JECRC UNIVERSITY

School of Science
Course Structure and Syllabus
B. Sc. Biotechnology (Hons.)
2021-2024

School of Science
Syllabi and Course Structure
B.Sc. Biotechnology (Hons.)
Academic Programmes
Batch (2021-2024)

Total credit for Batch 2021-2024: 148 Credits

Details of Scheme for B Sc. Biotechnology (Hons.) with various Courses & their credits with contact Hours

****Note: In 6th Semester Students have a Choice either he can go for offered Courses or he may avail Internship in some reputed Institute / Industry or In House Dissertation**

Semester I

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	1	BBI019B	Cell Biology	4	0	0	4	4	0	0	4	Core Course 1
2	1	BBI020B	Cell Biology Lab	0	0	2	2	0	0	1	1	
3	1	BBI021B	Biological Macromolecules	4	0	0	4	4	0	0	4	Core Course 2
4	1	BBI022B	Biological Molecules Lab I	0	0	2	2	0	0	1	1	
5	1	BBI023B	Microbiology	4	0	0	4	4	0	0	4	Core Course 3

6	1	BBI024 B	Microbiology Lab	0	0	2	2	0	0	1	1	
7	1	DCA001 A	Web Development	2	0	0	2	2	0	0	2	
8	1	DCA002 A	Web Development lab	0	0	2	2	0	0	1	1	
9	1	DEN001 A	Communication Skills	2	0	2	4	2	0	1	3	
10	1	DIN001 A	Culture Education -1	2	0	0	2	2	0	0	2	
11	1	DCH001 A	Environment Studies	3	0	2	5	3	0	1	4	
			Total	21	0	12	33	21	0	6	27	

***Field/ Project Work and Report**

Semester II

S.No.	**Semester**	**Subject code**	**Subject**	**Lecture Hours**	**Tutorial Hours**	**Practical Hours**	**Total Hours**	**Lecture Credit**	**Tutorial Credit**	**Practical Credit**	**Total Credits**	**Course Type**
1	2	BBI026 B	Metabolic Pathways	4	0	0	4	4	0	0	4	Core Course 4
2	2	BBI027 B	Biological Molecules Lab II	0	0	2	2	0	0	1	1	
3	2	BBI028 B	Genetics	4	0	0	4	4	0	0	4	Core Course 5
4	2	BBI029 B	Genetics Lab	0	0	2	2	0	0	1	1	
5	2	BBI030 B	Analytical Techniques	4	0	0	4	4	0	0	4	Core Course 6
6	2	BBI031 B	Analytical Techniqu	0	0	2	2	0	0	1	1	

			es lab									
7	2		DE 1	4	0	0	4	4	0	0	4	DE1
8	2		DE 1 Lab	0	0	2	2	0	0	1	1	
9	2	DCA003A	Project Management Lab	0	0	2	2	0	0	1	1	
10	2	DEN002A	Professional Skills	2	0	2	4	2	0	1	3	
11	2	DIN002A	Culture Education -2	2	0	0	2	2	0	0	2	
			Total	20	0	12	32	20	0	6	26	

Semester III

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	3	BBI033B	Introductory Immunology	4	0	0	4	4	0	0	4	Core Course 7
2	3	BBI034B	Immunological Techniques Lab	0	0	2	2	0	0	1	1	
3	3	BBI035B	r-DNA technology	4	0	0	4	4	0	0	4	Core Course 8
4	3	BBI036B	Genetic Engineering Lab	0	0	2	2	0	0	1	1	
5	3		DE 2	4	0	0	4	4	0	0	4	DE 2
6	3		DE2 Lab	0	0	2	2	0	0	1	1	
7	3	DCA004A	Advanced Spread Sheet Lab	0	0	2	2	0	0	1	1	

8	3	DEN003A	Life Skills 1(Personality Development)	1	0	2	3	1	0	1	2	
9	3	DIN003A	Value Education and Ethics-1	1	0	0	1	1	0	0	1	
10	3	BBI091	Open Elective -I	3	0	0	3	3	0	0	3	
11	3	BBI037A	Open Elective -II	3	0	0	3	3	0	0	3	
			Total	20	0	10	30	20	0	5	25	

