



Proposed syllabus for M. Sc (Masters of Science) Department of Biotechnology

as per

National Education Policy-2020

Academic session-2026-27

Board of Studies Members-

- | | |
|-------------------------------------------------------------------------------------------|-----------------|
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KMCL University Lucknow | Chairman |
| 2. Prof. Wahid Ali, Department of Pathology, King
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Aligarh | External Member |

Proposed by-

Dr. Tatheer Fatma

HOD/Dean, Department of Biotechnology,

Faculty of Science, KMCL University, Lucknow



Department of Biotechnology
Faculty of Science
Khwaja Moinuddin chishti Language Universiy Lucknow, U.P. (India)

Syllabus of Department of B.Sc. Biotechnoloy as per
National Education Policy-2020

Abbreviations:

S. No.	Abbreviati on	Full form
1	C	Credits
2	L	No. of Lectures/periods (One hour Lecture for theory & two hours lab for practical)
3	CIE	Continuous Internal Evaluation
4	UE	University Exam.
5	Th.	Theory paper
6	Prac.	Practical paper
7	UG	Under Graduation
8	PG	Post Graduation
9	MM	Maximum marks
10	POs	Programme Outcomes
11	PSOs	Programme Specific Outcomes
12	COs	Course Outcome



SYLLABUS NEP 2020 M.Sc. BIOTECHNOLOGY, KMCLU, Lucknow

1 st Year /1 st SEM						
Course Code	Type	Course title	Minimum credits	Internal	External	Total marks
MSB10101T	Core	Cell Biology and cytogenetics	4	25	75	100
MSB10102T	Core	Principles of Biochemistry and metabolism	4	25	75	100
MSB10103T	Core	Research methodology and Biostatistics	4	25	75	100
MSB10104T	Core	Tools in Bioanalysis and Biotechnology	4	25	75	100
MSB10105P	Practical	Lab1	4	25	75	100
TOTAL			20			500
1 st Year / 2 nd SEM						
MSB10201T	Core	Molecular Biology	4	25	75	100
MSB10202T	Core	Principles of Genetic Engineering	4	25	75	100
MSB10203T	Core	Computational biology, Bioinformatics and IPR	4	25	75	100
MSB10204T	Core	Concepts in Microbiology	4	25	75	100
MSB10205P	Practical	Lab2	4	25	75	100
TOTAL			20			500

OR

1 st Year /1 st SEM						
Course Code	Type	Course title	Minimum credits	Internal	External	Total marks
MSB10101T	Core	Cell Biology and cytogenetics	4	25	75	100
MSB10102T	Core	Principles of Biochemistry and metabolism	4	25	75	100
MSB10103T	Core	Research methodology and Biostatistics	4	25	75	100
MSB10105P	Practical	Lab1	4	25	75	100



ख्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)

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MSB 10106R	Project	Internship/Research Project/Survey work /Review writing	4	--	100	100
TOTAL			20			
1st Year / 2nd SEM						
MSB10201T	Core	Molecular Biology	4	25	75	100
MSB10202T	Core	Principles of Genetic Engineering	4	25	75	100
MSB10203T	Core	Computational biology, Bioinformatics and IPR	4	25	75	100
MSB10205P	Practical	Lab2	4	25	75	100
MSB10206R	Project	Internship/Research Project/Survey work /Review writing	4	--	75	100
TOTAL			20			500

2nd Year / 3rd SEM						
MSB10301T	Core	Plant and Animal Biotechnology	4	25	75	100
MSB10302T	Core	Nanobiotechnology	4	25	75	100
MSB10303T	Core	Nutraceuticals and Functional Foods	4	25	75	100
MSB10304P	Practical	Lab3	4	25	75	100
MSB10305R	Project	Internship/Dissertation/Research Project/Survey or Field work /Review writing	4	--	100	100
TOTAL			20			500
2nd Year / 4th SEM						
MSB10401T	Core	Industrial Biotechnology	4	25	75	100
MSB10402T	Core	Medical Biotechnology	4	25	75	100
MSB10403T	Core	Pharmaceutical Biotechnology	4	25	75	100
MSB10404P	Practical	Lab4	4	25	75	100
MB10405R	Project	Internship/Dissertation/Research Project/Survey or Field work /Review writing	4	--	100	100
TOTAL			20			500
GRAND TOTAL			80			2000

OR

12 Months Apprenticeship/Internship through NATS or from equivalent organization/ Industry/Institute in their 4th year, will be equal to 40 credits.



M.Sc. BIOTECHNOLOGY First Year

PROGRAMME OUTCOMES (POs)

PO1: Scientific Knowledge

Apply advanced knowledge of biological sciences, chemistry, and biotechnology principles to solve complex problems.

PO2: Technical Proficiency

Demonstrate proficiency in modern biotechnological techniques, including molecular biology, genetic engineering, bioinformatics, and bioprocessing.

PO3: Research Aptitude

Design and conduct scientific experiments, analyze data, interpret results, and contribute to research and innovation in biotechnology.

PO4: Critical Thinking & Problem-Solving

Apply analytical and critical thinking to identify, formulate, and solve biotechnological problems using scientific methods.

PO5: Ethics & Responsibility

Understand and apply ethical, biosafety, and IPR principles in biotechnological research and applications.

PO6: Communication Skills

Communicate scientific information effectively through technical reports, presentations, and scientific writing.

PO7: Lifelong Learning

Engage in continuous learning and adapt to emerging trends and technologies in biotechnology.

PO8: Professional & Societal Contribution

Apply biotechnological knowledge for sustainable development, healthcare, agriculture, and environmental management.



PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSOs for Semester I

PSO1.1: Understand cellular organization, communication, and cell cycle regulation in eukaryotic systems.

PSO1.2: Analyze biomolecular structure, function, and metabolic pathways.

PSO1.3: Use biostatistical methods for data analysis and interpretation in biological research.

PSO1.4: Utilize bioanalytical tools for molecular and cellular investigations.

PSOs for Semester II

PSO2.1: Explain molecular mechanisms of DNA replication, transcription, translation, and regulation.

PSO2.2: Apply genetic engineering tools and techniques for gene cloning, expression, and editing.

PSO2.3: Apply bioinformatics tools for sequence analysis, protein modeling, and drug design.

PSO2.4: Apply microbiological principles and techniques in biotechnological contexts.

SEMESTER-WISE MAPPING OF POs & PSOs

Semester	Course	POs Addressed	PSOs Addressed
I	Cell Biology & Cytogenetics	PO1, PO2, PO4	PSO1.1
I	Principles of Biochemistry and metabolism	PO1, PO2, PO4	PSO1.2
I	Research methodology and Biostatistics	PO2, PO3, PO6	PSO1.4
I	Tools in Bioanalysis and Biotechnology	PO1, PO2, PO8	PSO1.3
I	Practical –Lab I	PO2, PO3, PO6	PSO1.1–1.4
II	Molecular Biology	PO1, PO2, PO4	PSO2.1
II	Principles of Genetic Engineering	PO2, PO3, PO4	PSO2.2
II	Computational biology, Bioinformatics and IPR	PO5, PO6, PO7	PSO2.3
II	Concepts in Microbiology	PO4, PO5, PO8	PSO2.4
II	Practical –Lab II	PO2, PO3, PO6	PSO2.1–2.4



Year Wise Course Structure M.Sc. Biotechnology

M.Sc. I Year (Semester I) Biotechnology Paper 1 Cell Biology and cytogenetics MSB10101T

Programme/Class: Degree MSC	Year: 1	Semester: I
Subject: Biotechnology		
Course Code: MSB10101T	Course Title: Cell Biology and cytogenetics (Theory)	
Course outcomes:	Bloom's taxonomy	
CO1- To enable the student to comprehend problems and latest research in the area.	K4, K5	
CO2- Problem-oriented learning approach leading to independent learning of advanced cell biology concepts.	K3, K4	
CO3- Gaining fundamental knowledge on human genetics, clinical consequences	K2, K4	
CO4- Understand use of Chromosome banding, chromosome FISH etc. in diagnosis of different chromosomal abnormalities	K4, K5	
Credits: 4	Core Compulsory	
Max.Marks:25+75	Min.PassingMarks:40	
Total No.of Lectures-Tutorials- 60Lectures		
Unit	Topic	No.of Lectures
	PARTA	



I	Internal Organisation Of Cell <ul style="list-style-type: none">● Membrane structure – lipid bilayer and membrane proteins.● Electric properties of membrane. Transport across membranes – active transport, ionic gradient, carrier proteins, Na⁺ K⁺ pump, ATPase, ABC transporters, Ion channels Intra cellular compartmentalization – Cytosol, mitochondria, chloroplast, endoplasmic reticulum, peroxisome, lysosomes, endosomes.● Transport of molecules between nucleus and cytosol.● Transport into mitochondria and chloroplast, endocytosis and exocytosis.● Protein sorting.● Structure and functions of mitochondria. Structure and function of chloroplast. Multi drug resistant efflux forms	15
II	UNIT II CELL COMMUNICATION <ul style="list-style-type: none">● Overview of extracellular signaling.● Basic characteristics of Paracrine, endocrine, autocrine systems.● Tight junctions and Gap junctions .● Second messengers and their role in signal transduction. Second messengers Camp, lipid derived Second messengers (phosphatidyl inositol derived second messenger) & IP3. Role of calcium as second messenger.● Cell surface receptors in signal transduction. G-protein coupled receptor – structure and function. Ion channel receptors. Tyrosine kinase linked receptors Receptors with intrinsic enzyme activity (RTK). Interaction and regulation of cell signaling pathways.	15



III	CELL CYCLE AND CELL DIVISION <ol style="list-style-type: none">1. Components in cell cycle control - Cyclin, CDKs .Check points in cell cycle Intracellular control of cell cycle events, phase dependent cyclic CDK complexes eg. Yeast.2. Abnormalities in Cell Cycle – Cancer.3. Mechanics of Cell Division- An over view of M-Phase. Different stages of mitosis.4. Cohesins and Condensins in chromosome segregation. Microtubules in spindle assembly. Structure of kinetoshore, centrosomes and its functions.5. Sister Chromatid separation. Cytokinensis actin & myosin in the generation of contractile ring.6. Meiosis – Significance.Chiasma formation - Synaptonemal complex. Recombination during meiosis – Recombination nodules7. Introduction to Necrosis, Senescence, Apoptosis - Programmed cell death. Mechanisms of apoptosis.8. Apoptosis triggered by internal signals. Apoptosis triggered by external signals. Apoptosis inducing factor.9. Apoptosis in cancer, immune system, organ transplants.10. Apoptosis in plants	15
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IV	CHROMOSOME STRUCTURE AND ORGANIZATION 1. Chromatin structure: Histones, DNA, nucleosome and higher level organization, functional state of chromatin. 2. Chromosome organization; Metaphase chromosome: centromere, kinetochore, telomere and its maintenance; Holocentric chromosomes and supernumerary chromosomes; giant chromosomes: polytene and lampbrush chromosome. 3. Heterochromatin and euchromatin; Functional states of chromatin and alterations in chromatin organization; chromatin remodelling; DNase I hypersensitive regions. 4. DNA methylation & epigenetic effects. 5. Chromosomal anomalies: Numerical and structural alterations, 6. Concept of gene: Conventional and modern views; Fine structure of gene, split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families; 8. Sex determination in <i>Caenorhabditis elegans</i> , <i>Drosophila melanogaster</i> , mammals. 9. Dosage compensation in <i>Caenorhabditis elegans</i> , <i>Drosophila</i> and mammals.	15
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Suggested Reading:

