GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
SECTOR – 16 C, DWARKA, NEW DELHI - 110078

GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY

SIXTIETH (60th) MEETING
OF
THE ACADEMIC COUNCIL

DATE : 11.06.2025
TIME : 11:00 AM

OFFLINE / ONLINE ON ZOOM PLATFORM

MINUTES

Agenda Item No. AC 60.23: **To ratify the admission criteria for admission to M.S. (Packaging Technology) offered by USBAS with the order of preference of GATE, UGC-NET, CSIR-NET, CET and CUET w.e.f. Academic Session 2025-26.**

The Academic Council ratified the agenda item, as reported.

Agenda Item No. AC 60.24: **To consider and approve discontinuation of M.Tech. (Nano-Technology) programme offered by USBAS w.e.f. Academic Session 2025-26.**

The Academic Council considered and approved the agenda item, as proposed.

Agenda Item No. AC 60.25: **To consider and approve minor typographical corrections in the scheme for V, VI and VIII semester of B.Tech. (Biotechnology) Programme, for the batches admitted in the Academic Session 2022-23, 2023-24 & 2024-25.**

The Academic Council considered and approved the agenda item, as proposed.

Agenda Item No. AC 60.26: **To consider and approve the Scheme (1st – 8th Semester) and Syllabus (1st & 2nd Semester) of B.Tech. (Biotechnology) Programme as per NEP Guidelines, to be implemented from the Academic Session 2025-26.**

The Academic Council considered and approved the agenda item, as proposed.

Agenda Item No. AC 60.27: **To consider and approve the scheme and syllabus of M.Tech (Biotechnology) Programme, as per NEP, w.e.f. Academic Session 2025-26.**

The Academic Council considered and approved the agenda item, as proposed.

Agenda Item No. AC 60.28: **To ratify the scheme and syllabus for M.Tech. (Food Processing Technology) w.e.f. Academic Session 2024-25.**

SCHEME OF EXAMINATION

As per NEP

for

Bachelor of Technology (Biotechnology)

2025 onwards

UNIVERSITY SCHOOL OF BIOTECHNOLOGY
GGS INDRAPRASTHA UNIVERSITY
Sector 16C, Dwarka, New Delhi - 110 078

SCHEME OF EXAMINATION

Bachelor of Technology (Biotechnology)

COURSE STRUCTURE:

First Semester (20)

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 101 (Major Course)	Introduction to Biotechnology	4			4
BT – 103 (Minor Course)	Techniques in Biotechnology	3			3
(Multi-Disciplinary Course) MDC	One From Bunch **(To be offered from other departments)**	3			3
AEC-	Choose one from Appendix -I	2			2
SEC	Choose one from Appendix -II	3			3
VAC	Choose one from Appendix -III	2			2
Practicals/Labs					
BT-151	Introduction to Biotechnology-Lab			3	1.5
BT-153	Techniques in Biotechnology-Lab			3	1.5
	Total				**20**

- As per norms of NCC/NSS, credits will be earned by the student after completion of 6th semester. Students need to obtain the minimum no of credits required for each category as mentioned above. Courses mentioned under the categories of MDC, VAC, SEC and AEC in the scheme cannot be dropped.

- For optional/elective courses to be offered, at least a minimum of five students must opt for them.

Second Semester (24)

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 102 (Major Course)	Biochemistry	4			4
BT – 104 (Major Course)	Cell Biology	4			4
BT – 106 (Minor Course)	Introduction to Biostatistics	3			3
MDC	One from the bunch **(To be offered from other departments)**	3			3
AEC	Choose one from Appendix -I	2			2
SEC	Choose one from Appendix -II	3			3
VAC	Choose one from Appendix -III	2			2
Practicals/Labs					
BT – 252	Biochemistry-Lab			3	1.5
BT – 254	Cell Biology-Lab			3	1.5
	Total				**24**

- As per norms of NCC/NSS, credits will be earned by the student after completion of 6th semester.
- Students who wish to exit after the first two semesters shall undergo a four credits vocational course work based on learning/internship during the summer term in order to get a UG certificate in Biotechnology.
- After two semesters or one year and earning the minimum 44 credits, those who wish to exit the programme, will be awarded a Certificate in the concerned discipline provided they undertake a summer internship of 4 credits.
- For optional/elective courses to be offered, at least a minimum of five students must opt for them.

Third Semester (21)

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 201 (Major Course)	Microbiology	4			4
BT-203 (Minor Course)	Food and Nutrition	3			3
BT – 205 (Minor Course)	Heat and Mass Transfer	3			3
MDC	One FROM BUNCH **To be offered from other departments**	3			3
AEC	Choose one from Appendix -I	2			2
SEC	Choose one from Appendix -II	3			3
Practicals/Labs					
BT – 251	Microbiology-Lab			3	1.5
BT-253	Food and Nutrition-Lab			3	1.5
	Total				**21**

As per norms of NCC/NSS, credits will be earned by the student after completion of 6th semester

For optional/elective courses to be offered, at least a minimum of five students must opt for them.

Fourth Semester (23)

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 202 (Major Course)	Immunology	4			4
BT – 204 (Major Course)	Molecular Biology	4			4
BT – 206 (Major Course)	Enzyme Technology	4			4
BT – 208 (Minor Course)	Genetics	3			3
AEC	Choose one from Appendix -I	2			2
Practicals/Labs					
BT – 252	Immunology-Lab			3	1.5
BT – 254	Molecular Biology-Lab			3	1.5
BT – 256	Enzyme Technology-Lab			3	1.5
BT – 258	Genetics-Lab			3	1.5
	Total				**23**

- As per norms of NCC/NSS, credits will be earned by the student after completion of 6th semester In addition, students who wish to exit after the first four semesters will undergo a four credits vocational course work-based learning/internship during the summer term in order to get a UG Diploma certificate in Biotechnology.
- After four semesters or two years and earning the minimum 84 credits, those who wish to exit the programme will be awarded a Diploma in the concerned discipline provided they undertake a summer internship of 4 credits.
- For optional/elective courses to be offered, at least a minimum of five students must opt for them.

Fifth Semester (25)

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 301 (Major Course)	Bioinformatics and Computational Biology	4			4
BT – 303 (Major Course)	Animal Biotechnology	4			4
BT – 305 (Major Course)	Plant Biotechnology	4			4
BT-307 (Minor Course)	Unit Operation & Plant Design	3			3
Practicals/Labs					
BT-351	Bioinformatics and Computational Biology- Lab			3	1.5
BT-353	Animal Tissue Culture-Lab			3	1.5
BT-355	Plant Biotechnology-Lab			3	1.5
BT-357	Unit Operation & Plant Design Lab			3	1.5
SEC	*Summer Internship-60 days				4
	Total				**25**

*Summer internships can be completed either outside or within the department.

For optional/elective courses to be offered, at least a minimum of five students must opt for them.

Sixth Semester (20)

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 302 (Major Course)	Bioprocess Engineering	4			4
BT – 304 (Major Course)	Recombinant DNA Technology	4			4
BT-306 (Major Course)	IPR, Biosafety and Bioethics	4			4
BT – 308 (Minor Course)	Downstream Processing	3			3
Practicals/Labs					
BT – 352	Bioprocess Engineering/Down Stream processing-Lab			3	1.5
BT - 354	Recombinant DNA Technology-Lab			3	1.5
BT-292	NCC/NSS credits				2
	Total				**20**

Note:

- Students who wish to exit after the first six semesters must earn atleast 120 credits to get a Bachelor of Science in Biotechnology.

- After completing 6 semesters or 3 years and earning 126 credits, students will be awarded a UG degree with a major and minor. To earn a major in a discipline, a student is required to earn 60 credits from DSCs, MSCs and/or Workshop/Seminar/Internship and to earn a minor in a discipline a student is required to earn 20 credits from the concerned discipline from MSCs.

- For optional/elective courses to be offered, at least a minimum of five students must opt for them.

Seventh Semester (22.5)

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 401 (Major Course)	Genome Engineering and Editing	4			4
BT – 403 (Major Course)	Environment Biotechnology	4			4
BT – 405 (Major Course)	Protein Biotechnology	4			4
BT-407 (Minor Course)	Nanobiotechnology	3			3
BT-409 (Minor Course)	Precision Medicine and Wellness	3			3
Practicals/Labs					
BT – 451	Genome Engineering and Editing-Lab			3	1.5
BT – 453	Environment Biotechnology-Lab			3	1.5
BT – 455	Protein Biotechnology-Lab			3	1.5
	Total				**22.5**

For optional/elective courses to be offered, at least a minimum of five students must opt for them.

Eighth Semester (20)

#For students who wish to obtain U.G. degree in Biotechnology (Honors) with research project

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 402	Seminar *(NUES)	4			4
BT-452	#Project	16			16
	Total				20

*NUES-Non-University Examination System

Or

****For students who wish to obtain U.G. degree in Biotechnology (Honors) without research project**

Paper Code	Paper Title	L	T	P	Credits
Theory Papers					
BT – 402	Seminar *(NUES)	4			4
****BT-406 (minor)**	Recent Advances in Biotechnology	4			4
BT-454	Review Writing and Submission	12			12
	Total				20

All papers in Eighth semester are mandatory.

For optional/elective courses to be offered, at least a minimum of five students must opt for them.

Summary of credits

Semesters	Credits	Majors	Minors
I	20	5.5	4.5
II	24	11	3
III	21	5.5	7.5
IV	23	16.5	4.5
V	25	16.5	4.5
VI	20	15	3
VII	22.5	16.5	6
VIII	20	-	(3)
Total	175.5	86.5	33 (+3)

(+3) is an extra minor course for non-dissertation / project students.

Note: It is mandatory for the Undergraduate Students to appear in all subjects/papers (Theory and Labs), however student has to obtain minimum credits required for each category as mentioned below.

Students pursuing a four year UG degree at GGSIP University are expected to earn credits through IKS (online)/NCC/NSS/Clubs by the end of 6 semesters or 3 years by participating in any of these bodies/clubs for one year.

However, those who will take lateral admission directly in the 4th year of the UG programme, under the multiple entry-exit policy, will enrol themselves in any of these bodies/clubs/IKS (online) in the fourth year of the UG programme to earn these 2 credits.

