymerase Chain Reaction- basic principle; Modified PCR (Inverse PCR, Anchored PCR, PCR for mutagenesis, asymmetric PCR, RTPCR, PCR walking); Applications of PCR in biotechnology; Gene cloning Vs. Polymerase chain reaction; Ligase chain reaction and its application in biotechnology.

UNIT IV: **(8 Sessions)**

Isolation Sequencing and Synthesis of Genes: Methods of gene isolation; Construction and screening of genomic and cDNA libraries; Chromosome walking; Chromosome jumping, Transposon tagging; Map based cloning; Chemical synthesis of genes.

UNIT V: **(8 Sessions)**

Molecular Markers and DNA Chip Technology: Molecular-Markers-types and Applications; Construction of molecular maps (genetic and physical maps); DNA chip Technology & Microarrays.

Course Outcomes:

Students completing this course will be able to:

- Understand how gene manipulation can be done.
- Implementing the techniques to make new novel products which can be beneficial for humankind.
- Gain an appreciation and knowledge of how to deal with ethical issues relating to science.

Suggested Readings:

1. Gilmartin P.M., Bowler C. Molecular PlantBiology (Vol.I and II), Oxford University Press, 2002.
2. Primerose S.B, TwymanR..Principles of Gene Manipulation,,VII Ed., Wiley-Blackwell, 2006
3. Green M.R., Sambrook J. Molecular Cloning: A Laboratory Manual (Vol I/II/III), IV Ed., 2014.
4. Watson J.D. A Passion for DNA: Genes, Genome &Society, Cold Spring Harbor Laboratory Press, 2000.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books
- https://www.nature.com/

IFTM University, Moradabad
Masters of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)
(Effective from 2021-22)

MSB-304: ENVIRONMENTAL BIOTECHNOLOGY

Objective(s): The objectives of this course:

- Provides basic knowledge and introduction to the various aspects of environmental biotechnology to students.
- It gives students an understanding of how science and the scientific method work to address environmental problems.
- The student will become familiar with the Earth's major systems (ecosystems and biogeochemical cycles), how they function and how they are affected by human activity (population growth, air, water and soil pollution, ozone depletion, global warming, and solid waste disposal)

UNIT I: **(8 Sessions)**

Introduction to significance of Environmental studies: Ecosystem, Structure and Functions of an Ecosystem, Energy flow in ecosystem, Ecology succession, Causes of ecology succession, Food chain, Food web, Ecological Pyramids, Biogeochemical cycles- Carbon cycle, Nitrogen cycle and Sulfur cycle, Applications and Scope of Environment Biotechnology.

UNIT II: **(8 Sessions)**

Global Phenomenon & Their Management: Global Warming, Greenhouse effect, Ozone layer Depletion, Acid Rains, Bioconversion, Bioaccumulation, Bio-concentration, Biomagnifications, Biodegradation.

UNIT III: **(8 Sessions)**

Biofuels: Energy from biomass, bioethanol, Biodiesel, Biogas, Bio fertilizers- Bacterial, Algal, fungal. Earthworms as Bio fertilizers. Bio pesticides- categories and mode of applications.

UNIT IV: **(8 Sessions)**

Bioremediation: Principle and agents of bioremediations, *in-situ* and *ex-situ* bioremediation. Bioremediation of organic, inorganic and agrochemicals. Phytoremediation: Bio absorption of heavy metals, bio methylation, bioleaching and their types. Bio-drainage.

UNIT V: **(8 Sessions)**

Sewage and Waste water treatment: Physical chemical and biological characteristics of waste water. Primary, secondary and tertiary waste water treatment, Biological treatment systems; activated sludge processing, trickling filter, treatment processes, case studies of industrial waste water treatment in pulp and paper industries, tanning, distillery, dye and antibiotics industrial waste water.

Course Outcomes:

Students completing this course will be able to:

- It describes the existing and emerging technologies that are important in the area of environment its principles and techniques.

- Make understand the environmental issues including pollution, mineral resource, renewable energy and water recycling.
- Course will have a specific focus on bioremediation and treatment of polluted effluent.

Suggested Readings:

1. G. Tchnobanoglous, F.L. Burton, H.D. Stensel. Waste Water Engineering: Treatment and Reuse, IV Ed., Metcalfe and Eddy Inc., 2003.
2. S.K. Dhameja. Environmental Engineering and Managnent, S.K. Kataria& Sons, New Delhi, 2014.
3. P.D. Sharma, Ecology & Environment, Twelfth ed., Raastogi Publications, 2015.
4. Pradipta Kumar Mohapatra, Environmental Biotechnology, First ed. I.K. International Pvt. Ltd., 2006.