1. Lodish H *et al.*, (2007). *Molecular Cell Biology*, (6th Ed). W.H. Freeman & Company
2. Becker WM *et al.*, (2008). *The World of the Cell*, (7th Ed). Benjamin Cummings
3. Bruce Alberts *et al.*, (2008). *Molecular Biology of the Cell*, (5th Ed). Garland
4. Watson *et al.*, (2013). *Molecular Biology of the Gene*, (7th Ed). Pearson Prentice Hall.
5. Cooper GM. and Hausman RE., (2013). *The Cell: a Molecular Approach*, (6th Ed). Sinauer Associates Inc
6. Lewin B, (2013). *Lewin's Genes XI*, (11th Ed). Jones & Bartlett Learning
7. Bostock CJ & Summer AT, (1978). *The Eukaryotic Chromosome*, Elsevier
8. Harrison HJS & Flavell RB, (2004). *The Chromosome*, Taylor & Francis.
9. Hennig W, (1987). *Structure & Function of Eukaryotic Chromosomes*, (1st Ed). Springer
10. Alberts B *et al.*, (2009). *Essential Cell Biology*, (3rd Ed). Garland
11. De Robertis & Robertis, (1987). *Cell and Molecular Biology*, (8th Sub Ed).

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:



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- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.



M.Sc. I Year (Semester I) Biotechnology
Paper 2 Principles of Biochemistry and metabolism MSB10102T

Programme/Class: Degree MSC	Year: 1	Semester: I
Subject: Biotechnology		
Course Code: MSB10102T	Course Title: Principles of Biochemistry and metabolism (Theory)	
Course outcomes:	Bloom's taxonomy	
CO1 -Students will learn, understand and study the effect of pH, temperature on the activity of salivary amylase enzyme.	K1, K3	
CO2 -Students will be able to study activity of any enzyme under optimum conditions	K3, K5	
CO3 -Students will be study the effect of pH, temperature on the activity of salivary amylase enzyme.	K2, K3	
Credits: 4	Core Compulsory	
Max.Marks:25+75	Min.Passing Marks:40	
TotalNo.ofLectures-Tutorials-60 Lectures		
Unit	Topic	No.of Lectures
	PARTA	



I	CHEMISTRY OF BIOMOLECULES-I <ul style="list-style-type: none">• Carbohydrates: Classification, structure, configuration, conformation• Stability, formation of glycosidic bond, disaccharides & oligosaccharides.• Polysaccharides: structural (cellulose, chitin) storage (starch, glycogen, insulin). Hemicelluloses, Liginins, Pectins, Glycoso-amino-glycans, Blood group substances, glycoproteins, proteoglycans & bacterial cell wall polysaccharides (peptidoglycans).• Classification, characteristics of amino acids. Essential & Non essential amino acids.• Classification of proteins, Structural organization of proteins – primary, secondary, tertiary, quaternary. Ramchandran’s plot.• Structure, properties & classification of lipids, fatty acids. Porphyrins	15
II	CHEMISTRY OF BIOMOLECULES – II <ol style="list-style-type: none">1. Nucleic Acids: Structure of purines, pyrimidine’s, nucleosides and nucleotides.2. Watson & Crick model of DNA, Different forms of DNA.3. Circular DNA & super coiling.4. Types of RNA. Structure of t-RNA.5. Denaturation & renaturation of DNA6. Melting Curves. Calculation of Tm	15
III	BIOENERGETICS <ol style="list-style-type: none">1. Law of thermodynamics, Biological oxidation, Gibbs energy, free energy changes2. Redox potential & phosphate potential.3. High energy compounds. Glycolytic Pathway.4. TCA Cycle, Oxidative Phosphorylation, Photophosphorylation ,5. Electron Trasnport Chain, Glyoxylate Cycle, Pentose Phosphate Pathway.6. Gluconeogenesis.7. Photosynthesis.-Photosystems. Light & Dark Phases.8. C3 & C4 and CAM Pathways.9. Bioluminescence.10. Fatty acid Metabolism - β- Oxidation of fatty acids	15



IV	ENZYMOLGY 1. Introduction – special characteristics of enzymes, co-factors, specificity of enzymes. 2. Nomenclature & classification of enzymes, Steady state concept – Importance of K_m & V_{max} . 3. Michaelis-Menton equation. Factors affecting the rate of the reaction: 4. Enzyme activation. Types of Enzyme inhibitions. Enzyme inhibitors 5. Properties of enzymes: isolation methods & purifications. 6. Regulation- Hill equation, cooperativity, Multiple sites on an enzyme.	15
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Suggested reading:

1. Nelson & Cox *et al.*, (2000). Lehninger's Principles of Biochemistry. McMillan
2. Zubayet *et al.*, (1995.) Principles of Biochemistry. WCB
3. Voet *et al.*, (2004). Biochemistry Vols 1 & 2 Wiley
4. Murray *et al.*, (2003). Harper's Illustrated Biochemistry. McGraw Hill
5. Wilson and Walker. Cambridge University Press
6. Elliott and Elliott. Biochemistry and Molecular Biology. Oxford University press
7. Lodish H *et al.*, (2007). *Molecular Cell Biology*, (6th Ed). W.H. Freeman & Company

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as "SWAYAM" in India and Abroad.

Further Suggestions:

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M.Sc. I Year (Semester II) Biotechnology
Paper 3 Research methodology and Biostatistics MSB10103T

Programme/Class: Degree MSc	Year:1	Semester:I
Subject: Biotechnology		
Course Code: MSB10103T	Course Title: Research methodology and Biostatistics (Theory)	
Course outcomes:		Bloom's taxonomy
CO1- Identify and formulate research problems, research questions, and hypotheses, and explain the logic, importance, and procedures of hypothesis testing using appropriate research designs.		K2,K3
CO2- Differentiate between qualitative and quantitative research approaches, apply concepts of measurement, validity, reliability, and levels of measurement, and evaluate experimental designs involving independent and dependent variables.		K2,K3
CO3- Understanding of data and its analysis with the help of computers, Interpretation of data analysis.		K2, K4
CO4- Understanding the computational data analysis which in-turn can be used for interpretation of data analysis.		K2, K4
Credits: 4	Core Compulsory	
Max.Marks:25+75	Min.PassingMarks:40	
TotalNo.ofLectures-Tutorials-60Lectures		
Unit	Topic	No.of Lectures
	PARTA	
I	Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process	15



<p style="text-align: center;">II</p>	<p>Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis.</p> <p>Hypothesis Testing – Logic & Importance , Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses.</p> <p>Experimental Design: Concept of Independent & Dependent variables.</p> <p>Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.</p> <p>Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.</p>	<p style="text-align: center;">15</p>
<p style="text-align: center;">III</p>	<p>DESCRIPTIVE STATISTICS</p> <ol style="list-style-type: none"> 1. Sampling - Sampling procedure, homogenization of samples, samples size 2. Measurement of averages and variation 3. Measure of central values - Mean, median and mode, 4. Measures of dispersion - range , mean deviation , standard deviation, coefficient of variation, 5. Graphical representation of Data 6. Probability, Concept of Probability. Binomial distribution, Normal distribution , Poisson distribution & their applications. 	<p style="text-align: center;">15</p>
<p style="text-align: center;">IV</p>	<p>QUALITATIVE & QUANTITATIVE VARIABLES</p> <ol style="list-style-type: none"> 1. Concept of Test of hypothesis, Null & Alternative hypothesis 2. Chi square test & its applications 3. Large Sample Tests- Z-test of Means & Proportions. 4. Small sample test - T-test for Means, Paired T-test, 5. Analysis of Variance and Co-variance. One-Way ANOVA, Two way ANOVA, 6. F-test, Simple regression and correlation 	<p style="text-align: center;">15</p>

Suggested readings:

1. Research Methodology and Biostatistics: A comprehensive Guide for Health Care Professionals. By Sharma Suresh.
2. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
3. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.



4. Research Methodology – C.R.Kothari
5. Biostatistics and Computer Applications by G.N. Rao, N. K. Tiwari
6. Biostatistics: Basic Concepts and Methodology for the Health Sciences. By Wayne W. Oaniel.
7. Fundamentals of Biostatistics by Khan and Khanum

Suggested Continuous Evaluation Methods:

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- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

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M.Sc. I Year (Semester I) Biotechnology
Paper 4 Tools in Bioanalysis and Biotechnology MSB10104T

Programme/Class: Degree MSC	Year: 1	Semester: I
Subject: Biotechnology		
CourseCode:MSB10104T	Course Title: Tools in Bioanalysis and Biotechnology (Theory)	
Course outcomes:		Bloom's taxonomy
CO1- Understand and learn different types of microscopes and their use		K2, K3
CO2 Understand and learn different biophysical methods used in analyzing biomolecules		K2, K3
CO3- To learn about different Histochemical and Immunotechniques.		K3,K4
CO4- To learn about different molecular and radiotracer techniques for identification of biomolecules.		K2, K5
Credits: 4		CoreCompulsory
Max.Marks:25+75		Min.PassingMarks:40
TotalNo.ofLectures-Tutorials-60Lectures		
Unit	Topic	No.of Lectures :60
	PARTA	
I	Microscopic techniques <ul style="list-style-type: none"> ● Visualization of cells and subcellular components by light microscopy, ● Resolving powers of different microscopes, microscopy of living cells, ● Scanning and transmission microscopes, ● different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM, Fluorescence microscopy, ● Image processing methods in microscopy 	15



II	Biophysical Methods <ul style="list-style-type: none">• Molecular analysis using UV/visible, fluorescence, NMR and ESR spectroscopy;• Molecular structure determination using X-ray diffraction and NMR;• Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods. Histochemical and Immunotechniques <ul style="list-style-type: none">• Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy,• detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.	15
III	Molecular Biology techniques <ul style="list-style-type: none">• Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods.• Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Cell culture, cell counting, detection of live and dead cells, apoptotic assay, cell cycle analysis.	7
IV	Biochemical and Radiotracer techniques <ul style="list-style-type: none">• Principle and Types of Chromatography: paper, ion-exchange, gel filtration, HPLC, affinity• Biochemical techniques: Measurement of pH, Principle of Colorimetry/Spectrophotometry: Beer-Lambert law Measurement, applications and safety measures of radio-tracer techniques	7

Suggested Reading

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. WileyIndia
2. Krebs et al. Lewin's GENES XII, Twelfth Edition. Jones and Bartlett Learning.
3. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
4. Alberts et al: Molecular Biology of the Cell: Garland (2002).



5. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John WileyandSons. Inc.
6. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. LippincottWilliams and Wilkins, Philadelphia.
7. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM PressandSunderland, Washington, D.C.; Sinauer Associates, MA.

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

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M.Sc. I Year (Semester I) Biotechnology
Paper 5 Lab 1 MSB10105T

Programme/Class: Degree MSc	Year:1	Semester:I
Subject: Biotechnology(Practical)		
CourseCode: MSB10105P	Course Title: Lab1	
Course outcomes:	Bloom's taxonomy	
CO1: Demonstrate good laboratory practices by following safety rules, handling biochemical tools and equipment, and performing sterilization procedures for glassware and culture media preparation.	K2, K3	
CO2: Identify and qualitatively analyze major biological molecules including carbohydrates, amino acids, proteins, lipids, RNA, and DNA using standard biochemical tests.	K3, K4	
CO3: Quantitatively estimate carbohydrates, proteins, RNA, and DNA using colorimetric and spectrophotometric methods, and interpret absorbance data accurately.	K4, K5	
CO4: Apply separation techniques such as paper chromatography, thin layer chromatography, agarose gel electrophoresis, and SDS-PAGE to analyze biomolecules and microbial growth characteristics	K4, K5	
Credits: 4	CoreCompulsory	
Max.Marks: 25+75	Min.PassingMarks:40	
TotalNo.oflab.periods-30(60hours)		
	Topic	No.of lab.periods



	<ol style="list-style-type: none">1. Laboratory rules, Tools, Equipment and Other requirements in Biochemistry laboratory.2. Qualitative analysis of biological samples: Carbohydrates, amino acids and proteins, lipids, RNA and DNA3. Quantitative estimation of biological molecules: Colorometric/ spectrophotometric methods to quantitatively estimate Carbohydrates, Proteins, RNA and DNA4. Chromatography techniques: Separation of amino acids by thin layer chromatography5. To perform the sterilization technique for glassware for biotechnology laboratory.6. To perform the different types of media and broth preparation: solid and liquid media.7. Growth; Growth curve; Measurement of bacterial population by turbidity and serial dilution methods. Effect of temperature, pH and carbon nitrogen sources on growth.8. Separation of DNA by agarose gel electrophoresis.9. To perform the paper chromatography.10. Separation of proteins by SDS-PAGE.11. Separation of DNA by agarose gel electrophoresis.	60
<p>Suggested Readings:</p> <ol style="list-style-type: none">1. Glazier AN and Nikaido H (2007). Microbial Biotechnology – Fundamental & Applied Microbiology – Second Edition. Cambridge University Press.		

Suggested Continuous Evaluation Methods:

- Experimental work assessment.
- Practical exam.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

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M.Sc. I Year (Semester I) Biotechnology
Paper 6 Research project/internship/field or survey work MSB10106R

Programme/Class: Degree MSc	Year: 1	Semester : 1
Subject: Biotechnology(Research project/internship/field or survey work)		
CourseCode: MSB10106R	Course Title: Research project/internship/field or survey work	
Topic will be decided		



M.Sc. I Year (Semester II) Biotechnology
Paper 7 Molecular Biology MSB10201T

Programme/Class: Degree MSC	Year: 1	Semester: II
Subject: Biotechnology		
Course Code: MSB10201T	Course Title: Molecular Biology (Theory)	
Course outcomes:	Bloom's taxonomy	
CO1- To learn the dynamic properties of chromatin and its folding	K1, K2	
CO2 - To understand topological properties of DNA, reassociation kinetic, transposable elements and genetic code	K1, K2	
CO3- To provide students with a deep insight and mechanism of the various cellular processes such as DNA Replication, Transcription and Translation.	K2, K3	
CO4- To understand molecular mechanisms of protein localization, including synthesis and targeting of secretory and membrane proteins.	K2, K3	
Credits: 4	Core Compulsory	
Max.Marks:25+75	Min.PassingMarks:40	
Total No.of Lectures-Tutorials- 60 Lectures		
Unit	Topic	No.of Lectures: 60
	PARTA	
I	1. Introduction to Molecular Biology 2. DNA Replication — Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication. Enzymes and accessory proteins involved in DNA replication. 3. Recombination-Homologous recombination- Holiday junction, gene targeting, Cre/Lox recombination, RecA and other recombinases. 4. DNA Damage & Repair – Physical & Chemical Reasons of DNA damage] Direct Base & Nucleotide excision, mismatch repair.	15



II	1. Transcription Prokaryotic transcription, Eukaryotic transcription, RNA polymerase. General and specific transcription factors, Regulatory elements and mechanisms transcription regulation. Modification in RNA -5' – cap formation, Transcription (termination, 3' - end processing and polyadenylation, 2. Splicing, Editing, Nuclear export mRNA, mRNA stability. 3. Translation-Prokaryotic and Eukaryotic translation, the translation machinery Mechanisms of initiation, elongation and termination, Regulation of translation, co and post — translational modifications of proteins.	15
III	1. Protein Localization - Synthesis of secretory and membrane proteins, Import in nucleus, mitochondria, chloroplast and peroxisomes, receptor mediated endocytosis. 2. Antisense and Ribozyme technology- Molecular mechanism of Antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure a: capping, 3. Biochemistry of ribozyme; hammer - head, hairpin and other ribozyme strategies for designing ribozymes, Applications of Antisense and ribozyme technology	15
IV	1. Oncogenes and Tumor Suppressor Genes -Viral and cellular Oncogenes, Tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins. 2. Molecular Mapping of genome-Genetic and physical maps, physical mapping and Map- based cloning, Southern and fluorescence <i>in situ</i> hybridization for genome analysis.	15

Suggested readings

1. Molecular biology of the gene by Watson et. Al (5th edition), Pearson Publishers, USA
2. Genes XII by Benjamin Lewin, Oxford University Press
3. Biochemistry by Voet B and Voet JG, Wiley Publishers, USA
4. Biochemistry 5th Revised edition by LubertStryer, Jeremy M. Berg, John L. Tymoczko, Macmillan Publishers, USA
5. D.L. Nelson and M.M. Cox Lehninger Principles of Biochemistry, Publisher: WH Freeman; 8th ed.NewYork



Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.



M.Sc. I Year (Semester II) Biotechnology
Paper 8 Principles of Genetic Engineering MSB10202T

Programme/Class: Degree /MSc	Year:1	Semester:II
Subject: Biotechnology		
Course Code: MSB10202T	Course Title: Principles of Genetic Engineering (Theory)	
Course outcomes:	Bloom's taxonomy	
CO1- Describe the structure and function of DNA and RNA in the cell	K1, K3	
CO2- Students will get familiar with the method how genetic information is transmitted in organism.	K2, K4	
CO3- Students will have knowledge on biomolecules, like carbohydrates, lipids, enzymes and coenzymes besides their importance and Classification, forces stabilizing their structures, write and relate the role of them with day to day life.	K1,K4	
CO4- Various physiological and pathological aspects of by products of metabolic pathways and their regulations and relate with various industrial processes.	K3, K2	
Credits: 4	Core Compulsory	
Max.Marks:25+75	Min.PassingMarks:40	
TotalNo.ofLectures-Tutorials-60Lectures		
Unit	Topic	No.of Lectures
	PARTA	



<p>I</p>	<p>Tools for genetic engineering</p> <ol style="list-style-type: none">1. General requirements for performing a genetic engineering experiment;2. Types and properties of restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase;3. Cohesive and blunt end ligation; linkers; adaptors. <p>Introduction of foreign DNA into host cells</p> <ol style="list-style-type: none">1. Preparation of competent cells, transformation, electroporation, transfection;2. Construction of genomic and cDNA libraries, phage display; strategies for library screening;3. Radioactive and non-radioactive probes;4. Hybridization techniques: Northern, Southern, South-western and Far-western and colony hybridization,5. Labelling of DNA for probe preparation: nick translation, random priming.	<p>15</p>
<p>II</p>	<p>Different types of vectors</p> <ol style="list-style-type: none">1. Biology of plasmids and bacteriophages; Plasmids & M13 mp vectors; pUC19 series and Bluescriptvectors, T-vectors; phagemids; Lambda vectors;2. Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs);3. Principles for maximizing gene expression (RNA and protein), protein expression vectors; pET-based vectors;4. Protein purification; His-tag; GST-tag; MBP-tag <i>etc.</i>; Inclusion bodies; methodologies to reduce formation of inclusion bodies; protein refolding;5. Mammalian expression and replicating vectors; Baculovirus, yeast vectors, shuttle vectors, reporters and reporter assays; Yeast two-hybrid system.	<p>15</p>



III	Different types of PCR techniques 1. Principles of PCR; Primer design; properties of thermostable DNA polymerase enzymes and proofreading; 2. Types of PCR – multiplex, nested, inverse, reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, 3. RNA isolation, reverse transcriptase, cDNA synthesis, RNA quantitation, 4. Cloning of PCR products; PCR-based site directed mutagenesis.	15
IV	Genome editing technologies and Transgenics 1. Gene knockout/knockdown/mutation, conditional knockouts, gene deletion, gene insertion, gene correction; 2. Gene silencing techniques: principles, approaches - antisense, ribozymes, RNAi, microRNA; siRNA technology; 3. Delivery systems for genes and vectors; 4. Mechanisms of genome editing: targeted DNA double strand breaks repair (DSBs), major pathways— homology-directed repair (HDR), nonhomologous end-joining (NHEJ); 5. CRISPR/Cas9 system; Creation of transgenic organisms <i>eg.</i> plants, mice; 6. Introduction to methods of genetic manipulation in different model systems <i>e.g.</i> fruit flies (<i>Drosophila</i>), worms (<i>C. elegans</i>), frogs (<i>Xenopus</i>), fish (zebra fish) and chick; disease models.	15

Suggested readings:

1. Old, R.W.; Primrose, S.B.; & Twyman, R.M.; (2001). *Principles of Gene Manipulation: an introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, MR., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, TA. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Maeder, M. L., & Gersbach, C. A. (2016). *Genome-editing Technologies for Gene and Cell Therapy*. *Molecular Therapy*, 24(3), 430-446. doi:10.1038/mt.2016.10.
5. Genome Editing Resource Library (Thermo Fisher)
<https://www.thermofisher.com/in/en/home/life-science/genome-editing/genome-editing-learning-center/genome-editing-resource-library.html>.