Categories

Minimum Credit required to earn four-year U.G. degree: Bachelor of Technology (Honors) in Biotechnology =160
Minimum Credit required to earn four-year U.G. degree: Bachelor of Technology (Honors) with Research in Biotechnology =160
Minimum credit required to earn three-year U.G. Degree: Bachelor of Science in Biotechnology=120
Minimum credit required to earn "Diploma in Biotechnology" = 80
Minimum credit required to earn "Certificate in Biotechnology" = 40

Syllabus for

Bachelor of Technology (Biotechnology)

(Ist and IInd Semester)

[As per NEP]

AUGUST 2025 ONWARDS

UNIVERSITY SCHOOL OF BIOTECHNOLOGY
GGS INDRAPRASTHA UNIVERSITY
Sector 16C, Dwarka, New Delhi - 110 078

PaperCode: BT101	Paper: Introduction to Biotechnology	L	T/P	C
PaperID: 013101	(1st semester, Major Course)	3	1	4

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instruction for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 20 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 10.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives:

1:	To introduce different areas in Biotechnology to students, laying a foundation for future courses within our biotechnology programme.
2:	To provide a historical perspective of the growth and development of biotechnology, as well as its scope and importance.
3:	To help students understand the interdisciplinary nature of biotechnology, involving integration of several disciplines to generate knowledge and technology impacting society and environment.
4:	To sensitize students towards IPR, safety and ethical concerns in biotechnology research and applications.

Course Outcomes (CO):

CO1:	Understand the history, scope, interdisciplinary nature and significance of biotechnology.
CO2:	Understand the basics of recombinant DNA technology, protein structure and engineering, bioinformatics and principle(s) underlying basic biotechnological techniques.
CO3:	Describe the basics of culturing microbes, animal cells and plant cells in laboratory, and their respective applications in Biotechnology.
CO4:	Have an awareness about the IPR, safety and ethical issues involved in use of biotechnology.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping (scale 1: low, 2: Medium, 3: High)

CO/PO	*PO01*	*PO02*	*PO03*	*PO04*	*PO05*	*PO06*	*PO07*	*PO08*	*PO09*	*PO10*	*PO11*	*PO12*
CO1	3	2	3	3	1	1	1	-	-	-	-	1
CO2	3	2	3	3	1	1	2	-	-	-	-	1
CO3	3	2	3	3	1	-	-	-	-	-	-	1
CO4	3	2	3	3	1	-	-	-	-	-	-	1

Units

Unit I

Introduction: Historical perspective, Definition of Biotechnology; Areas of biotechnology; Scope; Importance and Commercial potential; Interdisciplinary nature;

Solutions and Buffers: Introduction to Solutions and Buffers; Modes of expressing concentration of a solution, Making solutions, Concept of pH and buffers, Henderson-Hasselbach equation, Criteria for selection of buffers (8)

Unit II

Recombinant DNA Technology: Tools of rDNA Technology; Making recombinant DNA; Introduction of recombinant DNA into host cells; Introduction to selection and screening techniques for identification of recombinants; Agarose Gel Electrophoresis; Principle, Steps and Applications of Polymerase Chain Reaction;

Protein Structure and Engineering: Introduction to the world of Proteins, Amino acids as building blocks, Non-covalent interactions, Structure of proteins, Structure Function relationship in Proteins, Recombinant proteins of high value, Introduction to Protein Engineering and Design, Introduction to Proteomics.

Introduction to basic techniques in Biotechnology: Beer-Lambert's Law, Spectrophotometer, Agarose Gel Electrophoresis, SDS- PAGE, Gel-Filtration Chromatography, Ion Exchange Chromatography, Affinity chromatography.

Introduction to Bioinformatics: Concept of Primary and Secondary databases, Nucleic acid and Protein databases, Introduction to sequence alignment, Applications of bioinformatics. (12)

Unit III

Microbial Biotechnology: Microbial Culture Techniques; Measurement and Kinetics of Microbial Growth; Scale up of microbial process; Isolation of microbial products; Strain Isolation; Improvement and Preservation;

Plant Biotechnology: History of plant tissue culture; Plant cell and tissue culture techniques; Transgenic plants with beneficial traits;

Animal Biotechnology: History of animal tissue culture; Animal Cell culture techniques; Finite and Continuous cell lines; Characterization of cell lines; Scale-up of animal cell culture; Applications of microbial, plant and animal biotechnology. (12)

[12Hrs]

Unit IV

Biotechnology and Society: Introduction to Patenting; Criterion for patents; Reading a patent; National and International Patent Laws; Safety and Ethical issues in Biotechnology; Biotechnology in India and global trends; Product safety and marketing. (8)

Text / Reference Books:

1. *Introduction to Biotechnology*, W.J. Thieman and M.A. Palladino, Pearson, 2019.
2. *Biotechnology Foundations*, J.O. Grady, 2019.
3. *Gene cloning and DNA Analysis. An introduction*. T. A Brown, Wiley-Blackwell Science, 2016.
4. *Concepts in Biotechnology: History, Science and Business*, K.Buchholz and J. Collins, Wiley-VCH, 2011.
5. *Biotechnology*, H.K. Das, 2010, Wiley Publishers.
6. *Biotechnology*, Smith, 2009, Cambridge Press.
7. *Principles and Techniques of Biochemistry and Molecular Biology* by Wilson & Walker, Cambridge Press, 2008.

Paper Code: BT-103	Paper name: Techniques in Biotechnology	L	T	P	C
Paper Id:	(I[st] Semester; Minor Course)	2	1		3

Course Objectives:

1. To understand the basic techniques employed in biotechnology research and analysis as well as data handling which are the prerequisites for a variety of courses defined in this syllabus in later semesters.
2. To study the principles and application of the modern techniques popularly employed in biotechnology.
3. To develop the understanding of various tools and techniques and where they may be employed in biotechnology analysis.

Course Outcomes:

After successful completion of this course, the students should be able to understand:

1. The theory behind various techniques used in biotechnology.
2. The utility of various biotechnology tools in biological research.
3. The basic concepts of analytical techniques and integrate its relevance to study biological processes at cellular and whole genome level.

Units

1. pH: Concept of pH, Henderson Hasselbach equation, composition and preparation of some commonly used buffers, pH meters.(2)

2. **Colorimetry and Spectroscopy:** Basic principles, nature of electromagnetic radiation, Beer-Lambert laws, colorimetric methods & instruments, principles of spectroscopy, types of spectra-absorbance, emission, fluorescence and action spectra, single and double beam spectrophotometers, densitometers, flame photometer, fluorimeters. (4)

3. **Cell separation:** Flow cytometry, magnetic beads, elutriator. (2)

4. **Microscopy:** Basic principles, instrumentation, light and phase contrast, interference, polarization, inverted fluorescence, confocal & electron microscopes & their applications, Introduction to microtome. (4)

5. **Centrifugation:** Principle, types of centrifuges, rotors, differential and gradient ultracentrifugation-preparative & analytical. (2)

6. **Chromatography:** Principles, methodology and applications of chromatography using paper, thin layer, column (gel filtration, ion exchange, affinity), GC, HPCL, FPCL. (3)

7. **Electrophoresis:** Principles and types of electrophoresis and their applications for proteins, nucleic acids, including gradient get and pulse-filed gel electrophoresis; gel matrices. polyacrylamide, agarose, etc. critical parameters for optimum separation and resolution, two dimensional electrophoresis (IEF). (3)

8. **Radioisotope Methods and Tracer Techniques in Biology:** Basic principles of radioactivity, properties & handling of radioisotopes in biology & medicine, radiation units, Geiger Muller & scintillation counters, autoradiography, radionuclide imaging, CTscan. (4)

9. **Immunochemical Techniques:** Production of antibodies, Immunoprecipitation, Immunoassays, Immunohistory and Immunocytochemistry (2)
10. **Biophysical Techniques:** X-ray crystallography, Nuclear Magnetic Resonance (NMR) spectra, Magnetic Resonance Imaging (MRI), lasers in biology and medicine, Mass spectrometry. (4)

Text / Reference Books:

1. Introductory Practical Biochemistry by Sawhney SK & Singh R; *Narosa Publishing House*, 2000.
2. Principles and Techniques of Biochemistry and Molecular Biology by Wilson K & Walker J, 6" Edition, Cambridge Press, 2008.
3. Practical Techniques in Molecular Biotechnology by Bal Ram Singh, Raj Kumar: Cambridge University Press, 2021
4. Advanced Methods in Molecular Biology and Biotechnology by Khalid Z. Masoodi, Saineena Maqbool Lone, Rovidha Saba Rasool; Elsevier Science, 2020.
5. Quantitative Bioimaging: An Introduction to Biology, Instrumentation, Experiments, and Data Analysis for Scientists and Engineers by Raimund J. Ober, E. Sally Ward, Jerry Chao; CRC Press, 2020

Course Outcome (CO) to Programme outcomes (PO) Mapping (Scale 1: Low; 2: Medium; 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	3	2	2	2	1	1	2	3
CO2	2	3	3	3	3	3	2	3	1	1	2	3
CO3	3	3	2	3	3	3	2	3	1	1	2	3
CO4	3	3	3	3	3	3	2	3	1	1	2	3

Paper Code: BT-102	Paper name: Biochemistry	L	T	P	C
Paper Id:	(2nd Semester; Major Course)	3	1		4

Course Objectives:

1. To provide an advanced understanding of the core principles and topics of biochemistry, their experimental basis and enable students to acquire a specialized knowledge & understanding of structure and functions of biomolecules like; Proteins, Carbohydrates and Lipids.
2. To provide understanding of characterization, separation and clinical significance of biomolecules like: Proteins, Carbohydrates and Lipids.
3. To provide understanding of metabolic pathways and their regulation with respect to biomolecules like: Proteins, Carbohydrates and Lipids.
4. To provide hands on approach and learnings of different laboratory techniques in the biochemical laboratory.

Course Outcomes: At the end of the course students will be able to:

1. Understand the structural and functional relationships of biological molecules that form the basis of living organisms.
2. Understand how biomolecules are isolated and characterized through various analytical techniques that are used in contemporary biochemistry laboratories.
3. Gain understanding on fundamental biochemical principles of metabolism of biomolecules (Proteins, Carbohydrates, Lipids). They will learn the biochemical reactions in metabolic pathways and understand their interrelations. Students would also gather a firm understanding and relevance of stringent regulations of metabolic pathways.
4. Have better practical understanding of methods/techniques covered in theory course.