Semester IV

S. No.	**Semester**	**Subject code**	**Subject**	**Lecture Hours**	**Tutorial Hours**	**Practical Hours**	**Total Hours**	**Lecture Credit**	**Tutorial Credit**	**Practical Credit**	**Total Credits**	**Course Type**
1	4	BBI040B	Molecular Biology	4	0	0	4	4	0	0	4	Core Course 9
2	4	BBI041B	Molecular Biology Lab	0	0	2	2	0	0	1	1	
3	4	BBI042B	Plant Biotechnology	4	0	0	4	4	0	0	4	Core Course 10
4	4	BBI043B	Plant Biotechnology Lab	0	0	2	2	0	0	1	1	
5	4	BBI044B	Bioprocess Engineering and Technology	4	0	0	4	4	0	0	4	Core Course 11
6	4	BBI045B	Fermentation	0	0	2	2	0	0	1	1	

			Technology Lab									
7	4	DCA005A	Python programming	2	0	0	2	2	0	0	2	
8	4	DCA006A	Python programming Lab	0	0	2	2	0	0	1	1	
9	4	DMA011A	Life Skills-II (Aptitude)	1	0	2	3	1	0	1	2	
10	4	DIN004A	Value Education and Ethics-2	1	0	0	1	1	0	0	1	
11	4		Research Methodology	3	1	0	4	3	1	0	4	
			Total	19	1	10	30	19	1	5	25	

Semester V

S. No.	**Semester**	**Subject code**	**Subject**	**Lecture Hours**	**Tutorial Hours**	**Practical Hours**	**Total Hours**	**Lecture Credit**	**Tutorial Credit**	**Practical Credit**	**Total Credits**	**Course Type**
1	5	BBI047B	Proteomics and Genomics	4	0	0	4	4	0	0	4	Core Course 12
2	5	BBI048B	Bioinformatics Lab	0	0	2	2	0	0	1	1	
3	5		Department Elective-3	4	0	0	4	4	0	0	4	DE-3
4	5		Department Elective Lab-3	0	0	2	2	0	0	1	1	
5	5		Department Elective 4	4	0	0	4	4	0	0	4	DE-4
6	5		Department Elective Lab-4	0	0	2	2	0	0	1	1	

7	5	BBI092	Open Elective III	3	0	0	3	3	0	0	3	Inter-disciplinary
8	5	BBI071A	Project	0	0	12	12	0	0	6	6	Discipline specific
				15	0	18	33	15	0	9	24	

Semester VI

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	6		Department Elective 5	4	0	0	4	4	0	0	4	DE-5
2	6		Department Elective -5 Lab	0	0	2	2	0	0	1	1	
3	6		Department Elective 6	4	0	0	4	4	0	0	4	DE-6
4	6		Department Elective -6 Lab	0	0	2	2	0	0	1	1	
5	6		Department Elective 7	4	0	0	4	4	0	0	4	DE-7
6	6		Department Electiv	0	0	2	2	0	0	1	1	

			e-7Lab									
7	6	BBI093	Open Elective-IV	3	0	0	3	3	0	0	3	Interdi
8	6	BBI094	Open Elective-V	3	0	0	3	3	0	0	3	Interdi
				18	0	6	24	18	0	3	21	

****Note: In 6th Semester Student have a Choice either he can go for offered Courses or he may avail Internship in some reputed Institute / Industry or In House Dissertation**

Total Credits

Credits	I Sem	II Sem	III Sem	IV Sem	V Sem	VI Sem	Total
	27	**26**	**25**	**25**	**24**	**21**	**148**

PROGRAM OUTCOMES

PO 1. **Disciplinary Knowledge and Skills**: Good knowledge and understanding of major concepts, theoretical principles in Biotechnology and its allied fields. The knowledge about the experimental findings in Biotechnology and its different subfields like Cell biology, Biochemistry, Microbiology, Genetic Engineering, medical biotechnology, environmental biotechnology, plant biotechnology, molecular biology, industrial biotechnology and immunology including broader interdisciplinary subfields like Chemistry, Mathematics, Life sciences, Environmental sciences, Computer science, Information Technology, forensic science and etc.

PO 2. Skilled communicator: Ability to transmit complex technical information relating all areas in Biotechnology in a clear and concise manner in writing and oral ability to present complex and technical concepts in a simple language for better understanding.

PO 3. Critical thinker and problem solver: Ability to employ critical thinking and efficient problem solving skills in all the basic areas of Biotechnology

PO 4. Sense of inquiry: Capability for asking relevant/appropriate questions relating to the issues and problems in the field of Biotechnology, and planning, executing and reporting the results of a theoretical or experimental investigation

PO 5. Skilled project manager: Capable of identifying/mobilizing appropriate resources required for a project, and manage a project through to completion, while observing responsible and ethical scientific conduct; and safety and laboratory hygiene regulations and practices.

PO 6. Ethical awareness / reasoning and Environmental Sustainability: The graduate should be capable of demonstrating ability to think and analyze rationally with modern and scientific outlook and identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, and adopting objectives, unbiased and truthful actions in all aspects of work. Understand the issues of environmental contexts and sustainable development.