6. Cox, D. B., Platt, R. J., & Zhang, F. (2015). *Therapeutic Genome Editing: Prospects and Challenges*. Nature Medicine, 21(2), 121-131. doi:10.1038/nm.3793.
7. Sander JD, Joung JK. (2014) *CRISPR-Cas systems for Editing, Regulating and Targeting Genomes*. Nature Biotechnology 32, 347–355 doi:10.1038/nbt.2842.
8. Doudna, J. A., & Charpentier, E. (2014). *The New Frontier of Genome Engineering with CRISPR-Cas9*. Science, 346(6213), 1258096-1258096. doi:10.1126/science.1258096

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

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M.Sc. 1st Year (Semester IV) Biotechnology
Paper 9: Computational biology, Bioinformatics and IPR MSB10203T

Programme/Class: Degree/MSc	Year:1 st year	M.Sc.2 nd Semester
Subject: Biotechnology		
Course Code: MSB10203T	Course Title: : Computational Biology,Bioinformatics and IPR	
Course outcomes:		Bloom's taxonomy
CO1: Understand biological databases, sequence analysis, and comparative genomics using bioinformatics tools.		K1, K4
CO2: Apply gene annotation, variant analysis, and phylogenetic methods for molecular and evolutionary studies.		K1, K2
CO3: Understand protein structure, modeling, and computational tools for structure prediction and visualization.		K2,K4
CO4: Basic knowledge of various forms of intellectual property right, filing of patent application, infringement of patent rights.		K2, K3
Credits:4		Core Compulsory
Max. Marks:25+75		Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		
Unit	Topics	No. of Lectures= 60
I	FOUNDATIONS OF COMPUTATIONAL BIOLOGY Computer hardware & software. Introduction to computer languages – C, C++, JAVA, PERL Foundations to bioinformatics – History, overview, applications Bioinformatics data – nucleic acid sequence, protein sequence Bioinformatics databases –DNA, RNA, Protein & Drug databases. Bioinformatics tools and Resources – Bioinformatics web-portals, free online tools, downloadable free tools, software packages	15



II	INTRODUCTION, DATABASES & SEQUENCE ANALYSIS <ol style="list-style-type: none">1. History and introduction of bioinformatics; evolution, genome projects, scope and applications; interdisciplinary nature2. Biological data types; primary, secondary and integrated databases; data curation and FAIR principles3. Major databases: GenBank, EMBL, DDBJ, UniProt, PDB, GEO, KEGG, Pfam, PROSITE, dbSNP, ClinVar4. Sequence properties; sequence identity, similarity and homology5. Pairwise alignment: global (Needleman–Wunsch) and local (Smith–Waterman)6. Scoring matrices (PAM, BLOSUM); E-value and bit score7. Database searching: BLAST, FASTA, PSI-BLAST, HMMER8. Motif and repeat analysis: MEME, PROSITE9. Multiple sequence alignment: ClustalΩ, MUSCLE, MAFFT10. Comparative genomics; homologues, orthologues and paralogues	15
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III	GENE ANNOTATION, VARIATION & PHYLOGENETICS 1.Genome organization; structural and functional annotation 2.Gene prediction: ab initio and evidence-based methods 3.Annotation tools and genome browsers: Prokka, Augustus, GeneMark, UCSC, Ensembl 4.Functional annotation: Gene Ontology, domains, pathways, PPI networks 5.Functional/network tools: InterProScan, Blast2GO, STRING, Cytoscape 6.Genetic variation: SNPs, indels, CNVs; polymorphism vs pathogenic mutation 7.Variant effect prediction and association studies: SIFT, PolyPhen, CADD, GWAS 8.Molecular evolution and phylogenetics; substitution models 9.Tree construction: NJ, MP, ML, Bayesian methods 10.Phylogenetic tools: MEGA, RAxML, MrBayes PROTEIN STRUCTURE & MODELLING 1.Protein structure hierarchy; folds and domains 2.Structure classification: SCOP, CATH • Secondary and tertiary structure prediction 3.Homology modeling, threading and ab initio methods • AI-based structure prediction: AlphaFold, RoseTTAFold 4.Molecular mechanics; force fields: AMBER, CHARMM 5.Energy minimization and molecular dynamics simulations 6.Modeling and visualization tools: MODELLER, SWISS-MODEL, GROMACS, PyMOL, Chimera	15
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IV	Overview and Introduction of Intellectual Property <ul style="list-style-type: none">• Intellectual property rights: Classification and forms. Rationale for protection of IPRs• Importance of IPRs in the fields of science and technology.• Patents – Concepts and principles of patenting – Patentable subject matter• Procedure of obtaining patents – Rights of patents – Infringement of patent rights.• Remedies for infringement of patent rights• Plant and Animal variety protection act, The strategy of protecting plants and animals• Recent Developments in Patent System and Patentability of biotechnological inventions.• IPR issues in Indian Context Role of patent in pharmaceutical industry,• Case studies Rice, Haldi, neem, etc. Patentability and emerging issues	15
Suggested Readings: <ol style="list-style-type: none">1. Bioinformatics-sequence, structure and databanks. (2000) D.Higgins and W. Taylor A practical approach.2. Bioinformatics computing (2003). B. Bergeman.3. Bioinformatics databases and algorithms (2007) N. Gautham. E-resources: <ol style="list-style-type: none">1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf Reference Journal: 1. Journal of Intellectual Property Rights (JIPR): NISCAIR http://nopr.niscair.res.in/handle/123456789/45 (Case Studies) Useful Websites: <ol style="list-style-type: none">1. Cell for IPR Promotion and Management (http://cipam.gov.in/)2. World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)		
Suggested Continuous Evaluation Methods: <ul style="list-style-type: none">• Seminar/Presentation on any topic of the above syllabus• Test with multiple choice questions/short and long answer questions.• Attendance		



Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

- It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.

At the End of the whole syllabus any remarks/ suggestions:

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M.Sc. I Year (Semester I) Biotechnology
Paper 10 Concepts in Microbiology MSB10204T

Programme/Class: Degree MSC	Year: 1	Semester: II
Subject: Biotechnology		
CourseCode: MSB 10204T	Course Title: Concepts in Microbiology (Theory)	
Course outcomes:		Bloom's taxonomy
CO1- Learn microbial evolution, bacterial taxonomy and nomenclature using modern approaches.		K2, K3
CO2 Understand diversity and metabolic capabilities of different types of microorganisms.		K3, K4
CO3- understand and learn principles of biosafety, antibiotic action, antimicrobial resistance, and antifungal therapy in laboratory and clinical contexts		K2, K4
CO4- understand life cycles of bacterial, plant, and animal viruses, and correlate microbial pathogens with major human, food-borne, and water-borne diseases.		K2, K5
Credits: 4	CoreCompulsory	
Max.Marks:25+75	Min.PassingMarks:40	
TotalNo.ofLectures-Tutorials-60Lectures		
Unit	Topic	No.of Lectures: 60
	PARTA	
I	1. Microbial Evolution. 2. Bacterial taxonomy - ribotyping 3. Nomenclature & Bergey's Manual 4. Cell wall of Gram Positive & Negative bacteria 5. Microbial Growth - Growth Curve, Measurement of growth & Factor affecting microbial growth. ●	15



II	1. Photosynthetic Pigments & Photosynthesis in microbes. 2. Chemolithotrophy - Sulphate reduction, iron & methanogens 3. Nitrogen Metabolism 4. Archae- Halophiles, Thermophiles, Psychrophiles 5. Bacteria - Purple & Green bacteria, Cyanobacteria, Gliding & Sheath bacteria, Endospore forming bacteria, Rickettsias, Chlamydia & Mycoplasma.	15
III	1. Structure & Life Cycle of Viruses - Bacterial (Lambda) plant (TMV) & Animal Adenovirus, Pox & Herpes. 2. Microbial diseases - Tuberculosis, Typhoid, AIDS, Hepatitis, Malaria, Candidiasis 3. Food & waterborne diseases - Cholera & Diarrhea	15
IV	1. Biosafety - Laboratory rules, biological safety cabinets, biosafety levels, biosafety levels of pathogenic micro organisms, Biohazards, GRAS organisms. 2. Antibiotics, Mode of action of antibiotics, Antibiotics resistance, Antifungal.	15

Suggested reading:

1. General Microbiology, Stainer, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. The Macmillan Press Ltd.
2. Brock Biology of Microorganisms, Madigan, M.T. Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R. Tata McGraw Hill (2009)
4. Microbial Genetics, Maloy, S.R., Cronan, J.E. Jr. and Freifelder, D. Jones, Bartlett Publishers.
5. Microbiology- a Laboratory Manual, Cappuccino, J.G. and Sherman, N. Addison Wesley.
6. Microbiological Applications, (A Laboratory Manual in General Microbiology) Benson, H.J. WCB: Wm C. Brown Publishers
7. Microbiology: Lansing Prescott, John Harley, and Donald Klein; McGraw Hill 5th Edition (2001)
8. Microbiology - Tortora, Funke and Case; 10th Edition Pearson Education Benjamin Cummings publishers

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.



- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

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M.Sc. I Year (Semester II) Biotechnology
Paper 11 Lab2 MSB10205P

Programme/Class: Degree M.Sc	Year:1	Semester:2
Subject: Biotechnology (Practical)		
CourseCode: MSB10205P	Course Title: Lab2	
Course outcomes:	Bloom's taxonomy	
CO1- To learn and apply proper laboratory practices, safety rules, and correct handling and use of basic laboratory instruments used in molecular biology experiments.	K2, K5	
CO2- To perform isolation, purification, and quantitative estimation of different types of nucleic acids (genomic DNA from plant and bacterial cells and plasmid DNA).	K1, K4	
CO3- To analyze DNA using agarose gel electrophoresis and perform PCR amplification of DNA samples.	K3, K4	
CO4- To apply basic biostatistical tools for analysis and interpretation of experimental data.	K3, K4	
Credits: 4	Core Compulsory	
Max.Marks: 25+75	Min.PassingMarks:40	
TotalNo.oflab.periods-30(60hours)		
	Topic	No.of lab.periods



	<ol style="list-style-type: none">1. To write the laboratory rule and instruments.2. To perform the isolation of genomic DNA from plant cells.3. To perform the isolation of genomic DNA from bacterial cells.4. To perform the isolation of plasmid DNA from bacterial cells.5. To perform the quantitative estimation of nucleic acids.6. Study of agarose gel electrophoresis and restriction mapping of DNA.7. Electrophoresis of DNA- linear, circular and super coiled8. To perform the PCR from given DNA sample9. Determination of mean, median & mode.10. Correlation analysis.11. Probability test.12. To the Calculation of T- test from given value.13. To the Calculation of Chi square test from given value.14. IPR: patent design and patent filing.	60
<p>Suggested Readings:</p> <ol style="list-style-type: none">1. Sambrook J, Fritsch EF, Maniatis T. Molecular cloning: a laboratory manual. 3rd ed. Cold Spring Harbor (NY): Cold Spring Harbor Laboratory Press; 2001.2. Vennison, S. J. (2009). <i>Laboratory Manual For Genetic Engineering</i>. PHI Learning Pvt. Ltd..		