Units

1. **Amino acids:** Classification, Structure, Function, Methods of Characterization, Separation Techniques based on their structure and properties, Clinical Significance. (3)
2. **Proteins:** Classification, Primary, Secondary, Tertiary and Quaternary structure, Function, Methods of separation & characterization and Modification of proteins. (3)
3. **Carbohydrates:** Mono, oligo and Polysaccharide, Classification, Structure, Function, Separation and Characterization Techniques, Clinical significance. (6)
4. **Lipids:** Classification, Structure, Function, Separation and Characterization Techniques, Clinical Significance. (6)
5. **Catabolic pathways and their Regulations:** Carbohydrates, Proteins and Lipids; Glycolysis, Protein catabolism, Fatty acid degradation and their regulations. (5)
6. **Anabolic pathways and their regulations:** Carbohydrates, Proteins and Lipids; Gluconeogenesis, Translation, Biosynthesis of saturated fatty acids and their regulations. (5)
7. **The Tricarboxylic Acid Cycle:** Discovery of the TCA Cycle, Steps in the TCA Cycle, Stereochemical Aspects of TCA Cycle Reactions, ATP Stoichiometry of the TCA Cycle, Thermodynamics of the TCA Cycle, The Amphibolic Nature of

the TCA Cycle, The Glyoxylate Cycle, Regulation of TCA Cycle Activity, Anaplerotic Reactions. (6)

8. **Electron Transport** and Oxidative Phosphorylation: The Mitochondria Electron Transport Chain, Oxidative Phosphorylation, Transport of Substrates, Pi, ADP and ATP into and out ot Mitochondria, Electron Transport and ATP Synthesis in Bacteria.(6).

Text/ Reference Books.'

1. Lehninger Principles ot Biochemistry by Nelson DL and Cox MM. W H Freeman & Co. 2017.
2. Biochemistry by Lubert Stryer. 4th Edition W H Freeman & Co. 1995.
3. An introduction to practical biochemistry by Plummer D. T. 2012.

Course Outcome(CO) to Programme outcomes(PO) Mapping (Scale 1: Low; 2: Medium; 3: High)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	1	1	3	3	3	3	3
CO2	3	2	3	3	3	2	1	3	3	3	3	3
CO3	3	2	3	3	3	1	1	3	3	3	3	3
CO4	3	2	3	3	3	2	2	3	3	3	3	3

Paper Code: BT-104	Paper name: Cell Biology	L	T	P	C
Paper Id:	(2nd Semester; Major Course)	3	1	0	4

Course Objectives:

1. To understand the structure and purpose of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles and the cytoskeleton.
2. To understand the process of cellular signaling, transport and trafficking with emphasis on the sub-cellular bio-molecules participating in these processes.
3. To know in detail the cell cycle, cellular replication process and cellular aberrations during oncogenic conditions.

Course Outcomes:

After successful completion of this course, the students should be able to understand:

1. The basic components of prokaryotic and eukaryotic cells
2. How molecules are transported across cell.
3. How cells perceive and transmit signal.
4. How cells undergo division and its regulation.

1. **The Cell:** Discovery of Cells and the Development of Cell Biology, Prokaryotic cell, Eukaryotic cells, Cellular compartmentalization, Organellar architecture. (3)

2. **The Nucleus:** Chromosomal DNA and its Packaging, The Global Structure of Chromosome. (4)

3. **Cytoskeleton:** The Nature of the Cytoskeleton, Intermediate Filaments, Microtubules, Cilia and Centrioles, Actin Filaments, Actin-binding Proteins, Muscle. (4)
4. Cell **Junctions, Ceh Adhesion, and** the Extracellular Matrix : Cell Junctions, Cell-Cell Adhesion, The Extracellular Matrix of Animals, Extracellular Matrix Receptors on Animal Cells- the Integrins, The Plant Cell Wall. (4)

5. **Membrane Structure, Transport of Molecules and Membrane Excitability:** The Lipid Bilayer, Membrane Proteins, Principles of Membrane Transport, Carrier Proteins and Active Membrane Transport, Ion channels and Electrical Properties of Membrane(s). (5)

6. **Protein Sorting and Vesicular Trafficking in the** Cell: The Compartmentalization of Higher Cells, The Transport of Molecules into and out of the Nucleus, The Transport of Proteins into Mitochondria and Chloroplasts, Peroxisomes, The endoplasmic reticulum., Transport from the ER through the Golgi Apparatus, Transport from the Trans Golgi Network to Lysosomes, Transport from the Plasma Membrane via Endosome: Endocytosis, The Molecular Mechanisms of Vesicular Transport and the Maintenance of Compartmental Diversity. (6)

7. **Cell Signaling:** General Principles of Cell Signaling, Signaling via G-Protein-linked Cell-Surface Receptors, Signaling via Enzyme linked Cell-Surface

Receptors, Kinase Receptors, Structural Features of Trans-membrane Receptors, Hormone Receptor Intemction, Two-component signaling, Second messengers. (6)

8. **Cell Cycle and Division:** The General Strategy of the cell Cycle, The Mechanics of Cell Division, The Early Embryonic Cell Cycle, Cell- Cycle control in Yeasts and Multicellular Animal. (4)
9. **Cancer:** Cancer as a Microevolutionary Process, Tumor cells, Proto-oncogenes and viral-oncogenes, Tumor suppressor genes. (4)

Text/ Reference books.

1. Molecular Biology of Cell by Bruce Alberts, et al., Garland Science. 20 17.
2. The World of the Cell, by Becker, Kleinsmith, and Hardin, 6th edition, Pearson Education. 2006.
3. The Cell: A Molecular Approach. Fourth Edition. By Cooper GM and Hausman RE. ASM Press and Sunderland (Massachusetts): Sinauer Associates. 2007
4. Molecular Cell Biology by Lodish H et at., Ninth Edition, Macmillan Learning. 2021
5. Cell and Molecular Biology by Karp. 9th Edition, John Wiley & Sons. 2019.

Course Outcome(CO) to Programme outcomes(PO) Mapping (Scale 1: Low; 2: Medium; 3: High)												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	3	1	3	2	1	1	2	2
CO2	2	3	2	2	3	1	3	2	1	1	2	2
CO3	2	3	2	2	3	1	3	2	1	1	2	3
CO4	3	3	3	3	3	1	3	2	1	1	2	2

Paper Code: BT-106	Paper name: Introduction to Biostatistics	L	T	P	C
Paper id:	(2nd Semester; Minor Course)	2	1	0	3

Course Objectives:

1. Understand and apply fundamental biostatistical concepts and methods.
2. Gain proficiency in the collection, organization, and analysis of data.
3. Develop skills to apply statistical methods to real-world biological and health science data.
4. Learn to use statistical software for effective data analysis and interpretation.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Describe and implement basic biostatistical concepts in biological and health sciences.
2. Collect, organize, and analyze data using appropriate statistical methods.
3. Conduct hypothesis tests, construct confidence intervals, and interpret the results.
4. Use statistical software tools to perform basic data analysis and generate reports.

Units:

1. **Introduction to Biostatistics and Data Types:** Overview of Biostatistics, Types of data: Qualitative vs. Quantitative, Levels of measurement: Nominal, Ordinal, Interval, and Ratio, Data collection methods, Sampling techniques. (4)

2. **Descriptive Statistics:** Measures of central tendency: Mean, Median, Mode, Measures of dispersion: Range, Variance, Standard Deviation, Interquartile Range, Data visualization: Histograms, Boxplots, Bar Charts, Pie Charts. (3)

3. **Probability and Distributions**: Basic probability concepts: Events, Sample Space, Probability Rules, Probability distributions: Binomial, Poisson, Normal distribution, The Central Limit Theorem, Significance of the Central Limit Theorem. (4)

4. **Confidence Intervals:** Concept of estimation, Confidence intervals for means, Confidence intervals for proportions, Interpretation of confidence intervals, Practical applications of confidence intervals. (4)

5. **Hypothesis Testing:** Concepts of null and alternative hypotheses, Type I and Type II errors, p-values, Statistical significance, t-tests: One-sample, Two-sample, Paired t-tests. (4)

6. **Analysis of Variance (ANOVA):** One-way ANOVA: Understanding and application, Assumptions of ANOVA, Post-hoc tests: Determining group differences. (3)

7. **Correlation and Regression Analysis**: Pearson correlation coefficient, Spearman correlation coefficient, Simple linear regression: Model building, Assumptions of linear regression, Interpretation of regression results, Multiple regression analysis: Concepts and applications. (4)

8. **Categorical Data Analysis:** Chi-square tests: Goodness-of-fit, Chi-square tests: Independence, Relative risk, Odds ratios, Introduction to logistic regression. (4)

Text/ Reference Books.

1. Biostatistics: A Foundation for Analysis in the Health Sciences by Wayne W. Daniel (Wiley).
2. Fundamentals of Biostatistics by Bernard Rosner (Cengage Learning).
3. Introductory Biostatistics by CHAP T. LE.
4. Mahajan's Methods in Biostatistics for Medical Students and Research. (2018). JAYPEE Brothers MEDICAL P.
5. Bland, M. (2015). An Introduction to Medical Statistics. Oxford University Press.

Course Outcome(CO) to Programme outcomes(PO) Mapping (Scale 1: Low; 2: Medium; 3: High)												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1	3	2	1	1	2	2
CO2	2	3	3	2	3	1	3	2	1	1	2	2
CO3	2	2	3	2	3	1	3	2	1	1	2	3
CO4	3	3	3	3	3	1	3	2	1	1	2	3

MDC-Multi-Disciplinary Courses

These courses will be offered to Bachelor students outside of the Biotechnology Department.

Paper code:	Paper Title	L	T	P	C	Hrs
BT-161 (MDC)	**Design Thinking and Innovation**	**2**	**1**	**0**	**3**	**30**

Course Objectives:

1. Explain the concept and process of design thinking for product and service development.
2. Develop the ability to identify innovation opportunities and apply human-centered design.
3. Equip students with tools for ideation, prototyping, testing, and implementation.
4. Foster skills to convert innovative ideas into viable products or solutions.
5. Encourage collaborative and empathetic problem-solving in real-world contexts.

Course Outcomes:

Upon completion, students will be able to:

1. Apply design thinking to solve complex problems.
2. Conduct empathy research and define user needs.
3. Generate, prototype, and test innovative ideas.
4. Communicate and implement solutions effectively.
5. Analyze and learn from real-world innovation case studies.