PO 7. Self-directed, Team player and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context social technological changes. Capable of working effectively in diverse teams in both classroom, laboratory, Biotechnology projects and workshop and in industry and field-based situations.

Semester I

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	1	BBI019B	Cell Biology	4	0	0	4	4	0	0	4	Core Course 1
2	1	BBI020B	Cell Biology Lab	0	0	2	2	0	0	1	1	
3	1	BBI021B	Biological Macromolecules	4	0	0	4	4	0	0	4	Core Course 2
4	1	BBI022B	Biological Molecules Lab I	0	0	2	2	0	0	1	1	
5	1	BBI023B	Microbiology	4	0	0	4	4	0	0	4	Core Course 3
6	1	BBI024B	Microbiology Lab	0	0	2	2	0	0	1	1	
7	1	DCA001A	Web Development	2	0	0	2	2	0	0	2	
8	1	DCA002A	Web Development Lab	0	0	2	2	0	0	1	1	
9	1	DEN001A	Communication Skills	2	0	2	4	2	0	1	3	
10	1	DIN001A	Culture Education -1	2	0	0	2	2	0	0	2	
11	1	DCH001A	Environment Studies	3	0	2	5	3	0	1	4	
			Total	21	0	12	33	21	0	6	27	

Department of Biotechnology,
B.Sc. Semester – I
Course – Cell Biology
Course Code – BBI019B
Lectures: 4 Hrs/week

UNIT 1	**Cell**
UNIT 2	**Cell division**
UNIT 3	**Transport across membrane**
UNIT 4	**Structure of cilia and flagella**
UNIT 5	**Centrioles and basal bodies**

Course outcome

CO-1 Students will be able understand the cell and different organelles

CO-2 Students will be able to describe and identify different chromosomes and cell division stages

CO-3 Students will be able to distinguish between passive and active transport; explain how substances are directly transported across a membrane. Describe the primary mechanisms by which cells import and export macromolecules and protein folding.

CO-4 Student will able to acquire skills to analyze the critical problems related to cell biology

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	0	2	0	1	1
CO2	3	3	2	1	1	0	1
CO3	2	2	3	2	1	0	0
CO4	3	2	3	2	3	1	1

1-LOW, 2-MEDIUM, 3-HIGH

BBI019B: CELL BIOLOGY **Credit(s): 4**

Unit-I

Cell: Shapes, Morphology, difference between plant cell and Animal cell, Prokaryotes and Eukaryotes, Structure, Function, Relationship including organelles and their Biogenesis (e.g., Endoplasmic reticulum, Golgi body, nucleus, Lysosomes, vacuoles); Cell theory; Membrane structure, cell wall.

Unit-II

Cell divisions: Cell cycles, Amitosis, Mitosis phases, structure and functions of spindle apparatus; anaphasic chromosome movement; Meiosis: phases, synaptonemal complex formation of chiasmata. Significance of mitosis and meiosis

Unit-III

Transport across membrane: Active, Passive, Facilitated; Protein synthesis and folding in the cytoplasm; Degradation of cellular components.

Chromosome organization: eukaryotic and prokaryotic, Chromosomes morphology: Centromere, Telomere; Specialized types of chromosomes: Sex chromosomes, Lampbrush chromosome, polytene chromosomes, Nucleosomes, Solanoid and Super solenoid modal

Unit-IV

Structure of cilia and flagella, microtubule and microfilament microtubule assembly, functions of filament and microtubules, Structure of Plastids and the light reaction and dark reaction, Centrioles and basal bodies: structure, chemical composition, duplication of centrioles, function of centrioles and basal bodies,

Unit-V

Structure of Mitochondria, Ribosomes Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. RNA Synthesis.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Text / Reference Books

1. Monroe W Strickberger; Genetics, 3rd Edition, Macmillan international editions in science.

2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P; The World of the Cell, 7thedition, Pearson Benjamin Cummings Publishing, San Francisco.

3. Geoffrey M. Cooper, Robert E. Hausman; The Cell: A Molecular Approach, 6th Edition, Sinauer Associates, Inc.

4. Bruce Alberts, Alexander D. Johnson, Juliian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Molecular Biology of the Cell, 5th Edition, Garland Science.