Suggested Continuous Evaluation Methods:

- Experimental work assessment.
- Practical exam.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

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ख्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)

U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE))

M.Sc. I Year (Semester II) Biotechnology
Paper 12 Research project/internship/field or survey work MSB10206R

Programme/Class: Degree MSc	Year: 1	Semester : II
Subject: Biotechnology(Research project/internship/field or survey work)		
CourseCode: MSB10206R	Course Title: Research project/internship/field or survey work	
Topic will be decided		



M.Sc. BIOTECHNOLOGY Second Year

PO1: Scientific Knowledge

Apply advanced knowledge of biological sciences, chemistry, and biotechnology principles to solve complex problems.

PO2: Technical Proficiency

Demonstrate proficiency in modern biotechnological techniques, including molecular biology, genetic engineering, bioinformatics, and bioprocessing.

PO3: Research Aptitude

Design and conduct scientific experiments, analyze data, interpret results, and contribute to research and innovation in biotechnology.

PO4: Critical Thinking & Problem-Solving

Apply analytical and critical thinking to identify, formulate, and solve biotechnological problems using scientific methods.

PO5: Ethics & Responsibility

Understand and apply ethical, biosafety, and IPR principles in biotechnological research and applications.

PO6: Communication Skills

Communicate scientific information effectively through technical reports, presentations, and scientific writing.

PO7: Lifelong Learning

Engage in continuous learning and adapt to emerging trends and technologies in biotechnology.

PO8: Professional & Societal Contribution

Apply biotechnological knowledge for sustainable development, healthcare, agriculture, and environmental management.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSOs for Semester III

PSO3.1: Apply plant tissue culture and animal cell culture techniques for crop improvement, metabolite production, and transgenic development.

PSO3.2: Design and evaluate nanomaterials for biomedical, agricultural, and environmental applications.

PSO3.3: Develop nutraceutical formulations and functional foods with health benefits and regulatory compliance.



PSO3.4: Conduct integrated practical experiments in plant, animal, and nanobiotechnology.

PSOs for Semester IV

PSO4.1: Design and optimize industrial bioprocesses for the production of biofuels, enzymes, and biopharmaceuticals.

PSO4.2:

PSO4.3: Develop pharmaceutical products including vaccines, biotherapeutics, and drug delivery systems.

PSO4.4: Execute research projects integrating industrial, computational, and pharmaceutical biotechnology.

SEMESTER-WISE MAPPING OF POs & PSOs

Semester	Course	POs Addressed	PSOs Addressed
III	Plant & Animal Biotechnology	PO1, PO2, PO4	PSO3.1
III	Nanobiotechnology	PO1, PO2, PO5	PSO3.2
III	Nutraceuticals & Functional Foods	PO1, PO4, PO8	PSO3.3
III	Practical Lab III	PO2, PO3, PO6	PSO3.1–3.4
III	Research Project	PO3, PO4, PO6, PO7	PSO3.1–3.4
IV	Industrial Biotechnology	PO2, PO4, PO8	PSO4.1
IV	Medical Biotechnology	PO1, PO2, PO7	PSO4.2
IV	Pharmaceutical Biotechnology	PO4, PO5, PO8	PSO4.3
IV	Practical Lab IV	PO2, PO3, PO6	PSO4.1–4.4
IV	Research Project	PO3, PO6, PO7, PO8	PSO4.1–4.4



M.Sc. 2nd Year (Semester III) Biotechnology
Paper 1 Plant and Animal Biotechnology MSB10301T

Programme/Class: Degree	Year: 2 nd year	M.Sc. 3 rd Semester
Subject: Biotechnology		
Course Code: MSB 10301T	Course Title: Plant and Animal Biotechnology	
Course outcomes:		Bloom's taxonomy
CO1: Understand plant tissue culture techniques and their applications in crop improvement.		K2, K5
CO2: Apply molecular plant biotechnology for stress tolerance and secondary metabolite production.		K5, K4
CO3: Understand animal cell culture, reproductive biotechnology, and assisted reproductive technologies.		K3, K4
CO4: Apply transgenic animal technologies, genome editing, and immunobiotechnology for research and therapeutic purposes.		K2, K5
Credits:4	Core Compulsory	
Max. Marks:25+75	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		
Unit	Topics	No. of Lectures= 60
I	<p>Plant Tissue Culture and Cellular Biotechnology</p> <p>1.Totipotency of plant cells Plant tissue culture: concept and applications Culture media: MS, B5, White's, Nitsch</p> <p>2.Callus and cell suspension cultures Micropropagation and somaclonal variation Organogenesis and somatic embryogenesis Protoplast isolation, culture and fusion Somatic hybridization and cybridization</p> <p>3.Haploid and doubled haploid production Synthetic seeds and encapsulation Cryopreservation and germplasm conservation Tissue culture in crop improvement</p>	15



II	Molecular Plant Biotechnology for Stress Tolerance and Metabolite Production 1.Plant cell cultures for secondary metabolite production. Cell line selection and commercial production. 3.Factors affecting metabolite yield. 2.Elicitation, permeabilization and immobilization. 3.Hairy root cultures and applications. 4.Biotransformation using plant cells. 5.Abiotic stress tolerance: drought, flood, salinity, temperature, light, metals. 6.Biotic stress tolerance: bacterial, fungal, viral resistance. 7.Stress signaling and defense mechanisms. 8.Molecular markers in crop improvement.	15
III	ANIMAL CELL CULTURE AND REPRODUCTIVE BIOTECHNOLOGY 1.Animal cell culture: principles and applications Culture facilities, biosafety and essential equipment Primary, diploid and continuous cell lines Cell line development, authentication and cryopreservation Culture media: balanced salt solutions, natural, defined and serum-free media Role of serum, growth factors and supplements Physico-chemical parameters: pH, CO ₂ , temperature, osmolarity 2.Conventional animal breeding: selection and crossbreeding Assisted reproductive technologies (ART): superovulation, oestrus synchronization Embryo technologies: collection, transfer and cryopreservation 3.In vitro maturation (IVM), IVF and embryo culture Micromanipulation, embryo splitting and cloning Somatic cell nuclear transfer (SCNT) and embryo sexing	15



IV	TRANSGENIC ANIMALS, GENOME EDITING AND IMMUNOBIOTECHNOLOGY 1. Transgenic animals: concepts and applications 2. Gene transfer methods: DNA microinjection, viral vectors, ES cell-mediated transfer 3. Transgenic and knockout mice models Gene knock-in and knock-out technologies 4. Genome editing tools: CRISPR-Cas systems (overview and applications) 5. Marker-assisted selection and genomic selection in livestock Transgenic animals as bioreactors for therapeutic proteins 6. Vaccines: subunit, recombinant and attenuated vaccines DNA and vector-based vaccines (overview) Monoclonal antibodies and recombinant antibodies Engineered immunotherapeutics and antibody-based therapies	15
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Suggested Readings:

1. Razdan MK – Introduction to Plant Tissue Culture 2nd Edition; Oxford & Ibh Publishing Co. Pvt Ltd 2010
2. Vasil IK – Plant Cell and Tissue Culture; Springer 1994
3. Bhojwani SS and Razdan MK – Plant Tissue Culture; Elsevier
4. TJ Fu, G Singh and WR Curtis (Eds): Plant Cell and Tissue Culture for the production of Food Ingredient. Kluwer Academic/Plenum Press, 1999
5. J Hammond, P McGarvey & V Yusibov (Eds): Plant Biotechnology, Springer Verlag.2000.
6. H.S. Chawla: Biotechnology in Crop Improvement, International Book Distributing Company, 1998.
7. H.S. Chawla: Introduction to plant biotechnology. Oxford & IBH Publishing Co. (P) Ltd.
8. B.D. Singh, (2004) Biotechnology. Expending Horizons. First Edition. Kalyani Publishers, Ludhiana.
9. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Edited by R. Ian Freshney. 6th Ed. Wiley Blackwell, 2010.
10. JM Davis. Basic Cell Culture. Oxford University Press. New Delhi, 2008.
11. Gene cloning and DNA analysis by T.A. Brown by Willey and sons. Lewin’s gene XI Krebs J.E, Kilpatrick S.T, and Bartlett publications.

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

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Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)

U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(F) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE))

At the End of the whole syllabus any remarks/ suggestions:

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M.Sc. 2nd Year (Semester III) Biotechnology
Paper 2: Nanobiotechnology MSB10302T

Programme/Class: Degree	Year: 2 nd year	M.Sc. 3 rd Semester
Subject: Biotechnology		
Course Code: MSB 10302T	Course Title: Nanobiotechnology	
Course outcomes:		Bloom's taxonomy
CO1: Understand fundamentals of nanobiotechnology, nanomaterials, and natural bionanomachines.		K4, K5
CO2: Apply principles of nano-biosensors and bioimaging for diagnostics and precision medicine.		K1, K4
CO3: Understand nanomedicine and advanced drug delivery systems, including targeted and stimuli-responsive therapies.		K3, K4
CO4: Evaluate applications, emerging trends, and ethical/regulatory aspects of nanobiotechnology in medicine, agriculture, and industry.		K2, K5
Credits:4	Core Compulsory	
Max. Marks:25+75	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		
Unit	Topics	No. of Lectures= 60



I	Fundamentals of Bionanotechnology 1.Introduction to nanobiotechnology: scope, interdisciplinary nature, and applications 2.Classification of nanomaterials: organic, inorganic, hybrid, and bio-inspired nanomaterials 3.Structure–property relationships of biomaterials at nanoscale 4.Size-dependent properties: surface area, quantum confinement, optical, electrical, and magnetic behavior 5.Nanostructures: nanoparticles, nanorods, nanowires, nanoclusters, quantum dots, and quantum wells Semiconductor nanomaterials in biological systems Role of aqueous environment, hydrogen bonding, and molecular crowding in bionanomachines 6.Natural bionanomachines: ATP synthase, DNA/RNA polymerases, thymidylate synthase, actin–myosin motor systems Quantum dots: structure, synthesis, surface functionalization, and bio-conjugation Lipids as nano-building blocks: self-assembled monolayers, bilayers, liposomes, and supported lipid membranes	15
II	Nano-Biosensors and Bioimaging 1. Biosensors: principles, components, and performance parameters 2.Classification of biosensors: <ul style="list-style-type: none">• Electrochemical (amperometric, potentiometric, impedimetric)• Optical (SPR, fluorescence, FRET-based)• Piezoelectric and acoustic sensors• Thermal and phase-transition-based sensors 3.Nanomaterials in biosensing: gold nanoparticles, carbon nanotubes, graphene, quantum dots Biomembrane-based and cell-based biosensors Nano-enabled diagnostic imaging: digital imaging, molecular imaging, contrast agents 4.Lab-on-chip and microfluidic-based nanosensors Wearable and implantable biosensors in precision medicine	15