Course Content:

Unit 1: Introduction to Design Thinking & Innovation, Definition, history, and importance of design thinking, Design thinking vs. traditional design, Types of thinking processes, Problem-solving and need. (5)

Unit 2: Human-Centered Design & Empathy, Identifying user needs, Empathy research methods, Human-centered design principles, Reframing problems. (5)

Unit 3: Opportunity Identification & Ideation, Problem space exploration, Ideation techniques: brainstorming, mind mapping, "How Might We?", Lateral thinking, analogies, synectics, Generating and evaluating ideas. (5)

Unit 4: Prototyping and Testing, Prototyping mindset and methods, Types and fidelity of prototypes, Iterative improvement, Product testing and validation, User feedback integration. (5)

Unit 5: Implementation & Strategic Innovation, Converting ideas to products/services, Business model design, Value redefinition and experience design, Storytelling and communication, Managing change and fostering creative culture. (5)

Unit 6: Case Studies & Real-World Applications, Disruptive design innovations, Success and failure stories, Industry-specific applications (IT, healthcare, etc.), End-to-end application of design thinking, Empathize, define, ideate, prototype, test, implement. (5)

Recommended Readings

[1]. Creative Confidence by Tom Kelley & David Kelley
[2]. The Design of Everyday Things by Don Norman
[3]. Design Thinking: Understanding How Designers Think and Work by Nigel Cross
[4]. Basics Design - 8: Design Thinking by Gavin Ambrose & Paul Harris
[5]. Handbook of Design Thinking by Christian Müller-Roterberg
[6]. Relevant articles, reviews, research papers and patents

Paper code:	Paper Title	L	T	P	C	Hrs
BT-162 (MDC)	**Project Management in Biotechnology**	**2**	**1**	**0**	**3**	**30**

Course Objectives:

1. To understand project management principles and methodologies in biotechnology.
2. To develop skills for creating detailed project plans and managing resources.
3. To learn effective implementation and monitoring of biotechnology projects.
4. To understand regulatory, ethical, and compliance requirements in biotechnology.
5. To enhance teamwork and communication skills within project teams.

Course Outcomes:

1. Students will describe core principles of project management in biotechnology.
2. Students will create detailed project plans with scope, schedule, resources, and risk management.
3. Students will execute and monitor project activities, ensuring timelines and quality standards.
4. Students will apply regulatory, ethical, and compliance knowledge in biotechnology projects.
5. Students will lead and collaborate effectively within project teams and communicate project information clearly.

Course Content:

Unit 1: Introduction to Project Management in Biotechnology

- Overview of Project Management, Importance of Project Management in Biotechnology, Project Life Cycle Phases, Roles and Responsibilities of a Project Manager, Key Competencies for Biotechnology Project Managers, Case Studies in Biotechnology Project Management (5)

Unit 2: Project Planning

- Defining Project Goals and Objectives, Stakeholder Analysis and Management, Project Feasibility Studies, Developing a Project Charter, Project Scope Management, Work Breakdown Structure (WBS) (5)

Unit 3: Project Scheduling and Resource Management

- Project Scheduling (Gantt Charts, Critical Path Method), Resource Planning and Budgeting, Team Building and Leadership in Project Management, Communication Planning and Management (5)

Unit 4: Project Execution

- Risk Management in Biotech Projects, Quality Management Systems (QMS) in Biotechnology, Regulatory Compliance and Ethical Considerations, Procurement and Supply Chain Management, Data Management and Documentation (5)

Unit 5: Project Monitoring and Controlling

- Key Performance Indicators (KPIs) and Metrics, Project Tracking Tools and Techniques (Kanban, Earned Value Management), Time Management and Schedule Control, Cost Control and Financial Management, Quality Control and Assurance in Biotech Projects, Managing Changes and Scope Creep, Issue and Conflict Resolution (5)

Unit 6: Project Closure and Evaluation

- Project Closure Processes, Lessons Learned and Knowledge Transfer, Final Project Reports and Presentations, Post-Project Review and Evaluation, Celebrating Successes and Recognizing Contributions, Continuous Improvement and Future Planning (5)

Recommended Readings

- "Project Management: A Systems Approach to Planning, Scheduling, and Controlling" by Harold R. Kerzner
- "Biotechnology Operations: Principles and Practices" by John M. Centanni and Michael J. Roy
- "Project Management for the Pharmaceutical Industry" by Laura Brown and Tony Grundy
- Research articles and case studies will be provided during the course

Paper code:	Paper Title	L	T	P	C	Hrs
BT-163 (MDC)	**Mass Spectrometry in Action: from theory to practice**	**2**	**1**	**0**	**3**	**30**

Course Objectives:

1. To understand basic principles and techniques of mass spectrometry through theoretical lectures.
2. To learn how mass spectrometry data is generated and interpreted.
3. To explore the applications of mass spectrometry across various scientific fields.
4. To understand how MS techniques solve basic problems in different disciplines.
5. To develop critical thinking and communication skills by discussing MS data.

Course Outcomes:

1. Students will explain fundamental concepts and techniques of mass spectrometry.
2. Students will describe how mass spectrometry data is generated and interpreted.
3. Students will identify applications of mass spectrometry in various fields.
4. Students will understand how MS techniques are used to solve basic problems.
5. Students will effectively discuss and communicate findings using mass spectrometry data.

Course Content:

Unit 1: Introduction to Mass Spectrometry

- Overview of Mass Spectrometry (MS), Basic Components of MS Instruments, Ionization Techniques (Electron Ionization, Chemical Ionization, ESI, MALDI), Fundamentals of Mass Analyzers (Quadrupole, Time-of-Flight, Ion Trap), Data Acquisition and Interpretation (5)

Unit 2: Environmental Science Applications

- Role of MS in Environmental Monitoring, Detection of Pollutants and Contaminants, Analysis of Organic and Inorganic Compounds, Case Studies: Water Quality and Air Pollution Analysis, Hands-On: Sample Preparation and Analysis Using GC-MS and ICP-MS (5)

Unit 3: Forensic Science Applications

- Use of MS in Forensic Investigations, Detection of Drugs and Toxic Substances, Analysis of Trace Evidence (Explosives, Fire Accelerants), Case Studies: Drug Analysis and Crime Scene Investigations, Hands-On: Forensic Sample Analysis Using LC-MS and GC-MS (5)

Unit 4: Materials Science Applications

- Application of MS in Materials Characterization, Analysis of Polymers, Nanomaterials, and Advanced Materials, Surface Analysis Techniques (SIMS), Case Studies: Materials Defect Analysis and Polymer Characterization, Hands-On: Materials Analysis Using MALDI-TOF and SIMS (5)

Unit 5: Chemical Analysis Applications

- MS Techniques in Organic and Inorganic Chemistry, Identification and Quantification of Organic Compounds, Analysis of Metal Ions and Complexes, Case Studies: Reaction Monitoring and Purity Assessment, Hands-On: Chemical Analysis Using LC-MS and ICP-MS (5)

Unit 6: Emerging Technologies and Advanced Applications

- Imaging Mass Spectrometry (IMS) and Its Applications, Ambient Mass Spectrometry Techniques (DESI, DART), Hybrid Technologies and Future Trends in MS, Case Studies: Real-World Applications in Various Industries, Hands-On: Advanced MS Techniques and Data Analysis (5)

Recommended Readings

- "Mass Spectrometry: Principles and Applications" by Edmond de Hoffmann and Vincent Stroobant
- "Introduction to Mass Spectrometry: Instrumentation, Applications, and Strategies for Data Interpretation" by Stephen Watts
- "Protein and Peptide Mass Spectrometry in Drug Discovery" by Michael L. Gross and Guodong Chen
- "The Encyclopedia of Mass Spectrometry, Volume 1: Theory and Ion Chemistry" edited by Michael L. Gross and Richard Caprioli
- "The Encyclopedia of Mass Spectrometry, Volume 6: Ionization Methods" edited by Michael L. Gross and Richard Caprioli
- Research articles by Ravi Kant, Michael L. Gross, and others from the field will be, provided during the course.

Paper code:	Paper Title	L	T	P	C	Hrs
BT-164 (MDC)	FOOD AND NUTRITION	2	1	0	3	30

Course Objectives:

1. To understand how importance of nutrition.
2. To appreciate the role of nutrition in cellular and physical growth and assess nutritional status.
3. To understand the basis of derivation of Dietary Reference Intakes for micronutrients and how requirements change under special conditions.

Course Outcomes:

Students will be able to understand:

1. Critically evaluate and derive requirements for specific macronutrients
2. Assess the nutritional status, Appreciate implications of poor dietary and lifestyle practices.
3. Critically evaluate the methodology and derivation of requirements for micronutrients.
4. Track emerging concepts in the field of nutrition. Understand nutritional management in special conditions.

UNIT I

Introduction to nutrition-importance of nutrition, role of nutrients in the body, classification and sources.

UNIT II

Nutrition bio-availability, deficiency & toxicity, food sources, functions, storage in body, Energy Expenditure measurement techniques.

UNIT III

Concept of Community Nutrition, food fortification and enrichment, Estimation of nutritional status, Nutritional intervention programmes. Nutrition Transition.

UNIT IV

Nutrition in Special Conditions; Extreme temperatures- low and high, High altitude, Space nutrition, , Nutrigenomics, Functional foods and Nutraceuticals.

UNIT V

Geriatric Food, Nutrion For Lactating And Pregnant Women, Diabetic Diet, Post And Pre Operative Diet, Food For Infants And Adolescence, Sports Nutrition.

Recommended Readings:

Mudambi S.R, M.V Rajgopal Fundamentals of Foods and Nutrition(2nded)Wiley Eastern Ltd,1990.

- Willson, EVAD Principles of Nutrition, 4thed. New York John Willey and Sons, 1979.
- Srilakshmi B.(2018).Nutrition Science. New Delhi: New Age International.
- Swaminathan M. (1991):Advanced Text Book on Food & Nutrition, Vol. I & 11 (2nd Edition, Revised), Bangalore printing & Publishing Ltd.
- Michael J. Gibney, Hester V Vorster and Frans J Kok (2003) Introduction to Human Nutrition. Blackwell publishing Oxford, U.K.
- Bamji, M.S., Krishnaswamy K. Brahmam G.N.V. (Eds.) (2017). Textbook of Human Nutrition. 4th Edition. New Delhi : Oxford and IBH Publishing Co. Pvt. Ltd.
- Chadha R., Mathur P. (Eds.) (2015). Nutrition: A Lifecycle Approach. New Delhi: Orient Blackswan
- Simopoulos A.P., Ordovas J.M. (Eds.) (2004). Nutrigenetics and Nutrigenomics. USA: Karger
- ILSI, NIN &SAI. (2017) Nutritional recommendations for high performance athletes2nded.
- Mahan, L. K. and Escott Stump S. (2016) Krause's Food & Nutrition Therapy. 14th ed. Saunders-Elsevier.
- Hickson JF and Wolinksky I. (1997) Nutrition for exercise and Sport. 2nd ed.CRC Press,
- Burke LM and Deakin V. (2002) Clinical Sports Nutrition, 2nd edition, Publishers McGraw Hill
- Dan Benardot. (2011) Advanced Sports Nutrition-2nd Edition.
- Fink H H and Mikesky A E. (2017) Practical Applications in Sports Nutrition 5th Edition.
- Bushman B. (2017) ACSM's Complete Guide to Fitness & Health 2nd Edition Published by ACSM.
- Vasuja, M (2017). Health Education and Sports Nutrition. New Delhi, Friend's Publication (India)
- Bamji, M.S., Krishnaswamy K. Brahmam G.N.V. (Eds). (2017). Textbook of Human Nutrition. 4th Edition. New Delhi : Oxford and IBH Publishing Co. Pvt. Ltd.