Website Sources:

- https://ocw.mit.edu/courses/environment-courses/
- https://www.researchgate.net/publication/282367631_The_Role_of_Bioreactors_in_Industrial_Wastewater_Treatment
- https://ebnet.ac.uk/
- https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
- https://online-learning.tudelft.nl/courses/industrial-biotechnology/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) II Year (III Semester)
(Effective from 2021-22)

MSB-305: IPR and Biosafety

Objective(s): The objectives of this course:

- Concentrates on technology, knowledge and business management aspect of intellectual property, including patenting aspect.
- Provide knowledge on biosafety and risk assessment of products, ethical issues in biological research.

UNIT I: **(8 Sessions)**

Introduction: Introduction to Intellectual Property; Types of IP; Importance of IPR; Patents- Patent file procedure, Patentable and Non-Patentable items Trademarks, Copyright and Related rights, Industrial Design; Geographical indications; Protection of biotechnological inventions; Patent file procedure.

UNIT II: **(8 Sessions)**

Agreement and Treaties: TRIPS, World Intellectual Property Rights Organization (WIPO). GATT, Patent cooperation treaty, WTO- Objective- Structural format of WTO - Economic Impact of WTO - Benefits of WTO; Compulsory licensing.

UNIT III: **(8 Sessions)**

Rights and Protection: Infringement or violation, remedies against infringement- civil and criminal; Indian Patent Law (1970); Various laws in India- licensing and technology transfer.

UNIT IV: **(8 Sessions)**

Bioethics: Ethical aspects of Genetic Engineering: Genetically modified food and crops,; Stem cell research: Hematopoietic stem cell and Embryonic stem cell; NGO for bioethics; Ethical issues and biosafety.

UNIT V: **(8 Sessions)**

Biosafety: Good laboratory practices (GLP); Biosafety guideline and regulation; Roles of institutional biosafety committee, RCGM, GEAC etc.; Biosafety levels, Cartegena protocol;

Course Outcome:

Students completing this course will be able to:

- Understanding of the fundamentals of IPR and Bioethics and key principles of it.
- Awareness of its major application.
- Ability to use or apply IPR related guidelines.

Suggested Readings:

1. Bioethics and Biosafety: M K Satheesh
2. Biotechnology and Patent Protection: Beier FK, Crespi RS and Straus
3. Intellectual Property Rights on Biotechnology: Singh K
4. Regulatory Framework for GMOs in India: Ministry of Environment and Forest, Govt. of India

5. Cartagena Protocol on Biosafety: Ministry of Environment and Forest, Govt. of Inida
6. Bioethics: Shaleesha A Stanley

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://library.nitrkl.ac.in/
- https://www.researchgate.net
- https://www.wipo.int/

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) II Year (III Semester)
(Effective from 2021-22)

MSB-306: Principles of Nanobiotechnology

Objective(s): The objectives of this course:

- Understand the principles of Nanobiotechnology and characterization of nano-structured materials.
- Equipments towards the cutting-edge areas of Nanobiotechnology.
- Encourage innovations and promote translational research to address various theranostics applications.

UNIT I: **(8 Sessions)**

Nanoscales: What is meant by Nanoscale – Nanoscale Processes – Physical and Chemical Properties of Materials in the Nanoscales - Nanoscale Measurements.

UNIT II: **(8 Sessions)**

Properties and Measurements of Nanomaterials: Optical Properties – Absorption and Fluroscence – Microscopy measurements – SEM –TEM - AFM and STM. Confocal imaging

UNIT III: **(8 Sessions)**

Nanobiology: Properties of DNA and motor proteins – Measurements of Conductivity of DNA nanowires and angular properties of motor -- Lessons from Nature on making nanodevices.

UNIT IV: **(8 Sessions)**

Bioconjugation of Nanomaterials To Biological Molecules: Reactive Groups on biomolecules (DNA & Proteins) -Conjugation to nanoparticles (ZnS- Fe3O4) - Uses of Bioconjugated Nanoparticles. Nano Drug Delivery: Various Drug Delivery Systems – aerosol - Inhalants - Injectibles – Properties of Nanocarriers – Efficiency of the Systems.

UNIT V: **(8 Sessions)**

Biosensors and microelectronic devices: Sensors-piezoelectric sensors, optical sensors, ampeomteric sensors and macro mechanical structures and their functioning, immuno-nanotechnology.