III	Nanomedicine and Advanced Drug Delivery Systems <ol style="list-style-type: none">1. Nanomaterials in diagnostics, therapeutics, and theranostics2. Nanoparticles as carriers for drugs, genes, and vaccines3. Targeted and stimuli-responsive drug delivery systems4. Nanotechnology in cancer therapy, neuroscience, cardiovascular disorders, and infectious diseases5. Tissue engineering and regenerative medicine: nanofibers, scaffolds, and hydrogels6. Dendrimers: structure, synthesis, and biomedical applications7. Drug delivery platforms: polymer–drug conjugates, polymeric micelles, liposomes, solid lipid nanoparticles8. Nanoparticles for gene delivery (siRNA, mRNA, CRISPR-Cas systems)9. Toxicity, biocompatibility, and regulatory aspects of nanomedicine	15
IV	Applications and Emerging Trends in Nanobiotechnology <ol style="list-style-type: none">1. Bio-barcode assays and ultra-sensitive diagnostics Antibody-based diagnostic techniques: micro- and nano-immunosensors2. Nanotechnology in agriculture: nano-fertilizers, nano-pesticides, and smart delivery systems Designer proteins and protein engineering at nanoscale Peptide nucleic acids (PNA) and nanostructured nucleic acid systems3. Environmental and industrial applications of nanobiotechnology4. Ethical, biosafety, and regulatory frameworks (DBT, ICMR, OECD guidelines)5. Future trends: AI-integrated nanobiotechnology, personalized nanomedicine, and sustainable nanomaterials	15



Suggested Readings:

1. C. M. Niemeyer, C. A. Mirkin, –Nanobiotechnology: Concepts, Applications and Perspectives||, Wiley – VCH, (2004).
- 2 T. Pradeep, –Nano: The Essentials||, McGraw – Hill education, (2007).
3. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, ||Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact||, Wiley – VCH, (2005).
4. Nicholas A. Kotov, –Nanoparticle Assemblies and Superstructures||, CRC, (2006).
5. David S Goodsell, “Bionanotechnology||, John Wiley & Sons, (2004)

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

- It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.

At the End of the whole syllabus any remarks/ suggestions:

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M.Sc. 2nd Year (Semester III) Biotechnology
Paper3: Nutraceuticals and Functional Foods MSB10303T

Programme/Class: Degree	Year: 2 nd year	M.Sc. 3 rd Semester
Subject: Biotechnology		
Course Code: MSB 10303T	Course Title: Nutraceuticals and Functional Foods	
Course outcomes:		Bloom's taxonomy
CO1: Understand concepts, classification, and molecular basis of nutraceuticals and functional foods.		K4, K3
CO2: Apply knowledge of absorption, bioavailability, metabolism, and cellular targets of nutraceutical compounds.		K1, K4
CO3: Understand antioxidants, oxidative stress, and the role of nutraceuticals in disease prevention and health management.		K3, K4
CO4: Evaluate functional food sources, formulation, safety, regulatory aspects, and industry applications.		K1, K5
Credits:4	Core Compulsory	
Max. Marks:25+75	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		
Unit	Topics	No. of Lectures= 60
I	<p>Nutraceuticals – Concepts and Molecular Classification</p> <ol style="list-style-type: none"> 1. Historical background, definition, and scope of nutraceuticals 2. Distinction between nutraceuticals, functional foods, dietary supplements 3. Classification based on chemical/biochemical nature: polyphenols, flavonoids, carotenoids, vitamins, minerals, essential fatty acids, phytosterols, dietary fibers, prebiotics, probiotics, bioactive peptides 4. Absorption, bioavailability, metabolism, and transport of nutraceutical compounds 5. Cellular and molecular targets; role in metabolic regulation 6. Emerging concepts: nutrigenomics, nutrigenetics, personalized nutrition 	15



II	Functional Food Science and Technology <ol style="list-style-type: none">1. Functional foods: definition, types, and scientific validation2. Functional food science: identification and characterization of bioactive compounds3. Food matrix–bioactive interactions4. Role of food biotechnology, fermentation, and processing5. Impact of processing and storage on functional efficacy6. Delivery systems for bioactives (encapsulation, nano-delivery)7. Indian functional food and nutraceutical industry: challenges and prospects	15
III	Antioxidants and Molecular Basis of Disease Prevention <ol style="list-style-type: none">1. Free radicals, ROS and RNS: sources and biochemical effects2. Oxidative stress and redox homeostasis3. Antioxidant defense systems: enzymatic (SOD, catalase, GPx) and non-enzymatic4. Antioxidants as nutraceuticals and functional foods5. Mechanisms of action: radical scavenging, metal chelation, gene regulation6. Role in prevention and management of cardiovascular diseases, diabetes, cancer, hypertension, obesity	15
IV	Functional Food Sources, Applications and Regulation <ol style="list-style-type: none">1. Food sources of nutraceuticals: cereals, fruits, vegetables, dairy, legumes, nuts, oilseeds, seafood2. Herbs, spices, medicinal plants as functional foods3. Functional beverages: tea, coffee, fermented drinks and health benefits4. Formulation, safety, toxicity, and clinical validation of nutraceuticals5. Marketing issues, health claims, and quality control6. Regulatory frameworks: CODEX Alimentarius, EFSA (EU), FSSAI (India)	15



Suggested Readings:

1. Wildman, R. E. C. Handbook of Nutraceuticals and Functional Foods – CRC Press
2. Bagchi, D. Nutraceuticals and Functional Foods in Human Health and Disease Prevention – CRC Press
3. Gibson, G. R., & Williams, C. M. Functional Foods: Concept to Product – Woodhead Publishing
4. Shahidi, F., & de Camargo, A. C. Bioactive Molecules in Food – Springer
5. Singh, R. B., et al. Functional Foods and Nutraceuticals in Metabolic and Non-Communicable Diseases – Academic Press
6. Belitz, H.-D., Grosch, W., & Schieberle, P. Food Chemistry – Springer
7. Gropper, S. S., & Smith, J. L. Advanced Nutrition and Human Metabolism – Cengage
8. Halliwell, B., & Gutteridge, J. M. C. Free Radicals in Biology and Medicine – Oxford University Press
9. Finkel, T., & Holbrook, N. J. Oxidants, oxidative stress and biology of ageing – Nature
10. Commission – Guidelines on Functional Foods and Nutraceuticals
11. EFSA (European Food Safety Authority) – Scientific opinions on health claims
12. FSSAI (India) – Regulations on Nutraceuticals, Health Supplements and Functional Foods

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

- It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.

At the End of the whole syllabus any remarks/ suggestions:

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**M.Sc. 2nd Year (Semester III) Biotechnology
Paper3: Lab3 MSB10304T**

Programme/Class: Degree/M.Sc	Year: 2 nd year	M.Sc. 3 rd Semester
Subject: Biotechnology		
Course Code: MSB10304P	Course Title: Lab3	
Course outcomes:		Bloom's taxonomy
CO1: Apply plant tissue and cell culture techniques for regeneration, protoplast manipulation, and secondary metabolite production.		K4, K5
CO2: Understand and perform animal cell culture, maintenance, cryopreservation, and media optimization.		K1, K4
CO3: Synthesize and characterize metal nanoparticles using chemical and green methods.		K3, K4
CO4: Analyze and evaluate nutraceuticals and functional foods, including bioactive compounds and antioxidant activity.		K2, K5
Credits:4	Core Compulsory	
Max. Marks:25+75	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		
Unit	Topics	No. of Lectures= 60



1. Preparation of plant tissue culture media (MS, B5, White's) and standardization of aseptic techniques for in vitro culture.
2. Callus induction from different plant explants and regeneration through organogenesis using appropriate auxin–cytokinin combinations.
3. Establishment of plant cell suspension cultures and analysis of growth kinetics under controlled in vitro conditions.
4. Isolation of plant protoplasts, assessment of viability, and demonstration of protoplast fusion leading to somatic hybridization and cybridization.
5. Application of plant cell and tissue cultures for secondary metabolite production, including the study of factors affecting metabolite yield, elicitation and immobilization (demonstration/analytical).
6. Study of animal cell culture media including balanced salt solutions, natural, defined and serum-free media, and the role of serum, growth factors and supplements.
7. Maintenance and subculturing of an established animal cell line, including observation of cell morphology and demonstration of trypsinization and passaging.
8. Cryopreservation of animal cells: preparation of freezing medium, use of cryoprotectants and principles of long-term storage (demonstration).
9. Chemical synthesis of silver nanoparticles using reduction methods and confirmation of nanoparticle formation through visual observation and UV–Visible spectral analysis.
10. Chemical synthesis of gold nanoparticles and study of size-dependent optical properties based on surface plasmon resonance using UV–Visible spectroscopy.
11. Green synthesis of metal nanoparticles using biological (plant or microbial) extracts and evaluation of synthesis efficiency, stability, and eco-friendly advantages.
12. Survey and molecular classification of nutraceuticals and functional food products
13. Qualitative detection of bioactive nutraceutical compounds in common food sources
14. Preparation of a model functional food formulation
15. Demonstration of antioxidant activity of nutraceutical-rich food extracts

15

1. Study of the effect of food processing on nutraceutical stability
2. Analysis of food labels, health claims, and regulatory compliance





Suggested Readings:

1. Bhojwani, S.S. and Dantu, P.K. *Plant Tissue Culture: An Introductory Text*. Springer.
2. Razdan, M.K. *Introduction to Plant Tissue Culture*. Oxford & IBH.
3. George, E.F., Hall, M.A. and De Klerk, G.J. *Plant Propagation by Tissue Culture*. Springer.
4. Gamborg, O.L. and Phillips, G.C. *Plant Cell, Tissue and Organ Culture: Fundamental Methods*. Springer.
5. Evans, D.A., Sharp, W.R., Ammirato, P.V. and Yamada, Y. *Handbook of Plant Cell Culture*. Macmillan.
6. Ramawat, K.G. and Mérillon, J.M. *Bioactive Molecules in Plant Cell Cultures*. Springer.
7. Verpoorte, R., Alfermann, A.W., Johnson, T.S. and Pras, N. *Metabolic Engineering of Plant Secondary Metabolism*. Springer.
8. Chawla, H.S. **Introduction to Plant Biotechnology**. Oxford & IBH Publishing.
9. Trivedi, P.C. (Ed.). **Plant Tissue Culture**. Panima Publishing Corporation.
10. Ignacimuthu, S. **Plant Biotechnology**. Oxford & IBH Publishing.
11. Keshavachandran, R. et al. **Plant Biotechnology and Genetic Engineering**. PHI Learning.
12. Singh, B.D. **Biotechnology: Expanding Horizons**. Kalyani Publishers.
13. Freshney, R.I. **Culture of Animal Cells: A Manual of Basic Technique**. (Indian edition widely prescribed).
14. Talwar, G.P., Hasnain, S.E. and Sarin, S.K. **Textbook of Biotechnology**. Tata McGraw-Hill.
15. Gupta, P.K. **Biotechnology and Genomics**. Rastogi Publications.
16. Dubey, R.C. **A Textbook of Biotechnology**. S. Chand & Company.
17. Pradeep, T. **Nano: The Essentials**. McGraw-Hill Education.
18. Kumar, C.S.S.R. **Nanomaterials for Medical Diagnosis and Therapy**. Wiley-VCH.
19. Goodsell, D.S. **Bionanotechnology: Lessons from Nature**. John Wiley & Sons.
20. Niemeyer, C.M. and Mirkin, C.A. **Nanobiotechnology: Concepts, Applications and Perspectives**. Wiley-VCH.
21. Challa, S.S.R. Kumar. **Biological and Bio-Inspired Nanomaterials**. Wiley-VCH
22. Wildman, R. E. C. *Handbook of Nutraceuticals and Functional Foods*
23. Gibson, G. R. & Williams, C. M. *Functional Foods: Concept to Product*
24. Shahidi, F. *Nutraceuticals, Functional Foods and Health*
25. ICMR. *Dietary Guidelines for Indians*
26. FSSAI. *Regulations on Nutraceuticals, Health Supplements and Functional Foods*