Paper code:	Paper Title	L	T	P	C	Hrs
BT-165 (MDC)	**FOOD COMMODITIES**	2	1	0	3	30

Course Objectives:

1. To understand how importance of different food commodities.
2. To understand the basis of types of food groups and their functions in human body.

Course Outcomes:

Students will be able to understand:

1. Different food groups and their roles.
2. To understand different nutrient uptakes and requirements by these food commodities.
3. To have knowledge of different functions of food with relation to human health.

UNIT I

Cereals and pulses: Selection and variety, storage, processing, nutritional aspects. Pulses and legumes, millets, breakfast cereals, cereal products Concept of bakery and bakery products.

UNIT II

Milk and milk products: Composition, classification, nutritional aspects and processing methods of milk and milk products (curds, butter milk, paneer, cheese, ice-cream)

UNIT III

Meat, poultry, Eggs and sea food: meat and meat products, Composition, grade, quality, selection, storage, spoilage, uses and nutritional aspects. Composition of and structure Egg. Fish, Poultry and meat: Selection, storage, uses and nutritional aspects, spoilage, shellfish.

UNIT IV

Vegetables and fruits: Post harvest management, processing of fruits and vegetable, Variety, selection, purchase, storage, availability, uses and nutritional aspects of raw and processed vegetables and fruits.

UNIT V

Beverages and confectionery: Carbonated alcoholic and non alcoholic beverages, non carbonated beverages, chocolate and cocoa products, tea, coffee sugar based confections.

REFERENCE BOOKS:

1. B. Srilakshmi : Food Science
2. Lavies, S (1998): Food Commodities Ltd. London.
3. Hughes, 0. and Bennion, M (1970); Introductory Foods, Macrnillan & Co., New York.
4. Pyke, M. (1974); Catering Service and Technology, John Murrey Pube,' London.
5. Foods Facts and Principles- S. Manay
6. Clinical Nutrition & Dietetics- F. P. Antia and Philip Abraham, Oxford University Press

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APPENDIX-I

Paper code:	Paper Title	L	T	P	C	Hrs
BT-181 (AEC)	**Use of Generative Artificial Intelligence**	**2**	**0**	**0**	**2**	**20**

Course Objectives:

1. Understand core principles and mechanisms of generative AI across multiple modalities.
2. Gain proficiency in using leading generative AI tools for text, image, spreadsheet (Excel), presentation, audio, and video content creation.
3. Develop prompt engineering skills to optimize outputs from generative models.
4. Critically evaluate the ethical, legal, and societal implications of generative AI.
5. Apply generative AI to real-world projects in business, education, marketing, and creative domains.

Course Outcomes:

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

1. Confidently use leading generative AI tools for text, images, spreadsheets, presentations, audio, and video.
2. Craft effective prompts and workflows for AI-driven content creation.
3. Critically assess the outputs and limitations of generative AI.
4. Navigate ethical, legal, and societal challenges of AI-generated media.
5. Deliver a portfolio of AI-generated content across multiple modalities.

Course Content:

Unit 1: Introduction to Generative AI, History and evolution of generative AI, Core concepts: LLMs, GANs, VAEs, Diffusion Models, Multimodal AI: integrating text, image, audio, video, Major platforms and tools overview (ChatGPT, Gemini, Copilot, Midjourney, DALL-E, etc.), (4)

Unit 2: Text Generation with AI, Prompt engineering for text, Content creation: articles, summaries, emails, reports, Copywriting, creative writing, and translation, Automating routine writing tasks, Legal and ethical considerations for AI-generated text. Image Generation and Editing, Text-to-image and image-to-image generation, Tools: DALL-E, Midjourney, Stable Diffusion, Style transfer, image editing, enhancement, Use cases: marketing, design, social media, Copyright and ownership issues. (4)

Unit 3: Generative AI for Excel and Data Analysis, AI-assisted formula creation and optimization, Automating data cleaning, analysis, and visualization, Generating reports and dashboards, Using AI for task automation (VBA, macros), Integrated AI tools: Copilot, Gemini, ChatGPT for Excel. AI-Driven Presentations, Generating slides and visual content from text prompts, AI tools for design, layout, and storytelling, Automating data visualization and infographics, Integrating multimedia (images, audio, video) into presentations, Best practices for effective AI-powered presentations. (4)

Unit 4: Audio Generation and Enhancement, Text-to-speech, voice cloning, and music generation, Tools: ElevenLabs, Descript, Adobe Podcast, Suno, etc., Podcasting, narration, and audio branding, Ethical issues: deepfakes, consent, and authenticity. Video Generation and Editing, Text-to-video and image-to-video tools, AI for motion graphics, animation, and video editing, Integrating AI-generated assets (audio, images, text) into video, Tools: Runway, Synthesia, Pika, Lumen5, Adobe Firefly, Copyright, licensing, and data privacy. (4)

Unit 5: Multimodal AI and Advanced Applications, Cross-modal generation: combining text, image, audio, video, Multimodal prompt engineering, Real-world applications: marketing, education, accessibility, entertainment, Limitations and future trends. Ethics, Legal, and Societal Implications, Copyright, ownership, and licensing, Bias, misinformation, and AI hallucinations, Security, privacy, and data protection, Responsible and transparent AI use. (4)

Recommended Readings

[1]. Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play by David Foster
[2]. Generative AI: The Future of Everything by Sharad Gandhi
[3]. Ripples of Generative AI: How Generative AI Impacts, Informs and Transforms Our Lives by Jacob Emerson
[4]. The Big Book of Generative AI (Databricks)
[5]. AI Made Simple: A Beginner's Guide to Generative Intelligence by Rajeev Kapur

Suggested Tools & Platforms

[1]. Text: ChatGPT, Gemini, Claude, Jasper
[2]. Image: DALL-E, Midjourney, Stable Diffusion, Canva AI
[3]. Excel/Data: Microsoft Copilot, ChatGPT for Excel, Gemini for Sheets
[4]. Presentations: Tome, Gamma, Beautiful.ai, Canva AI Presentations
[5]. Audio: ElevenLabs, Descript, Adobe Podcast, Suno
[6]. Video: Runway, Synthesia, Pika, Lumen5, Adobe Firefly

Paper code:	Paper Title	L	T	P	C	Hrs
BT-182 (AEC)	**Environmental Science and sustainable development**	**2**	**0**	**0**	**2**	**20**

Course Objectives:

1. To understand the basic principles of environmental science and sustainable development.
2. To learn about the impact of human activities on the environment and strategies for mitigation.
3. To explore various sustainable practices and technologies used to protect and conserve natural resources.
4. To investigate global environmental issues and policies aimed at promoting sustainable development.
5. To develop critical thinking and problem-solving skills for addressing environmental challenges.

Course Outcomes:

1. Students will explain the foundational concepts of environmental science and sustainable development.
2. Students will describe the effects of human activities on the environment and methods to mitigate these impacts.
3. Students will identify and assess sustainable practices and technologies used in environmental conservation.
4. Students will understand global environmental issues and the role of policies in promoting sustainability.
5. Students will effectively analyze and propose solutions for environmental challenges through critical thinking and problem-solving skills.

Course Content:

Syllabus Overview:

Unit 1: Introduction to Environmental Science

- Fundamental Concepts of Environmental Science, Ecosystems and Biodiversity, Human Impact on the Environment, Basic Environmental Metrics, Importance of Environmental Science in Today's World (4)

Unit 2: Human Activities and Environmental Impact

- Pollution Sources and Types (Air, Water, Soil), Climate Change and Global Warming, Deforestation and Land Use Changes, Case Studies: Industrial Pollution and Urbanization, Mitigation Strategies for Environmental Impact (4)

Unit 3: Sustainable Practices and Technologies

- Principles of Sustainability, Renewable Energy Sources (Solar, Wind, Hydropower), Waste Management and Recycling, Sustainable Agriculture and Water Conservation, Case Studies: Successful Sustainable Projects (4)

Unit 4: Global Environmental Issues and Policies

- Major Global Environmental Challenges (Climate Change, Resource Depletion, Loss of Biodiversity), International Agreements and Policies (Paris Agreement, Kyoto Protocol), Role of Organizations in Environmental Protection (UNEP, Greenpeace), Case Studies: Global Efforts in Environmental Conservation (4)

Unit 5: Solutions and Future Directions

- Innovative Solutions for Environmental Challenges, Technological Advances (Green Tech, Eco-Friendly Materials), Community Engagement and Education, Future Trends in Sustainable Development, Case Studies: Emerging Solutions and Their Impacts (4)

Recommended Readings

- "Environmental Science: Toward a Sustainable Future" by Richard T. Wright and Dorothy F. Boorse
- "Principles of Environmental Science: Inquiry and Applications" by William P. Cunningham and Mary Ann Cunningham
- "Sustainable Development: Principles, Frameworks, and Case Studies" by Flevia Starr
- "Our Common Future (The Brundtland Report)" by World Commission on Environment and Development
- Research articles from the field will be provided during the course

Paper code:	Paper Title	L	T	P	C	Hrs
BT-183 (AEC)	**Scientific communication and writing**	**2**	**0**	**0**	**2**	**20**

Course Objectives:

1. To understand the fundamental principles of scientific communication and writing.
2. To develop skills for writing clear and concise scientific papers and reports.
3. To learn how to effectively present scientific information orally and visually.
4. To conduct and synthesize literature reviews in a coherent manner.
5. To communicate scientific information to diverse audiences.