Course Outcomes:

At the end of the course students will able to:

- Acquire the knowledge of synthesis and characterization of nonmaterial's for its various applications in the field of biological sciences.
- Develops the understanding of utilizing biomolecules for designing tools and equipment for various applications in food, medicine and health science.

Suggested Readings:

1. Christ of Niemeyer, Chad Mirkin, Nanobiotechnology- concepts, applications and perspectives, First ed., Wiley- VCH publishers, 2004.
2. Donald Martin, Nanobiotechnology of biomimetic membranes, Springer, 2007
3. Physical Chemitry by P. W. Attkins, Oxford Press.
4. Introduction to Modern Colloid Science by Robert J. Hunter, Oxford University Press.
5. Nanoscale Materials in Chemistry by Kenneth J. Khabhunde (ed.) Wiley Interscience.
6. Thermodynamics and Statistical Mechanics by A N Tikhonov, Peter Theodore Landsberg.
7. Thermodynamics and Statistical Mechanics by John M. Seddon, J. D. Gale.

8. Physical Chemistry, 1st Edition by David H. Ball, Brookes Cole.

Website Sources:

- https://onlinecourses.nptel.ac.in/
- https://www.wikipedia.org/
- https://www.ncbi.nlm.nih.gov/books
- https://www.masterclass.com

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) II Year (III Semester)
(Effective from 2021-22)

MSB-307: BIOSTATISTICS

Objective(s): The objective of this course:

- Is to study advance statistical science and its application to problems of human health and disease, with the ultimate goal of advancing statistics and analyzing data from research problems.
- It helps to design data collection plans, analyze data appropriately and interpret and draw conclusions from those analyses.

UNIT I: (8 Sessions)

Biostatistics: Definition and applications of Biostatistics, Concept of variables in biological systems, Collection, classification, Tabulation, Graphical and diagrammatic representation of numerical data. Diagrams (Bar & Pie), Histogram, Frequency curve and frequency polygon.

UNIT II: (8 Sessions)

Measures of central tendency: Mean, Median, Mode, Arithmetic, Geometric & Harmonic mean, Measures of dispersion, Variability and changes, Quartile deviation, Mean deviation, Standard deviation, Standard error, Coefficient of variations, Skewness and Kurtosis .

UNIT III: (8 Sessions)

Probability and distributions: Random experiment, Events, Sample space, mutually exclusive events, Independent and dependent events; Various definitions of probability, addition and multiplication theorems of probability, Random variables (discrete and continuous), Probability density function and its properties. Binomial, Poisson and Normal distributions.

UNIT IV: (8 Sessions)

Correlation and Regression analysis: Relation between two variables, scatter diagram, definition of correlations, curve fitting, principles of least squares, Two regression lines, Karl Pearson's coefficient of correlation, Rank correlation, Tied ranks.

UNIT V: (8 Sessions)

Introduction to Test of Significance & Hypothesis: Concept of population and sample, random samples, Sampling distribution of mean and standard error, z and t-test, Chi- square test for goodness of fit, independence of attributes, and homogeneity of samples, interrelation between t-test and F-Test & ANOVA.

Course Outcomes:

Students completing this course will be able to:

- Demonstrate knowledge of the properties of parametric, semi-parametric and nonparametric testing procedures in Biostatistics.
- Remember restate the principal concepts about biostatistics and collect data relating to variable which will be examined.
- Understand and interpret the concepts of descriptive statistics from these data.

- Understand and be able to address ethical, regulatory and practical aspects of human subject research including human subject's protections.
- Be capable of self-directed learning of unfamiliar statistical methods and written and oral presentation of results/findings.

Suggested Readings:

1. George W and Willian G., Statistical Methods, IBH Publication
2. Zar, J, Biostatistics, Prenticw Hall, London R. Rangaswami, A Text Book of Agricultural Statistics, New Age International Publication.
3. Methods in *Biostatistics* by B. K. *Mahajan*
4. Fundamentals of Applied *Statistics S.C. GUPTA* & V.K. KAPOOR

Website Sources:

- www.pdfdrive.com
- www.dmi.gov.in
- www.yourarticlelibrary.com
- onlinecourses.nptel.ac.in
- en.wikipedia.org

IFTM University, Moradabad
Master of Science (M.Sc.), Programme
M.Sc. (Biotechnology/Microbiology) II Year (III Semester)
(Effective from 2021-22)

MSB-308: BIOINFORMATICS

Objective: The objective of this course:

- Is to introduce the field of bioinformatics to study the tools and databases in homology identification, structure visualization and designing new drug molecules**.**

UNIT I: (8 Sessions)

Introduction to Bioinformatics: Introduction and application of bioinformatics, Classification of biological databases, Biological database retrieval system, sequence and molecular file format.