Suggested Continuous Evaluation Methods:

- Experimental work assessment.
- Practical exam.
- Attendance



Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

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At the End of the whole syllabus any remarks/ suggestions:

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ख्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
Khwaja Moinuddin Chishti Language University, Lucknow, U.P. (India)

U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(F) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE))

M.Sc. 2nd Year (Semester III) Biotechnology
Paper5: Research project/internship/field or survey work MSB10305R

Programme/Class: Degree/ MSc	Year: 2	Semester : III
Subject: Biotechnology(Research project/internship/field or survey work)		
CourseCode: MSB10305R	Course Title: Research project/internship/field or survey work	
Topic will be decided		



M.Sc. 2nd Year (Semester IV) Biotechnology
Paper 6: Industrial Biotechnology MSB10401T

Programme/Class: Degree	Year: 2 nd year	M.Sc. 4 th Semester
Subject: Biotechnology		
Course Code: MSB 10401T	Course Title: Industrial Biotechnology	
Course outcomes:		Bloom's taxonomy
CO1: Understand microbial growth, bioreactor design, and operation principles for industrial fermentation processes.		K4, K5
CO2: Apply enzyme technology, including kinetics, immobilization, and industrial biocatalysis.		K1, K4
CO3: Understand downstream processing strategies for product recovery, purification, and quality control.		K3, K4
CO4: Apply principles of bioprocess plant design, metabolic engineering, and synthetic biology for strain improvement and industrial applications.		K2, K5
Credits:4	Core Compulsory	
Max. Marks:25+75	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		
Unit	Topics	No. of Lectures= 60



I	BIOPROCESS ENGINEERING AND FERMENTATION TECHNOLOGY 1. Microbial growth phases and physiology <ul style="list-style-type: none">• Growth kinetics: Monod, inhibition models, yield coefficients• Substrate utilization and product formation kinetics 2. Culture systems: batch, fed-batch, continuous (chemostat, turbidostat) 3. Types of bioreactors: STR, air-lift, bubble column, plug flow, enzyme reactors <ul style="list-style-type: none">• Bioreactor components, sensors and control• Sterilization methods and thermal death kinetics• Mass and energy balance in bioprocesses• Dissolved oxygen effects and oxygen transfer (kLa)• Aeration, agitation and power requirements• Fluid rheology and non-Newtonian behavior 4. Industrial fermentation processes: antibiotics, organic acids, alcohols <ul style="list-style-type: none">• Production of amino acids, vitamins, enzymes and bioplastics• Biotransformation of steroids and pharmaceuticals• Process flow sheet and basic process economics	15
II	ENZYMES AND MICROBIAL TECHNOLOGY 1. Enzyme classification and properties 2. Enzyme kinetics and inhibition 3. Enzyme stability and regulation 4. Biocatalysis and industrial applications 5. Enzymes in organic solvents and ionic liquids 6. Non-aqueous and green biocatalysis 7. Enzyme engineering concepts 8. Directed evolution and random mutagenesis 9. Rational and semi-rational protein engineering 10. Immobilization of enzymes and whole cells 11. Immobilization methods: adsorption, covalent, entrapment, encapsulation 12. Immobilized enzyme reactor design and operation 13. Kinetics of immobilized systems 14. Diffusional resistance, Thiele modulus and effectiveness factor	15



III	DOWNSTREAM PROCESSING IN BIOTECHNOLOGY 1.Role and objectives of downstream processing 2.Biomass removal: filtration, centrifugation, flocculation 3.Cell disruption: mechanical and non-mechanical methods 4.Primary purification strategies 5.Precipitation using salts, solvents and polymers 6.Aqueous two-phase extraction systems 7.Membrane separation: MF, UF, NF, RO 8.Adsorption principles • Chromatographic techniques: IEC, affinity, HIC, SEC 9.Solvent extraction methods • Supercritical fluid extraction • Product polishing and concentration 10.Drying methods: spray drying, freeze drying 11.Product formulation and quality control	15
IV	BIOPROCESS PLANT DESIGN, METABOLIC ENGINEERING AND SYNTHETIC BIOLOGY 1. Principles of bioprocess plant design • Process flow sheet development • Selection and specification of bioprocess equipment • Utilities, safety and waste management 2.Scale-up criteria: mixing, oxygen and heat transfer • Scale-down models and limitations • Scale-up of downstream processes 3.Cost estimation and economic evaluation • Feasibility and profitability analysis 4.Principles of metabolic engineering • Pathway analysis and flux balance analysis • Metabolic control analysis • Strain improvement strategies • Synthetic biology concepts • Design–build–test–learn cycle • Synthetic gene circuits and regulatory elements • CRISPR-based genome editing 5.Industrial and therapeutic applications	15



Suggested Readings:

1. **Wildman, R. E. C.** *Handbook of Nutraceuticals and Functional Foods* – CRC Press
2. **Bagchi, D.** *Nutraceuticals and Functional Foods in Human Health and Disease Prevention* – CRC Press
3. **Gibson, G. R., & Williams, C. M.** *Functional Foods: Concept to Product* – Woodhead Publishing
4. **Shahidi, F., & de Camargo, A. C.** *Bioactive Molecules in Food* – Springer
5. **Singh, R. B., et al.** *Functional Foods and Nutraceuticals in Metabolic and Non-Communicable Diseases* – Academic Press
6. **Belitz, H.-D., Grosch, W., & Schieberle, P.** *Food Chemistry* – Springer
7. **Gropper, S. S., & Smith, J. L.** *Advanced Nutrition and Human Metabolism* – Cengage
8. **Halliwell, B., & Gutteridge, J. M. C.** *Free Radicals in Biology and Medicine* – Oxford University Press
9. **Finkel, T., & Holbrook, N. J.** Oxidants, oxidative stress and biology of ageing – *Nature*
10. **Commission** – Guidelines on Functional Foods and Nutraceuticals
11. **EFSA (European Food Safety Authority)** – Scientific opinions on health claims
12. **FSSAI (India)** – Regulations on Nutraceuticals, Health Supplements and Functional Foods

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

- It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.

At the End of the whole syllabus any remarks/ suggestions:

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**M.Sc. 2nd Year (Semester IV) Biotechnology
Paper 7 Medical Biotechnology MSB10402T**

Programme/Class: Degree MSC	Year: 2	Semester: IV
Subject: Biotechnology		
Course Code: MSB10402T	Course Title: Medical Biotechnology (Theory)	
Course outcomes:	Bloom's taxonomy	
CO1- Introduce students to the principles of and clinical genetics.	K1, K2	
CO2- Students learn about the fundamental principles of heredity and deviations from mendelian behavior and human genomic disorders.	K1, K4	
CO3- Understand different therapeutics used in genetic disorders.	K3, K4	
CO4- Learn about molecular tools including prenatal diagnosis.	K2, K5	
Credits: 4	CoreCompulsory	
Max.Marks:25+75	Min.PassingMarks:40	
TotalNo.ofLectures-Tutorials-60Lectures		
Unit	Topic	No.of Lectures
	PARTA	



I	CLASSIFICATION OF GENETIC DISEASES <ol style="list-style-type: none">1. Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies,2. Structural disorders e.g. deletions, duplications, translocations & inversions,3. Chromosomal instability syndromes.- Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial4. disorders and Multifactorial conditions5. Identification of disease genes .Functional cloning –eg. haemophilia gene .Positional cloning – eg. DMD and CGD6. genes.7. Candidate gene approach – eg. Marfan’s syndrome, Alzheimer’s disease.8. Molecular basis of human diseases - Pathogenic mutations. Gain of function mutations: Oncogenes, Huntingtons9. Disease, Pittsburg variant of alpha 1 antitrypsin.10. Loss of function - Tumour Suppressor Genes, PAX- 3 gene.11. Gene Dosage Effect - PMP22 Collagen gene.12. Genomic Imprinting -Mechanisms, Praderwilli / Angelman syndrome, WAGR syndrome, Beckwith Weidemann Syndrome.13. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy.Mitochondrial diseases: MELAS, LHON, MERRF.14. Immuno Pathology, Hepatitis, HIV, Autoimmune Disorders-SLE, RA	15
II	DIAGNOSTICS. <ol style="list-style-type: none">1. Prenatal diagnosis - Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS),2. Non-invasive techniques - Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood.3. Diagnosis using protein and enzyme markers, monoclonal antibodies.4. DNA/RNA based diagnosis Hepatitis, CML – bcr/abl, HIV - CD 4 receptor.5. Microarray technology- genomic and c DNA arrays, application to diseases	15



III	THERAPEUTICS <ol style="list-style-type: none">1. Clinical management and Metabolic manipulation – PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism.2. Gene therapy - Ex-vivo, Invivo, Insitu gene therapy Strategies of gene therapy: gene augmentation – ADA deficiency,3. CFTR Prodrug therapy/ suicide gene – glioma, evoking immune response – melanoma TFO,4. Antisense therapy, Ribozymes, Protein Aptamers, Intrabodies.5. Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes,6. receptor mediated gene transfer.7. Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solid tumours.8. Cell and tissue engineering: Encapsulation technology and therapeutics-Diabetes, Hypothyroidism, Haemophilia9. Bioartificial organs, Artificial Cells- For Haemophilia, Phenyl Ketonuria, Diabetes.10. Stem cell therapy - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent Cells.11. Testing and generation of embryonic stem cells, Testing for adult stem cells and differentiation. Potential use of stem12. cells – Cell based therapies. Nanomedicine – Nanoparticles, Nanodevices-medical microrobotics, nanorobotics ,13. Microbiovers, Nanomedicine and Nanosurgery – for cancers, neurological disorders	15
IV	GENE PRODUCTS IN MEDICINE <ol style="list-style-type: none">1. Functional cloning – anti-haemophilic factor .2. Positional cloning- Dystrophin.3. Gene products in medicine – Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon.4. DNA based vaccines. subunit vaccines – Herpes Simplex Virus. Attenuated Vaccines– Cholera, Salmonella	15

Suggested Reading:

1. Medical Genetics, 5th edition by Lynn B. Jorde, John C. Carey, Michael J. Bamshad. Elsevier Publications, 2016.



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2. Human Molecular Genetics, 4th Edition by Tom Strachan and Andrew Read. Garland Science Publications, 2011.
 3. Emery's Elements of Medical Genetics, 15th Edition by Peter Turnpenny and Sian Ellard. Elsevier Publications, 2017.
 4. Principles of Genetics, 8th Edition by M J Gardner, 'MJ Simmons, DP Snustad. John Wiley and sons Publications, 2006

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as "SWAYAM" in India and Abroad.