Course Outcomes:

1. Students will explain the foundational principles of scientific communication and writing.
2. Students will write clear and concise scientific papers and reports.
3. Students will effectively present scientific information both orally and visually.
4. Students will conduct and synthesize coherent literature reviews.
5. Students will communicate scientific information to diverse audiences

Course Content:

Unit 1: Principles of Scientific Writing

- Introduction to Scientific Communication, Structure of Scientific Papers (Abstract, Introduction, Methods, Results, Discussion), Writing Style and Clarity, Common Pitfalls in Scientific Writing (4)

Unit 2: Conducting Literature Reviews

- Importance of Literature Reviews, Steps in Conducting a Literature Review, Summarizing and Synthesizing Information, Citing Sources Appropriately, Writing a Literature Review Section (4)

Unit 3: Writing Scientific Papers and Reports

- Detailed Examination of Each Section of a Scientific Paper, Writing Research Proposals, Laboratory Reports, and Review Articles, Editing and Revising Scientific Documents, Peer Review Process (4)

Unit 4: Oral and Visual Scientific Communication

- Preparing and Delivering Oral Presentations, Designing Effective Visual Aids (Graphs, Tables, Posters), Communicating Data Visually, Using Presentation Software (PowerPoint, Prezi) (4)

Unit 5: Communicating Science to Diverse Audiences

- Techniques for Explaining Complex Scientific Concepts to Non-Scientists, Writing for General Audiences (Blogs, Popular Science Articles), Public Speaking and Science Outreach, Ethical Considerations in Scientific Communication (4)

Recommended Readings

- "Scientific Writing and Communication: Papers, Proposals, and Presentations" by Angelika H. Hofmann
- "The Craft of Scientific Writing" by Michael Alley
- "Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded" by Joshua Schimel
- "The Elements of Style" by William Strunk Jr. and E.B. White
- "How to Write and Publish a Scientific Paper" by Barbara Gastel and Robert A. Day
- "The Chicago Manual of Style" by The University of Chicago Press Editorial Staff
- "Science Research Writing for Non-Native Speakers of English" by Hilary Glasman-Deal
- "Presenting Science Concisely: How to Give High-Impact Presentations in Biology, Chemistry, Engineering, and Medicine" by Dennis Meredith

Paper code:	Paper Title	L	T	P	C	Hrs
BT-184 (AEC)	**Good "x"Practices (GxP)**	**2**	**0**	**0**	**2**	**20**

Course Objectives:

1. Understand the principles, scope, and importance of Good Laboratory Practices (GxP) in scientific research and testing.
2. Gain practical knowledge of implementing, maintaining, and auditing GLP in laboratory environments.
3. Develop skills in documentation, quality assurance, equipment management, data integrity, and regulatory compliance.
4. Prepare for certification and compliance with international GLP standards (OECD, WHO, FDA, etc.).

Course Outcomes:

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

1. Explain the principles and regulatory requirements of GxP.
2. Implement and manage GLP-compliant laboratory operations.
3. Develop SOPs, maintain documentation, and ensure data integrity.
4. Prepare for and respond to audits and regulatory inspections.
5. Foster a culture of quality, safety, and ethics in laboratory environments.

Course Content:

Unit 1: Introduction to Good Laboratory Practices, Definition, history, and scope of GLP, Objectives and significance, Regulatory landscape (OECD, WHO, FDA, etc.), GLP vs. GMP and GCP, GLP Principles and Quality Systems, The 10 OECD GLP Principles, Quality management systems in laboratories, Integration with ISO/IEC 17025 and laboratory accreditation. (4)

Unit 2: Laboratory Organization and Personnel, Organizational structure and roles, Responsibilities of management, study director, QA personnel, Training, qualification, and competency records. Facilities, Equipment, and Environment, Facility design and maintenance, Equipment qualification, calibration, and maintenance, Environmental controls and safety. (4)

Unit 3: Standard Operating Procedures (SOPs) and Documentation, SOP development and management, Protocols and study plans, Record-keeping, data integrity, and traceability, Test and Reference Items, Sample Handling, Receipt, storage, and tracking, Labelling and chain of custody, Handling, preparation, and disposal. (4)

Unit 4: Study Conduct and Data Management, Study planning and execution, Data collection, analysis, and reporting, Electronic data management and computer-based record keeping. Quality Assurance (QA) and Auditing, QA programs and responsibilities, Internal and external audits, Corrective and preventive actions (CAPA), Inspection readiness. (4)

Unit 5: GLP Compliance, Regulatory Inspections, and Certification , GLP compliance requirements, Regulatory inspections and responses, Certification processes and international perspectives (OECD, FDA, WHO), Mutual Acceptance of Data (MAD). Health, Safety, and Ethics in the Laboratory, Laboratory safety protocols, Waste management and biosafety, Ethical considerations and data falsification prevention. (4)

Recommended Readings

[1]. WHO/TDR Handbook on Good Laboratory Practice (GLP)
[2]. OECD Principles of Good Laboratory Practice (latest edition)
[3]. Certified in Good Laboratory Practice (IGMPI study material)
[4]. Good Laboratory Practices GLP Training (Pertecnica, CDG Training)
[5]. Statistical Quality Control by Grant & Leavenworth

Paper code:	Paper Title	L	T	P	C	Hrs
BT-185 (AEC)	**Emerging Technologies in Food Industry**	**2**	**1**	**0**	**3**	**30**

Course Objectives:

To understand about new developments in food industry and to impart knowledge about the importance and applications of the technology.

Course Outcomes:

Tthe student will be able to understand:
Emerging / alternative technologies applied to food processing.
Relative advantages / disadvantages over existing technologies.
Economics and commercialization of newer technologies.

UNIT I

Membrane separation process Membrane Technology-process- Micro-filtration, Ultra-filtration, Nano-filtration and Reverse Osmosis-advantages-equipment

UNIT II

High pressure processing and microwave heating, dielectric heating of foods, cold plasma techniques.

UNIT III

Irradiation and PEF and ohmic heating Pulsed electric field – equipment –mechanism of PEF-advantages, Ohmic heating of foods- mechanism- principle-advantages, applications. Irradiation- principle- types of irradiation-advantages-applications

UNIT IV

Osmotic dehydration of foods and minimal processing Principle – Mechanism of osmotic dehydration – Effect of process parameters on mass transfer – Methods to increase the rate of mass transfer – Applications – Limitations of osmotic dehydration – Management of osmotic solutions. Minimal processing-principle-methods- advantages

UNIT V

Nanotechnology and antimicrobial technology Role of Antimicrobial agents in food –Plant and animal derived antimicrobials – Antimicrobial enzymes, antimicrobial food packaging, nanotechnology-application of nanotechnology in food industry.

Recommended Readings

1. Leistner L. and Gould G. Hurdle Technologies – Combination treatments for food stability safety and quality, Kluwer Academics / Plenum Publishers, New York (2002)
2. Novel Food Processing Technologies(Food Science and Technology Series) by Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Publisher: CRC Press, November 2004, ISBN-13: 9780824753337,
3. P Richardson (2001), "Thermal Technologies in Food Processing", Campden and Chorleywood Food Research Association, UK, Woodhead Publishing Limited.

Paper code:	Paper Title	L	T	P	C	Hrs
BT-186 (AEC)	**PUBLIC HEALTH NUTRITION**	**2**	**0**	**0**	**2**	**20**

Course Objectives:

This course will enable the students to become familiar with the prevalence and determinants of nutritional/ health problems in the population. They will learn about the public health implications of various nutritional problems and the strategies to overcome the same. The students will also get acquainted with the various national/ public sector policies and programmes for promotion of health and nutritional status in India.

Course Outcomes:

Students will be able to:

1. Become familiar with the prevalence and determinants of nutritional/ health problems in the population.
2. Acquire knowledge about the public health implications of various nutritional problems and the strategies to overcome the same.
3. Get acquainted with national/ public sector policies and programmes for promotion of health and nutritional status in India.

UNIT I

Public Health Aspects of Undernutrition- Etiology, public health implications, preventive strategies and community based management, Malnutrition and major micronutrient deficiencies and emerging nutrient deficiencies of public health significance, Maternal Nutrition, Adolescent Nutrition and Anemia.

Unit II

Public Health Aspects of Life Style Related Disorders, Public health implications and preventive strategies for obesity, hypertension, coronary heart disease, diabetes, osteoporosis, cancer and dental caries.

Unit III

National / Public Sector Policies for Promotion of Nutrition and Health Status of the Population, National Nutrition Policy, Poshan Abhiyan, National Health Policy, National Food Security Act, National Water Policy, National Urban Sanitation Policy.

Unit IV

National / Public Sector Programmes for Promotion of Nutrition and Health Status of the Population, Nutrition sensitive and nutrition specific programmes, Critical appraisal of ongoing public sector programmes and some success stories.

Recommended Readings

1. Gibney M.J., Margetts, B.M., Kearney, J. M. Arab, I., (Eds) (2004) Public Health Nutrition, NS Blackwell Publishing.
2. National Consensus Workshop on Management of SAM children through Medical Nutrition Therapy (2009)-Compendium of Scientific Publications Volume I and II. Jointly organized by AIIMS, Sitaram Bhartia Institute of Science and Research, IAP (Subspeciality chapter on Nutrition), New Delhi. Sponsored by DBT.
3. National Nutrition Policy, GoI. http://wcd.nic.in/sites/default/files/nnp_0.pdf
4. Park, K. (2017) Park's Textbook of Preventive and Social Medicine, 24th edition. Banarsidas Bhanot Publishers.
5. Vir, S.C. (Ed.). (2011). Public Health Nutrition in Developing Countries. Part 1 and 2. Woodhead Publishing India.

APPENDIX -II

Paper code:	Paper Title	L	T	P	C	Hrs
BT-171 (SEC)	**New Product Development in Biotechnology**	**2**	**1**	**0**	**3**	**30**

Course Objectives:

1. To provide a comprehensive understanding of the end-to-end process of new product development (NPD) in biotechnology.
2. To equip students with knowledge and practical skills in ideation, research, design, development, regulatory, and commercialization aspects of biotechnological products.
3. To develop critical thinking regarding ethical, legal, and societal issues in biotech innovation.
4. To foster interdisciplinary teamwork and project management skills for successful biotech product launches.

Course Outcomes:

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

1. Understand and apply the full NPD process in biotechnology from ideation to commercialization.
2. Design and evaluate biotechnological products for healthcare, agriculture, and environmental applications.
3. Navigate regulatory, ethical, and legal frameworks for biotech products.
4. Develop business strategies and commercialization plans for new biotech products.
5. Work effectively in interdisciplinary teams and communicate complex ideas to diverse stakeholders.

Course Content:

Unit 1: Introduction to Biotechnology Product Development, Overview of NPD in biotechnology, Types of biotech products: drugs, vaccines, biologics, diagnostics, agricultural, and environmental products. Ideation and Market Analysis, Identifying unmet needs and market opportunities, Problem Inventory Analysis (PIA), Technology scouting, Market research and feasibility analysis, Intellectual property (IP) landscape.