BBI020B: Cell Biology Lab **Credit(S): 1**

1. To analyze prepared slides of mitosis
2. To perform and identify different stages of mitosis in onion root tip
3. To analyze prepared slides of meiosis
4. To perform and identify different stages of mitosis in onion flower bud
5. To prepare the slide of Giant chromosome
6. To analyze slides of different cell organelles
7. Introduction to microtomy and apparatus handling
8. To localize lipid Histochemically
9. To localize starch Histochemically
10. To localize proteins Histochemically
11. To perform paper chromatography for dyes

Virtual Lab link

S.No.	Course name	Sources	Link
1.	Cell Biology Virtual Lab I	Amrita Vishwa Vidyapeetham	http://cbi-au.vlabs.ac.in/
2.	Cell Biology Virtual Lab II	Amrita Vishwa Vidyapeetham	http://cbii-au.vlabs.ac.in/
3.	Cell Biology Tutorials I	Genetic Science Learning Center by Arthur Lakes Library Colorado School of Mines	https://learn.genetics.utah.edu/content/cells/
4.	Cell Biology Tutorials II	MIT	http://star.mit.edu/CellBio/animations/index.html

B.Sc. Semester- I
Course-Biological Macromolecules
Course Code-BBI020B
Lectures: 4 Hrs/week

UNIT 1	**Molecular Interaction and vitamins**
UNIT 2	**Carbohydrates**
UNIT 3	**Lipids**
UNIT 4	**Amino acids and Proteins**
UNIT 5	**Nucleic acids**

Course outcome

CO-1 Students will be able to describe the basics of biomolecules and carbohydrates
CO-2 Students will be able to illustrate different types of lipids and relate their structure to their role in biological systems.

CO-3 Students will be able to recognize amino acid structures and illustrates the function of proteins.
CO-4 Students will be able to describe/recognize nucleic acids, DNA and RNA.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	2	2	2
CO2	3	2	3	1	2	2	1
CO3	3	2	2	1	2	2	2
CO4	2	3	3	2	2	1	2

1-LOW, 2-MEDIUM, 3-HIGH

BBI021B: BIOLOGICAL MACROMOLECULES **Credit(s):4**

Unit-I

Molecular interactions: The concept of pH, dissociation and ionization of acids and bases, Lewis acid and base, buffers and their role in biology, buffering mechanism, Henderson-Hasselbalch equation, biological buffer and Their Importance

Vitamins: Structure and biochemical properties of water soluble and fat soluble vitamins and their coenzyme activity.

Unit-II

Carbohydrates: Introduction, biological importance. Definition, Classification, Monosaccharides other than glucose, glycosidic, bond, disaccharides, polysaccharides (starch, glycogen, peptidoglycan) Hetero polysaccharides, Mutarotation, osazone formation, Inversion of Sucrose

Unit-III

Lipids: Introduction Structure, distribution and biological importance of fats and fatty acids; Chemical properties and characterization of Fats, Waxes, Cerebrosides, gangliosides, phospholipids and their types and proteolipids; Steroids and Prostaglandins

Unit-IV

Amino acids: Definition, Classification, Structure and types; Proteins: Classification, structure and properties, biologically active peptides, classification and properties of proteins, structure of proteins-primary, secondary, tertiary and quaternary structure of proteins.

Unit-V

Nucleic acids: Structure of purines, pyrimidines, nucleosides and nucleotides; Structure, types and biological role of RNA and DNA

Text / Reference Books

1. Linda Sherwood, Chris Woolverton, Joanne Willey; Prescott's Microbiology, 9th Edition, McGraw-Hill LLC.
2. E E Conn, P K Stumpf, G Bruening and R Y; General Microbiology, 5th Edition, 1987, John Wiley and Sons, New York.
3. Alberf L. Lehninger, David L. Nelson, and Michael M. Cox.; Principles of Biochemistry, 2nd Edition, Worth Publishers, 33 Irving Place, New York
4. Jeremy M Berg, John L Tymoczko, and Lubert Stryer; Biochemistry, 5th edition, 2002.

BBI022B: Biological Molecules Lab 1 **Credit(s): 1**

1. To prepare the solutions of given normality and its standardization.
2. To Calibrate the pH meter by using different buffer solutions
3. To Prepare the buffer solutions
4. To determine the pKa value and hence the Dissociation constant of a given acid by using pH meter.
5. To perform Qualitative estimation of carbohydrates
6. To perform Qualitative estimation of proteins
7. To perform Qualitative estimation of lipids
8. To Determine the acid value of oil

Virtual Labs link

S.No.	Course name	Sources	link
1	Biochemistry Virtual Lab I	Amrita Vishwa Vidyapeetham	http://biotech01.vlabs.ac.in/
2	Biochemistry Virtual Lab II	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/?sub=3&brch=64

B.Sc. Semester- I
Course- Microbiology
Course Code: BBI023B
Lectures: 4 Hrs/week

UNIT 1	**History, classification and staining**
UNIT 2	**Diversity, morphology and microbial associations**
UNIT 3	**Bacterial Growth, cultivation and preservation**
UNIT 4	**Nutritional classification, Control of Growth of Microbes**
UNIT 5	**Virus structure and types**

Course outcome

CO-1 Students will learn the fundamentals of microbiology, describe the facts and principles about microorganisms that apply to various fields, and explain how microorganisms are used as model systems to study basic biology, genetics, metabolism, and ecology.