UNIT II: (8 Sessions)

Sequence analysis: Types of sequence alignment, Dot matrix analysis: Dynamic programming algorithm (Needleman Wunsch and Smith Waterman), Heuristic methods (BLAST and FASTA), Scoring matrices-PAM and BLOSUM.

UNIT III: (8 Sessions)

Protein structure prediction: Protein databases, **P**rotein identification and characterization, Primary structure analysis and prediction, Secondary structure analysis and prediction, Microarray Data Analysis.

UNIT IV: (8 Sessions)

Protein modeling and visualization: Method of protein modeling, Homology modeling, Fold recognition, Ab–initio modeling, Protein classification and protein structure visualization databases and tools

UNIT V: (8 Sessions)

Evolutionary analysis and molecular phylogeny: Concept of phylogeny, Types of tree, Distance based methods (UPGMA and NJ algorithm), Character based methods (maximum parsimony and maximum likelihood) phylogenetic software-PHYLIP, PAUP, tree viewing software.

Course Outcomes:

Students completing this course will be able to:

- Bioinformatics databases and tools for molecular structure and function prediction.
- Identify the homologous protein and DNA sequences.
- Visualization and characterization of protein structures.

Suggested Readings:

1. N. Gautham. Bioinformatics databases and Algorithms, Alpha Science Publishers, 2006.
2. A. Lark. Introduction to Bioinformatics, IV Ed., Oxford Press, 2014.
3. Orpita Bosu, Simminder Kaur Thukral,Bioinformatics: Database, Tools, Algorithms,Oxford University Press, 2007

Website Sources:

- https://pubmed.ncbi.nlm.nih.gov/
- www.ncbi.nlm.nig.gov
- http://www.bic.nus.edu.sg/

IFTM University, Moradabad
Masters of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)
(Effective from 2021-22)

MSB-351: Biostatistics and Bioinformatics

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	To calculate Mean, Median and mode using excel software.	Experiment 1
6	To calculate Standard deviation using excel software.	Experiment 2
7	To perform two sample student's t-test assuming equal variance using excel software	Experiment 3
8	To perform one-way ANOVA.	Experiment 4
9	Introduction to various biological databases.	Experiment 5
10	To identify the 10- homologues sequences of P68871 of various origins. Find the conserved region existing between them comment on the same	Experiment 6
11	To perform blast of given sequences.	Experiment 7
12	Comment on the evolutionary relationship between the sequences	Experiment 8

IFTM University, Moradabad
Masters of Science (M.Sc.), Programme
M.Sc. Biotechnology II Year (III Semester)
(Effective from 2021-22)

MSB-355: Genetic Engineering

1	Introduction of Laboratory Practices	
2	Safety Measures	
3	Do and Don't	
4	About Equipment and Accessories and Working	
5	Isolation and enumeration of microorganisms from soil by serial dilution agar plating method	Experiment 1
6	To extract the genomic DNA from Plant Leaves	Experiment 2
7	Electrophoresis of extracted DNA	Experiment 3
8	To perform restriction digestion of λ- DNA with EcoR1 & HIND-III enzymes and electrophoresis of digested DNA.	Experiment 4
9	To perform ligation of Lambda (λ) Hind III digest.	Experiment 5
10	To transform plasmid DNA into bacteria.	Experiment 6
11	To amplify a specific DNA fragment by Polymerase Chain Reaction using random primers.	Experiment 7
19	Isolation and purification of plasmid DNA.	Experiment 8

IFTM UNIVERSITY, MORADABAD
COURSE STRUCTURE
M.Sc. (BIOTECHNOLOGY)
(Effective from 2021-22)
Fourth Semester

S.N.	Module Code	Module Name	Periods			EVALUATION SCHEME				Course Total	Credits
			L	T	P	Mid Sem Exam	AS +AT	Total	End Sem Exam		
PRACTICAL											
1.	MSB-482	Dissertation	0	0	-	-	-	150	250	400	20
		Total Credit						**150**	**250**	**400**	**20**

Note: The student has to complete his/her dissertation preferably in Industry or Research Institute. In some exceptional cases he/she may apply to pursue his/her dissertation on campus. The student must have internal supervisor.