(6)

Unit 2: Research and Discovery Phase, Target identification and validation, High-throughput screening, molecular modeling, In vitro and in vivo studies, Omics technologies (genomics, proteomics, metabolomics), Case studies of successful discoveries. Product Design and Development, Designing for function, safety, and manufacturability, Formulation development (stabilization, delivery systems), Analytical method development and quality control, Scale-up and process optimization.

(6)

Unit 3: Preclinical and Clinical Development, Preclinical testing (safety, efficacy, toxicity), Design and phases of clinical trials (I-IV), Clinical trial protocols, endpoints, data analysis, Manufacturing and Quality Assurance, Upstream and downstream processing, Good Manufacturing Practices (GMP), QA, QC, Scale-up, production challenges, Product consistency, validation, and documentation.

(6)

Unit 4: Regulatory Affairs and Compliance, Regulatory bodies (FDA, EMA, CDSCO, ICH), Regulatory pathways for different products, IND, NDA, BLA submissions, Navigating regulatory inspections and approvals, Biosafety and bioethics. Commercialization and Business Strategy, Business models for biotech products, Market access, pricing, and reimbursement, Licensing, partnerships, and alliances, Marketing, branding, and sales strategies, Post-market surveillance and lifecycle management.

(6)

Unit 5: Intellectual Property and Legal Issues, Patents, trademarks, and trade secrets, Patent application and management, Freedom to operate, IP litigation, Legal and contractual issues in biotech, Societal, Ethical, and Environmental Considerations, Bioethics and biosafety, Societal acceptance and public communication, Environmental impact assessments, Responsible innovation.

(6)

Recommended Readings

[1]. Biotechnology Product Development: Planning, Design, and Implementation by Michael J. Groves
[2]. Bioprocess Engineering by Michael L. Shuler, Fikret Kargi, Matthew DeLisa
[3]. Drug Delivery and Targeting by A.M. Hillery, A.W. Lloyd, J. Swarbrick
[4]. Pharmaceutical Dosage Forms and Drug Delivery Systems by H.C. Ansel et al.
[5]. Regulatory and IP guidelines (FDA, EMA, ICH, WIPO documents)
[6]. Relevant articles, reviews, research papers and patents.

Paper code:	Paper Title	L	T	P	C	Hrs
BT-172 (SEC)	**Quality Management Systems**	**2**	**1**	**0**	**3**	**30**

Course Objectives:

1. Understand the principles, processes, and importance of Quality Management Systems (QMS).
2. Gain practical knowledge of implementing, maintaining, and improving QMS in various industries.
3. Learn about international standards (ISO 9001, ISO 13485), regulatory frameworks, and best practices.
4. Develop skills in quality assurance, control, auditing, and continual improvement.

Course Outcomes:

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

1. Define and explain the principles and structure of QMS.
2. Interpret and apply ISO and industry-specific quality standards.
3. Use statistical tools for quality control and process improvement.
4. Plan, implement, and audit QMS in various organizational contexts.
5. Foster a culture of continual improvement and quality excellence.

Course Content:

Unit 1: Introduction to Quality and Quality Management, Definitions and dimensions of quality, History and evolution of quality management, Quality control vs. quality assurance, Economics of quality, Quality policy and objectives. Quality Management Systems (QMS) Fundamentals, Principles and components of QMS, Structure and documentation (manuals, procedures, work instructions), Benefits and challenges of QMS, QMS in manufacturing and service sectors. (6)

Unit 2: Quality Standards and Models, ISO 9000 series: ISO 9000, ISO 9001, ISO 9004, Industry-specific standards (ISO 13485, 21 CFR Part 820), National and international standardization bodies, Certification and accreditation processes. (6)

Unit 3: Quality Assurance and Auditing - Quality assurance concepts and methodologies, Internal and external audits, Audit planning, execution, and reporting, Corrective and preventive actions (CAPA), Quality rating and field complaints. (6)

Unit 4: Implementation and Continuous Improvement, Steps to establish a QMS, Plan-Do-Check-Act (PDCA) cycle, Kaizen, benchmarking, and best practices, Employee involvement and leadership in quality, Change management for QMS, QMS in software and service industries, Quality in supply chain management. (6)

Unit 5: TQM and organizational culture, Emerging trends: digital QMS, risk-based thinking, Legal, Regulatory, and Ethical Aspects, Legal frameworks and compliance, National/international regulations (e.g., FDA, EMA), Documentation and record-keeping, Ethics in quality management. (6)

Recommended Readings

[1]. ISO 9001:2015 Quality Management Systems – Requirements
[2]. Total Quality Management by Dale H. Besterfield
[3]. Juran's Quality Handbook by Joseph M. Juran
[4]. Statistical Quality Control by Eugene L. Grant and Richard S. Leavenworth

Paper code:	Paper Title	L	T	P	C	Hrs
BT-173 (SEC)	**Protein footprinting**	**2**	**1**	**0**	**3**	**30**

Course Objectives:

1. To understand the fundamental principles and techniques of protein footprinting through theoretical lectures.
2. To learn how protein footprinting data is generated and interpreted.
3. To explore the applications of protein footprinting in understanding protein structure and function.
4. To investigate the role of protein footprinting in drug discovery and enzymatic mechanisms.
5. To develop critical thinking and communication skills through the analysis and discussion of protein footprinting data.

Course Outcomes:

1. Students will explain the foundational concepts and techniques of protein footprinting.
2. Students will describe the processes of generating and interpreting protein footprinting data.
3. Students will identify applications of protein footprinting in studying protein structure and function.
4. Students will understand the role of protein footprinting in drug discovery and enzymatic studies.
5. Students will effectively analyze and communicate findings from protein footprinting data.

Syllabus Overview:

Unit 1: Introduction to Protein Footprinting

- Overview of Protein Footprinting, Basic Concepts of Protein Structure, Overview of Techniques (Hydroxyl Radical Footprinting, Hydrogen-Deuterium Exchange and covalent modifications), Basic Data Collection and Interpretation (5)

Unit 2: Applications in Structural Biology

- Role of Protein Footprinting in Studying Structures, Mapping Protein Interactions, Case Studies: Protein Complexes, Interpreting Data on Protein Structures (5)

Unit 3: Applications in Drug Discovery

- Use of Protein Footprinting in Finding Drug Targets, Identifying Binding Sites, Case Studies: Drug-Protein Interactions, Interpreting Drug Discovery Data (5)

Unit 4: Applications in Enzyme Mechanisms

- Studying Enzyme Actions with Footprinting, Mapping Active Sites, Case Studies: Enzyme-Substrate Interactions, Interpreting Enzyme Data (5)

Unit 5: Applications in Protein Folding and Stability

- Investigating Protein Folding and Stability, Monitoring Folding Processes, Case Studies: Protein Misfolding, Interpreting Folding Data (5)

Unit 6: Emerging Techniques and Advanced Applications

- New Footprinting Techniques, High-Throughput Methods, Combining Footprinting with Other Techniques, Case Studies: Real-World Applications, Interpreting Advanced Data (5)

Recommended Readings

- "Mass Spectrometry in Structural Biology and Biophysics: Architecture, Dynamics, and Interactions of Biomolecules" by Igor A. Kaltashov and Stephen J. Eyles
- "Protein and Peptide Mass Spectrometry in Drug Discovery" by Michael L. Gross and Guodong Chen
- "The Encyclopedia of Mass Spectrometry, Volume 1: Theory and Ion Chemistry" edited by Michael L. Gross and Richard Caprioli
- "The Encyclopedia of Mass Spectrometry, Volume 6: Ionization Methods" edited by Michael L. Gross and Richard Caprioli
- Research articles from the field will be provided during the course

Paper code:	Paper Title	L	T	P	C	Hrs
BT-174 (SEC)	FOOD SAFETY AND QUALITY CONTROL	2	1	0	3	30

Course Objectives:
To understand about food safety measure with guidelines outlined with Government amendments in food industries.

Course Outcomes:
The student will be able to understand:

- Emerging / alternative food laws applied to food processing.
- Food prevention techniques.

UNIT I
The relationship of microorganisms to sanitation, Environmental effects of microbial growth. Effects of microorganisms on food degradation and food-borne illnesses-bacteria, virus, molds, yeasts, and parasites.

UNIT II
Importance of personal hygiene of food handlers: Habits, clothes, illness, education of food handler in handling and serving food. Concept of food contamination. Cleaning methods - sterilization, and disinfection: products and methods-use of detergents, heat, chemicals etc.

UNIT III
Food Safety: Definition and factors affecting food safety, safety of left over foods. Control of Food spoilage. Control of infestation: rodent control- rats, mice; vector control-use of Pesticides.

UNIT IV
Food Adulteration: Definition, reasons and types. Adulterants in common food items. Food sanitation, control and inspection-planning and implementation of training programme for health personnel.

UNIT V
Food Laws and Standards: Codex Alimentarius, Prevention of Food Adulteration (PFA) Act , Agmark, Bureau of Indian Standards (BIS), Food Standards and Safety Authority of India (FSSAI).

UNIT VI
Food Safety and Quality Control, Concept of Food Safety Management System, GHP and GMP, HACCP, ISO 22000, Food Laws, Regulations and Standards.

Recommended Readings

1. Srilakshmi B.(2018). Food Science. New Delhi: New Age International.
2. Roday S.(1998). Food Hygiene and Sanitation 10th Reprint. New Delhi: Tata McGrawHill Education.
3. Chattopaday Ghosh S and Basu N.(2015). Uccha Madhaymik Khadda O Pusti, Calcutta Book House
4. Textbook of Food and Beverage Management by Sudhir Andrews, Tata Mc Graw Hill, New Delhi.
5. Food Hygiene and Sanitation by S. Roday
6. Essentials of food safety and sanitation by David Ms Swane, Nancy Rue and Richard Linton
7. Essentials of Food Sanitation by Marriott, Norman
8. Food Safety, Sanitation and Personal Hygiene by BC Cook Articulation Committee and The BC Cook Articulation Committee
9. Manual of Methods of Analysis of Foods- Microbiological Testing. (2012). Lab Manual 14. FSSAI, GoI, New Delhi.

Paper code:	Paper Title	L	T	P	C	Hrs
BT-175 (SEC)	**FOOD PRESERVATION**	2	1	0	3	30

Course Objectives:

To understand about techniques to prevent spoilage and extend the shelf life of food, ensuring it remains safe and palatable for consumption

Course Outcomes:

The student will be able to understand:

1. Different Methods like canning freezing drying and fermentation to extend shelf life reduce waste and ensure food safety
2. Food prevention methods and techniques to reduce food spoilage and enhance food safety.