CO-2 Students will explain and analyze the concepts, structures, nature, types of associations present among microbes and differentiate and classify them.

CO-3 Students will able to assess the elements of a problem and develop and test a solution based on logic and the best possible information, analyze and interpret results and use mathematical and graphing skills and reasoning to solve problems in microbiology.

CO-4 Students will be able to understand and appreciate the value of cooperating and working effectively with peers and demonstrate a commitment to developing such skills and identifying and discussing the ethical issues and responsibilities of microbiology.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2		1	
CO2	3	3	2	1			1
CO3	2	2	3	2	3	3	3
CO4	1	1			3	3	3

L-1, M-2, H-3

BBI023B: MICROBIOLOGY **Credit(s): 4**

Unit-I

Microbiology: Introduction, Scope, History and Evolution of Microbiology

Stains & Staining techniques: Definition of auxochrome; Chromophores; Compounds for Staining, Aims and Theories of Staining, Smear-Preparation and Fixation, Simple staining-

negative and monochrome staining, Differential staining- Gram staining; acid fast staining, endospore staining;; capsule staining; flagella staining

Microbial Taxonomy: Terminologies, Whittaker's Five-kingdom classification, three- domain classification, Binomial Nomenclature, Classification of microorganisms – numerical taxonomy, chemotaxonomy, molecular taxonomy; introduction to Bergy'smanual

Unit-II

Microbial Diversity: Morphology and cell structure of major groups of microorganisms e.g., Bacteria-Actinomycetes, Rickettsia, Archaebacteria; Fungi, Algae, Protozoa and Unique features of viruses; Mycoplasma and Cell wall deficient bacteria

Anatomy of Prokaryotic Cell: Cell wall, Plasma Membrane, Cytoplasm, Nucleoid, plasmids, episomes, mesosomes, ribosomes, cell Inclusions, flagella and endoflagella, pili, fimbriae, glycocalyx, endospores and sporulation; Difference between Prokaryotic and Eukaryotic cells

Microbial Associations: Mutualism, Proto-co-operation, Syntrophism, Commensalism, Commensalism, Predation, Parasitism, Amensalism

Unit-III

Microbial growth: Growth curve, Mathematical expression for Growth, Generation time, measurement of growth, continuous growth, synchronous growth and diauxic growth, environmental factors (physical and chemical) affecting growth.

Cultivation and Identification of Microbes: Media-types; Isolation methods for bacteria and fungi, Identification – morphological, biochemical, cultural characteristics, physiology, serology

Preservation of Microorganisms: objectives, necessities and methods of preservation, culture collection centre

Unit-IV

Nutritional Classification of Microbes: Basis of classification and categorization

Control of Growth of Microbes: Introduction and related terminologies, Sterilization-physical method of disinfection and sterilization; radiation (mode of action, applications); Chemical agents-gases and liquid; Mechanical methods-filtration;

Disinfection– Characteristics of disinfectant, disinfectants, Methods of assessment of chemicaldisinfectant-phenol coefficient-definition and method of determination

Unit-V

Viruses: Structure of viruses, Prions and Viroids, cultivation and identification of viruses, Virus Replication Cycles, Mechanisms of Viral Entry and Spread of Infection, Bacteriophages – structure and replication, Animal viruses - HIV, Plant Viruses - TMV

Text / Reference Books

1. Rogier Y. Stanier, John L. Ingraham, Mark L. Wheelis, Page R. Painter; General Microbiology, 5th ed., 2000, Tata-McGraw Hill.

2. Ronald M. Atlas; Principles of Microbiology, 2nd edition, 1997, McGraw-Hill.

BBI024B: Microbiology Lab **Credit(s): 1**

1. To perform the Simple staining
2. To perform the Gram staining
3. To perform the Endospore staining
4. To perform the Acid fast staining
5. To Prepare Broth for bacterial and fungal culture
6. To Prepare Nutrient Agar or Potato Dextrose Agar (PDA) or Sabouraud Dextrose Agar (SDA) media for bacterial and fungal culture
7. To isolate microflora from soil of Rajasthan and identify their shapes
8. To Culture microflora from Industries water of local area by serial dilution method spreading
9. Determination of bacterial cell size by micrometry.
10. Enumeration of microorganism- total & viable count.