Further Suggestions:

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M.Sc. 2nd Year (Semester IV) Biotechnology
Paper 8: Pharmaceutical Biotechnology MSB10403T

Programme/Class: Degree/MSc	Year: 2 nd year	M.Sc. 4 th Semester
Subject: Biotechnology		
Course Code: MSB 10403T	Course Title: : Pharmaceutical Biotechnology	
Course outcomes:		Bloom's taxonomy
CO1: Understand fundamentals of pharmacology, drug classification, mechanisms of action, and factors affecting drug response.		K4, K5
CO2: Apply pharmacokinetic principles, drug metabolism, and therapeutic drug monitoring in clinical contexts.		K1, K4
CO3: Understand drug discovery, preclinical development, and clinical trial processes, including ethical and regulatory considerations.		K3, K4
CO4: Evaluate regulatory affairs, industrial practices, and emerging trends in pharmaceutical biotechnology, including personalized medicine and in silico drug design.		K2, K5
Credit: 4	Max. Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		
Unit	Topics	No. of Lectures= 60



I	FUNDAMENTALS OF PHARMACOLOGY AND DRUG ACTION <ol style="list-style-type: none">1. History and evolution of pharmacology and pharmaceutical biotechnology2. Nature, sources and classification of drugs (chemical, biological, biotech products)3. Dosage forms: solid, liquid, semi-solid, topical, aerosols and advanced formulations4. Routes of drug administration; advantages, limitations and clinical relevance5. Drug targets and sites of action; receptor types and signal transduction pathways6. Mechanisms of drug action; agonists, antagonists and partial agonists7. Drug–drug interactions; synergism and antagonism8. Factors modifying drug action: age, genetics, disease, tolerance and dependence9. Adverse drug reactions (ADR), toxicity and pharmacovigilance basics	15
II	PHARMACOKINETICS, DRUG METABOLISM AND THERAPEUTIC MONITORING <ol style="list-style-type: none">1. Basic and clinical pharmacokinetics; compartmental and non-compartmental models2. Drug absorption mechanisms; transmembrane transport and drug permeability3. Bioavailability and bioequivalence; factors affecting systemic availability4. Drug distribution and plasma protein binding5. Drug metabolism: Phase I and Phase II reactions; cytochrome P450 enzyme system6. Drug–drug interactions at metabolic level7. Drug excretion: renal, biliary and extra-renal routes8. Biological half-life, clearance and volume of distribution9. Drug accumulation and steady-state kinetics10. Bioassays and therapeutic drug monitoring (TDM); clinical applications	15



III	DRUG DISCOVERY, PRECLINICAL DEVELOPMENT AND CLINICAL TRIALS 1. Drug discovery pipeline: target identification, validation and lead discovery 2. Lead generation approaches: rational design, antisense approach, HTS and AI-assisted screening 3. Sources of lead molecules: natural products, synthetic libraries and in silico-designed molecules 4. Hit-to-lead optimization; prodrugs and chiral drugs 5. Biopharmaceuticals: vaccines, monoclonal antibodies, cytokines, hormones and gene-based therapies 6. Preclinical studies: acute, subacute and chronic toxicity 7. Animal testing ethics and regulatory guidelines (OECD, CPCSEA) 8. Formulation development and drug delivery systems 9. Clinical trials: ethical considerations, regulatory framework and Phases I–IV	15
IV	REGULATORY AFFAIRS, INDUSTRIAL PRACTICES AND FUTURE TRENDS 1. Good practices: GMP, GLP and GCP 2. Drug development process and industrial workflow 3. Regulatory authorities and frameworks: USFDA, WHO, EMA and DCGI 4. Indian regulatory system: Drugs and Cosmetics Act; Schedule Y, M and T 5. GMP inspections and compliance 6. Pharmaceutical industry structure; manufacturing of small molecules, biologics and finished dosage forms 7. Intellectual property rights, patents and regulatory exclusivity 8. Emerging trends: biosimilars, novel drug delivery systems and targeted therapies 9. In silico drug discovery: molecular modeling, docking and ADMET prediction 10. Omics technologies in drug development: genomics, proteomics, metabolomics and pharmacogenomics 11. Personalized and precision medicine; future perspectives in pharmaceutical biotechnology	15



Suggested Readings:

1. **R. S. Satoskar, S. D. Bhandarkar and S. S. Ainapure.** *Pharmacology and Pharmacotherapeutics*, 23rd Edition, Bombay Popular Prakashan – foundational text for pharmacology and therapeutics with Indian clinical relevance.
2. **Rang, Dale, Ritter and Flower.** *Rang and Dale's Pharmacology*, 8th Edition, Elsevier – comprehensive coverage of mechanisms of drug action and modern pharmacology.
3. **Tripathi, K. D.** *Essentials of Medical Pharmacology*, 8th Edition, Jaypee Brothers – concise, exam-oriented pharmacology reference.
4. **Goodman and Gilman.** *The Pharmacological Basis of Therapeutics*, 13th Edition, McGraw-Hill – authoritative reference for drug mechanisms, pharmacokinetics and therapeutics.
5. **Ho, Nag and Rouse.** *Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs*, Wiley – core text on biopharmaceutical development and biotechnology-based therapeutics.
6. **Walsh, G.** *Biopharmaceuticals: Biochemistry and Biotechnology*, 3rd Edition, Wiley – detailed coverage of biologics, vaccines and biosimilars.
7. **Patrick, G. L.** *An Introduction to Medicinal Chemistry*, 7th Edition, Oxford University Press – essential reading for drug design, SAR and lead optimization.
8. **Aulton, M. E. and Taylor, K.** *Aulton's Pharmaceutics: The Design and Manufacture of Medicines*, Elsevier – formulation science and drug delivery systems.
9. **Silverman, R. B. and Holladay, M. W.** *The Organic Chemistry of Drug Design and Drug Action*, Academic Press – molecular basis of drug–target interactions.

Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

- It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.

At the End of the whole syllabus any remarks/ suggestions:

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M.Sc. 2nd Year (Semester IV) Biotechnology
Paper 9: Lab4 MSB10404P

Programme/Class: Degree/MSc	Year: 2 nd year	M.Sc. 4 rd Semester
Subject: Biotechnology		
Course Code: MSB10404P	Course Title: Lab4	
Course outcomes:		Bloom's taxonomy
CO1: Understand microbial growth, enzyme activity, and basic fermentation processes.		K1, K2
CO2: Apply enzyme immobilization techniques and primary downstream processing methods.		K1, K4
CO3: Use bioinformatics tools for sequence analysis, gene annotation, phylogenetics, and protein structure modeling.		K2, K4
CO4: Understand fundamentals of pharmacology, drug classification, routes of administration, and basic pharmacokinetic calculations.		K2, K5
Credits:4	Core Compulsory	
Max. Marks:25+75	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L- 4/w		
Unit	Topics	No. of Lectures= 60



	<ol style="list-style-type: none">1. Study of microbial growth phases using batch culture2. Determination of enzyme activity under different conditions (pH and temperature)3. Demonstration of batch fermentation process using a model system4. Immobilization of enzyme by simple entrapment method5. Study of primary downstream processing by centrifugation and filtration6. Retrieval and analysis of nucleotide and protein sequences from biological databases7. Pairwise sequence alignment and homology search using database search tools8. Multiple sequence alignment and conserved motif and domain analysis9. Gene prediction and functional annotation using genome annotation tools10. Phylogenetic tree construction and molecular evolutionary analysis11. Protein structure visualization and structure-based drug designing (molecular docking and virtual screening – introductory)12. Study and classification of drugs and pharmaceutical dosage forms13. Study of routes of drug administration with clinical relevance14. Basic pharmacokinetic calculations using standard model data	
	15.	



Suggested Readings:

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. *Principles of Fermentation Technology*
2. Shuler, M. L. & Kargi, F. *Bioprocess Engineering: Basic Concepts*
3. Bailey, J. E. & Ollis, D. F. *Biochemical Engineering Fundamentals*
4. Bisswanger, H. *Enzyme Kinetics*
5. Belter, P. A., Cussler, E. L., & Hu, W. S. *Bioseparations: Downstream Processing for Biotechnology*
6. Mount, D. W. *Bioinformatics: Sequence and Genome Analysis*
7. Baxevanis, A. D. & Ouellette, B. F. F. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*
8. Lesk, A. M. *Introduction to Bioinformatics*
9. Pevsner, J. *Bioinformatics and Functional Genomics*
10. Tutorials and manuals from NCBI, EMBL-EBI, UniProt, PDB and KEGG
11. Katzung, B. G. *Basic and Clinical Pharmacology*
12. Rang, H. P., Dale, M. M., Ritter, J. *Rang & Dale's Pharmacology*
13. Shargel, L. & Yu, A. B. C. *Applied Biopharmaceutics and Pharmacokinetics*
14. Patrick, G. L. *An Introduction to Medicinal Chemistry*
15. Regulatory documents from CDSCO/DCGI, WHO and USFDA

Suggested Continuous Evaluation Methods:

- Experimental work assessment.
- Practical exam.
- Attendance

Suggested equivalent online courses:

- IGNOU & Other centrally/ state operated Universities /MOOC platforms such as "SWAYAM" in India and Abroad.

Further Suggestions:

- It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.

At the End of the whole syllabus any remarks/ suggestions:

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ख्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)
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U.P. STATE GOVERNMENT UNIVERSITY,
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by (AICTE))

M.Sc. 2nd Year (Semester IV) Biotechnology
Paper 10: Research project/internship/field or survey work MSB10405R

Programme/Class: Degree/ MSc	Year: 2	Semester : IV
Subject: Biotechnology(Research project/internship/field or survey work)		
CourseCode: MSB10405R	Course Title: Research project/internship/field or survey work	
Topic will be decided		