UNIT I

Food preservation: definition, objectives and principles of food preservation. Different methods of food preservation.

UNIT II

Preserved Products: Jam, Jelly, Marmalade, Sauces, Pickles, Squashes, Syrups-types, composition and manufacture, selection, cost, storage, uses and nutritional aspects.

UNIT III

Sugar and sugar products: Different forms of sugar (sugar, jaggery, honey, syrup), selection, storage and use, preserves. Salts: Types, uses in the diet.

UNIT IV

Fats and Oils: Types and sources of fats and oils (animal and vegetable), processing, uses, storage and nutritional aspects

UNIT V

Raising agents: preservation method. Food adjuncts: Spices, condiments, herbs, extracts, concentrates- origin, classification, description, uses, specifications, procurement and storage.

Recommended Readings

1. Subalakshmi, G and Udipi, S.A. Food processing and preservation; New Age International Publishers, New Delhi, 2001.
2. Srilakshmi, B. Food Science. New Age International Publishers, New Delhi, 2003.
3. Potter, N.N. and Hotchkiss J. H. Food Science. CBS publishers and distributors. 1996.
4. Srivastava, R.PO and Kumar, S. Fruit and vegetable preservation, International Book distribution Company, Lucknow, 1994.
5. MC Williams, M and Paine, H. Modern Food preservation. Surjeet Publications, Delhi, 1984.
6. Cruess, W.V. Commercial Fruits and Vegetable Products, Anees Offset press, New Delhi, 1997

APPENDIX-III

Paper code:	Paper Title	L	T	P	C	Hrs
BT-191 (VAC)	**Bioentrepreneurship**	**2**	**0**	**0**	**2**	**20**

Course Objectives:

1. Equip students with skills to launch and manage ventures in biotechnology, healthcare, and life sciences.
2. Integrate scientific knowledge with business strategy, innovation, and ethical practices.
3. Develop competencies in market analysis, product development, funding, and regulatory compliance.
4. Foster entrepreneurial thinking through case studies, industry collaborations, and hands-on projects.

Course Outcomes:

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

1. Launch and manage ventures in biotechnology and allied fields
2. Integrate scientific knowledge with business strategy, innovation, and ethical practices.
3. Develop competencies in market analysis, product development, funding, and regulatory compliance.
4. Foster entrepreneurial thinking

Course Content:

Unit 1: Introduction to Bioentrepreneurship, Definition, scope, and global trends, Life science sectors: biotech, medtech, digital health, Bioeconomy and sustainability principles, Case studies of successful ventures. (4)

Unit 2: Opportunity Identification & Market Analysis, Unmet needs in healthcare/biotech, Feasibility studies (market, technical, financial), Competitive landscape analysis, Intellectual property (patents, licensing), (4)

Unit 3: Business Planning & Strategy, Business model canvas for life sciences, Funding strategies: grants, VC, crowdfunding, Risk management and exit strategies, Pitch deck development, Product Development in Life Sciences, Drug/devices R&D pipelines, Regulatory pathways (FDA, EMA, CDSCO), Clinical trials and compliance (GCP, GMP), Scale-up and manufacturing. (4)

Unit 4: Marketing & Commercialization, Value proposition design, Pricing, reimbursement, market access, Digital marketing for biotech, Post-market surveillance. (4)

Unit 5: Funding & Financial Management, Venture capital/angel investing in biotech, financial modeling and valuation, Grant writing, Legal & Ethical Considerations, Bioethics and biosafety regulations, Data privacy, Contract negotiations and partnerships, Global compliance challenges. (4)

Recommended Readings

[1]. Bioentrepreneurship: From Idea to Marketplace by J. Edwards,
[2]. Innovation and Entrepreneurship in Biotechnology: Concepts, Theories and Cases by Damian Hine and John Kapeleris
[3]. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries
[4]. Academic Entrepreneurship: How to Bring Your Scientific Discovery to a Successful Commercial Product by Jeffrey S. Aramini
[5]. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies by Craig Shimasaki
[6]. Bioentrepreneurship: From Idea to Market by Arvind K. Bansal and Shikha Bansal

Paper code:	Paper Title	L	T	P	C	Hrs
BT-192 (VAC)	**Ethics in Biotechnology**	2	0	0	2	20

Course Objectives:

1. To understand key ethical principles and frameworks in biotechnology.
2. To identify and analyze ethical issues arising from biotechnological innovations.
3. To evaluate the social, environmental, and individual impacts of biotechnology.
4. To discuss the role and responsibilities of biotechnologists in ethical decision-making.
5. To develop critical thinking skills to navigate ethical dilemmas in biotechnology.

Course Outcomes:

1. Students will explain key ethical principles and frameworks related to biotechnology.
2. Students will identify and critically analyze ethical issues in biotechnological advancements.
3. Students will evaluate the social, environmental, and individual impacts of biotechnological innovations.
4. Students will articulate the role and responsibilities of biotechnologists in ethical decision-making.
5. Students will develop and apply critical thinking skills to address ethical dilemmas in biotechnology.

Course Content:

Unit 1: Introduction to Ethics and Biotechnology

- Fundamental Ethical Principles (Beneficence, Non-Maleficence, Autonomy, Justice), Ethical Theories (Utilitarianism, Deontology, Virtue Ethics), Overview of Biotechnology and Its Applications, Historical Context of Ethics in Biotechnology (4)

Unit 2: Genetic Engineering and Ethical Concerns

- Ethical Issues in Genetic Modification (GMOs, CRISPR, Gene Therapy), Impact on Agriculture and Food Security, Human Genetic Engineering and Enhancement, Case Studies: Ethical Dilemmas in Genetic Engineering (4)

Unit 3: Medical Biotechnology and Bioethics

- Ethical Considerations in Medical Biotechnology (Stem Cell Research, Cloning, Personalized Medicine), Patient Consent and Privacy, Access to Biotechnological Treatments, Case Studies: Ethical Issues in Medical Biotechnology (4)

Unit 4: Environmental Biotechnology and Sustainability

- Biotechnology and Environmental Ethics, Bio-Remediation and Conservation, Impact of Biotechnology on Biodiversity and Ecosystems, Case Studies: Environmental Ethics in Biotechnology (4)

Unit 5: Policy, Regulation, and the Role of Biotechnologists

- Role of Policy and Regulation in Biotechnology, Ethical Guidelines and Regulatory Frameworks, Responsibilities of Biotechnologists and Professional Conduct, Case Studies: Policy and Ethical Decision-Making in Biotechnology (4)

Recommended Readings

- "Ethical Issues in Biotechnology" by Richard Sherlock and John D. Morrey
- "Bioethics: Principles, Issues, and Cases" by Lewis Vaughn
- "Biomedical Ethics" by Thomas A. Mappes and David DeGrazia
- "The Ethics of Biotechnology" by Jonathan Morris
- "From Chance to Choice: Genetics and Justice" by Allen Buchanan, Dan W. Brock, Norman Daniels, and Daniel Wikler
- "Biotechnology and Society: An Introduction" by Hallam Stevens
- "Ethics in Biomedical Research: International Perspectives" edited by Matthias Kaiser and John-Stewart Gordon

Research Articles and Ethical Guidelines:

- Selected research articles and ethical guidelines (e.g., Nuffield Council on Bioethics reports, UNESCO Bioethics guidelines) provided during the course to enhance understanding of contemporary ethical issues in biotechnology.

Paper code:	Paper Title	L	T	P	C	Hrs
BT-193 (VAC)	**Regulatory affairs in Biotechnology**	2	0	0	2	20

Course Objectives:

1. To understand the fundamental principles of regulatory affairs in biotechnology.
2. To identify the major regulatory agencies and their roles in biotechnology.
3. To understand the regulatory processes involved in the development and approval of biotechnological products.
4. To discuss the importance of compliance and quality assurance in biotechnology.
5. To develop skills to navigate regulatory challenges in the biotechnology industry.

Course Outcomes:

1. Students will explain the basic principles and importance of regulatory affairs in biotechnology.
2. Students will identify key regulatory agencies and understand their roles in biotechnology.
3. Students will outline the regulatory processes for biotechnological product development and approval.
4. Students will discuss the significance of compliance and quality assurance in ensuring product safety and efficacy.
5. Students will develop problem-solving skills to address regulatory challenges in the biotechnology industry.

Course Content:

Unit 1: Introduction to Regulatory Affairs

- Overview of Regulatory Affairs, Importance in Biotechnology, Key Concepts (Regulation, Compliance, Standards), Historical Context and Evolution of Regulations in Biotechnology (4)

Unit 2: Regulatory Agencies and Frameworks

- Major Regulatory Agencies (FDA, EMA, WHO), Key Regulatory Frameworks and Guidelines (ICH, GLP, GMP), Roles and Responsibilities of Regulatory Agencies, Case Studies: Regulatory Processes Across Different Regions (4)

Unit 3: Regulatory Processes and Product Development

- Stages of Product Development (Preclinical, Clinical Trials, Market Approval), Regulatory Submissions and Documentation (IND, NDA, BLA), Safety and Efficacy Evaluations, Case Studies: Successful Regulatory Approvals (4)

Unit 4: Compliance and Quality Assurance

- Principles of Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), Quality Assurance and Control, Risk Management in Biotechnology, Case Studies: Ensuring Compliance and Quality (4)

Unit 5: Regulatory Challenges and Future Directions

- Common Regulatory Challenges (Emerging Technologies, Global Harmonization), Navigating Regulatory Pathways, Future Trends in Biotechnology Regulation, Role of Regulatory Affairs Professionals, Case Studies: Addressing Regulatory Challenges (4)

Recommended Readings

- "Fundamentals of EU Regulatory Affairs - Eighth Edition" by Regulatory Affairs Professionals Society (RAPS)
- "FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics" by Douglas J. Pisano and David S. Mantus

- "The Regulatory Compliance Almanac" by Les Schnoll
- "Biotechnology: Business, Regulation, and Law" by Edward L. Hennessy and Albert J. Rosenthal
- "Good Pharmaceutical Manufacturing Practice: Rationale and Compliance" by John Sharp
- "Biotechnology and Biopharmaceutical Regulation in Value Chains" by Børge Obel and Frederik Ørsted
- "Quality Assurance and Quality Control in the Analytical Chemical Laboratory: A Practical Approach" by Piotr Konieczka and Jacek Namiesnik

Regulatory Documents and Guidelines:

- Selected regulatory documents and guidelines (e.g., FDA guidance documents, ICH guidelines, EMA reports) provided during the course to enhance understanding of regulatory frameworks and compliance procedures.