Virtual Labs link

S. No.	Course Name	Source	Link
1.	Microbiology Virtual Lab I	Amrita Vishwa Vidyapeetham	https://mvi-au.vlabs.ac.in/
2.	Microbiology Virtual Lab II	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/?sub=3&brch=76

SEMESTER-II

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	2	BBI026B	Metabolic Pathways	4	0	0	4	4	0	0	4	Core Course 4
2	2	BBI027B	Biological Molecules Lab II	0	0	2	2	0	0	1	1	
3	2	BBI028B	Genetics	4	0	0	4	4	0	0	4	Core Course 5
4	2	BBI029B	Genetics Lab	0	0	2	2	0	0	1	1	
5	2	BBI030B	Analytical Techniques	4	0	0	4	4	0	0	4	Core Course 6
6	2	BBI031B	Analytical Techniques lab	0	0	2	2	0	0	1	1	
7	2		Department Elective 1	4	0	0	4	4	0	0	4	DE1
8	2		Department Elective 1 Lab	0	0	2	2	0	0	1	1	
9	2	DCA003A	Project Management Lab	0	0	2	2	0	0	1	1	
10	2	DEN002A	Professional Skills	2	0	2	4	2	0	1	3	
11	2	DIN002A	Culture Education -2	2	0	0	2	2	0	0	2	
			Total	20	0	12	32	20	0	6	26	

B.Sc. Semester-II
Course – Metabolic Pathways
Course Code – BBI026B
Lectures: 4 Hrs/week

UNIT 1	**Bioenergetics; General Concepts of Thermodynamics**
UNIT 2	**Carbohydrate Metabolism**
UNIT 3	**Lipid Metabolism**
UNIT 4	**Amino Acid Metabolism**
UNIT 5	**Nucleotide Metabolism**

Course outcome

CO-1 Students will be able to demonstrate familiarity with the basics of metabolic pathways and metabolism of carbohydrates.
CO-2 Students will be able to describe what happens in fatty acid oxidation and synthesis.
CO-3 Students will be able to explain what happens during protein metabolism.
CO-4 Students will be able to acquire skills to demonstrate the functioning and metabolism of nucleic acids.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	1	1
CO3	3	3	3	2	2	1	1
CO4	3	3	3	2	1	2	2

1 – LOW , 2- MEDIUM , 3-HIGH

BBI026B: Metabolic Pathways **Credit(s): 4**

Unit-I

Bioenergetics; General concepts of Thermodynamics: Laws of Thermodynamics, Enthalpy, Entropy, Free energy & Chemical Equilibria, High Energy Bonds & Compounds, ATP-ADP Cycle, Oxidation-reduction Reactions and Redox potential, chemosmotic theory for ATP Production, Metabolism: Introduction (Anabolism & catabolism),

Unit-II

Carbohydrate metabolism: Glycolysis, Fermentation, Citric acid cycle, Oxidative Phosphorylation and ETS, Gluconeogenesis, Glycogenesis and Glycogenolysis, HMP shunt, Glyoxylate pathway.

Unit-III

Lipid metabolism: Fatty acid degradation (beta, alpha, and omega degradation), degradation of odd chain fatty acids, Fatty acid synthesis, Regulation of fatty acid metabolism. Cholestrol Biosynthesis, Ketone Bodies formation and degradation

Unit-IV

Amino acid metabolism: Transamination, deamination, oxidative deamination, Amino acid degradation & Biosynthesis, Urea cycle and its regulation.

Unit-V

Nucleotide metabolism: Synthesis of purines & pyrimidines nucleotides, salvage pathway, nucleotide degradation, associated metabolic disorders. LeaschNayan Syndrome, SCID

Text / Reference Books

1. E E Conn, P K Stumpf, G Bruening and R Y; General Microbiology, 5th edition., 1987, John Wiley and Sons, New York
2. Jeffory Zubey; Principles of Biochemistry, 4th edition, (1997), McGraw-Hill College, USA
3. Jeremy M Berg, John L Tymoczko, and Lubert Stryer; Biochemistry, 5th edition, 2002.
4. Donald Voet, Judith G. Voet, Charlotte W. Pratt; Principles of Biochemistry, 5th Edition , 2018, Wiley.
5. David L. Nelson, Michael M. Cox; Lehninger's Principles of Biochemistry, 7th edition, 2017, WH Freeman.

BBI027B: Biological Molecules Lab II **Credit(s): 1**

1. To perform Quantitative estimation of carbohydrates by anthrone method
2. To perform acid value for given oil
3. To perform Quantitative estimation of RNA using Orcinol method
4. To perform Quantitative estimation of DNA using DPA method
5. To separate Amino acid using paper chromatography
6. To Determine saponification value of oil
7. To perform Quantitative estimation of Protein by Biuret method
8. To perform Quantitative estimation of Protein by Barford method
9. To perform Quantitative estimation of reducing sugar

Virtual Labs Link

S.No.	Course Name	Sources	Link

1	Biochemistry Virtual Lab I	Amrita Vishwa Vidyapeetham	http://biotech01.vlabs.ac.in/
2	Biochemistry Virtual Lab II	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/?sub=3&brch=64

B.Sc. Semester-II
Course-Genetics
Course Code-BBI028B
Lectures: 4 Hrs/week

UNIT 1	**Mendelian Principles and factor hypothesis**
UNIT 2	**Linkage and crossing over, chromosome maps, genes and genetic code**
UNIT 3	**Sex determination, sex linked and extra chromosomal inheritance**
UNIT 4	**Heteroploidy, chromosomal aberrations and mutations**
UNIT 5	**Human and Population Genetics**

Course outcome

CO-1 Students will describe and explain genetics, Mendel's experimental design, principles, gene linkage, and the role of genetic mechanisms in evolution. They will be able to explain and evaluate the principles of genetics, gene mapping, sex determination, chromosomal anomalies, study pedigrees, evolutionary and quantitative genetics, etc.

CO-2 Students will acquire knowledge to design, execute, and analyze the results of genetic experiments, recognize the experimental rationale of genetic studies, and evaluate conclusions based on genetic data. They will gain insight into the mathematical, statistical, and computational basis of genetic analyses.

CO-3 Students will apply communication skills required in the discipline, including oral presentations; publish articles, and poster presentations.

CO-4 Students will learn teamwork and leadership skills, including group analysis of data, working together in the laboratory, joint compositions of written reports, substantive participation in research group meetings, etc.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1		2		1	
CO2	2		3	2	3	3	1
CO3	1	3			1	2	
CO4	1	1	2	1	2		3

1-LOW, 2-MEDIUM, 3-HIGH

BBI028B: Genetics **Credit(s): 4**

Unit-I

Mendelian principles: Principle of segregation, monoclonal crosses, dominance, co dominance, lethal genes. Principle of independent assortment: dihybrid gene interactions, epistasis, multiple alleles. Interaction of Genes: Inter-allelic, Non-allelic interactions, Pleiotropic effect of genes

Unit-II

Linkage: linkage groups, history, arrangement of linked genes, complete and incomplete linkage; linkage and recombination in Neurospora. Crossing over: mechanism of crossing over, stages at which crossing over occurs, cytological basis of crossing over, frequency, types of crossing over Chromosome maps: chromosome mapping by two factor and three factor crosses, interference and coincidence. Genes: gene concept, molecular structure of gene, types of genes, functioning of gene. Genetic code: degeneracy and discovery of genetic code

Unit-III

Sex determination: Mechanism of sex determination: identification of sex chromosomes, chromosomal mechanism, genic balance theory of sex determination, hormonal and environmental factors in sex determination, Y chromosome and sex determination in mammals, Sex linked inheritance: discovery, sex linkage-drosophila, man, poultry and moths, types, sex limited and sex influenced genes. Extra-chromosomal inheritance: Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity

Unit-IV

Variation in chromosome number (Heteroploidy): euploidy and aneuploidy and other types of variations. Chromosomal Aberrations: change involving number of gene loci and arrangement of genes, Mutations: spontaneous and induced, substitution mutation, frame shift mutation, induced mutations in plants, animal and microbes for economic benefit of man

Unit-V

Human Genetics and Population Genetics: Human Karyotype, Pedigree analysis, chromosomal banding, turner syndrome, klinfiter syndrome, Down syndrome, patau syndrome, Edward syndrome, cat cry syndrome, barr body, Hardy-Weinberg frequencies

Text / Reference Books

1. Monroe W. Strickberger; Genetics, Macmillan international editions in science.

2. David Freifelder; Microbial Genetics, Jones and Barlett, 1987, The university of Michigan

BBI029B: Genetics Lab **Credit(s): 1**

1. To study the Mendel's law of inheritance
2. To analyze various chromosomal abnormalities
3. To perform the Karyotyping of normal and abnormal human cells
4. To perform the Pedigree analysis
5. To determine the Problems related to pedigree analysis (2)
6. To determine the Problems related to linkage
7. To analyze Barr body using methylene blue
8. Pedigree charts of diseases in families

Virtual Labs link

S. No.	Course Name	Source	Link
1.	Genetics Lab Tutorials I	Genetic Science Learning Center by Arthur Lakes Library Colorado School of Mines	https://learn.genetics.utah.edu/content/basics/
2.	Genetics Lab Tutorials II	Genetic Science Learning Center	https://learn.genetics.utah.edu/content/pigeons/
3.	Genetics Lab Tutorials III	Genetic Science Learning Center	https://learn.genetics.utah.edu/content/epigenetics/
4.	Genetics Lab Tutorials IV	Genetic Science Learning Center	https://learn.genetics.utah.edu/content/science/

B.Sc. Semester-II
Course-Analytical Techniques
Course Code-BBI030B
Lectures: 4 Hrs/week

UNIT 1	**Instruments, basic principle and usage**
UNIT 2	**Microscopy**
UNIT 3	**Basic principles of electrophoresis**
UNIT 4	**Chromatography**
UNIT 5	**Spectroscopic Techniques**

Course outcome

CO-1 Students will be able understand different analytical techniques for identification of biomolecules in Biotechnology
CO-2 Students will be able to describe and compare different types of chromatographic, electrophoresis and spectrometric techniques
CO-3 Students will be able to distinguish different separation techniques used for different molecules.
CO-4 Student will able to acquire skills to analyze the critical problems related to instruments used in biology

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	0	1
CO2	3	2	2	1	3	0	1
CO3	3	1	2	2	2	0	2
CO4	3	2	3	2	2	0	1

BBI030B: Analytical Techniques **Credit(s): 4**

Unit-I

Instruments, basic principle and usage: pH meter, Measurement of pH: Principles of glass and reference electrodes, types of electrodes, calibration of pH meter, Handerson equation, biological buffer.

Unit-II

Microscopy: Simple microscopy, Phase contrast microscopy and electron microscopy (TEM and SEM).Sedimentation-Sedimentation velocity, preparative and analytical ultracentrifugation techniques

Unit-III

Basic principles of electrophoresis: AGE and SDS-PAGE and their importance, Radioisotopic Techniques: Types of radioisotopes used in Biochemistry, units of radioactivity measurements, isotopes commonly used in biochemical studies – 32P, 35S, 14C and 3H), application of isotopes, Autoradiography: Biological hazards of radiation and safety measures in handling radioisotopes; Biological applications

Unit-IV

Chromatography: General principles and applications of – Adsorption chromatography, Ion-exchange chromatography, Thin-layer chromatography, Hydrophobic chromatography, Gas-liquid chromatography, HPLC, Affinity chromatography, Paper chromatography.

Unit-V

Spectroscopic Techniques: Beer-Lambert law, light absorption and its transmittance, determination and application of extinction coefficient, application of visible and UV spectroscopic, and its application, IR spectroscopy and their applications

Text / Reference Books

1. D.P. Khandelwal; Textbook of optics and atomic physics, Himalaya Publishing House.
2. S.B. Patel; Nuclear physics an introduction, 2nd Edition, New Age International Pvt Ltd
3. Vasantha Pattabhi and N. Gautham; Biophysics, 2nd edition , Narosa Publishing House.
3. B C Nakara, K K Choudhari; Instrumentation measurements and analysis, 2nd Edition,Tata McGraw Hill.
4. Raghbir Singh Khandpur; Handbook of analytical instruments , Tata McGraw Hill.
5. Arthur Beiser; Perspectives of modern physics, McGraw Hill.
6. Harvey Elliott White; Introduction to atomic spectra, McGraw Hill.
7. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. Molecular cell biology; New York: W. H. Freeman.
8. Cotrell; Biophysics, Eastern Economy Edition.
9. P. Narayanan; Clinical Biophysics –Principles and Techniques; 1st Edition, Bhalani Pub., Mumbai

BBI031B: Analytical Techniques Lab **Credit(s): 1**

1. To Calibrate the spectrophotometer
2. To perform Verification of Beer-Lambert Law
3. To calibrate pH meter without buffer solution
4. To prepare a solution of different Normality, molarity
5. To prepare primary and secondary standard solution
6. To convert secondary standard solution into primary standard solution
7. To determine the λ_{max} for DNA
8. To separate various molecule on the basis of their sedimentation coefficient

9. To separate Amino acid using paper chromatography
10. To separate Amino acid using thin layer chromatography
11. To separate the aliphatic and aromatic fraction of oil by column chromatography
12. To separate the DNA using agarose gel electrophoresis

Virtual Labs link

S. No.	Course Name	Source	Link
1.	Analytical Techniques Lab II	Labster.com	https://www.labster.com/try/

SEMESTER-III

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	3	BBI033B	Introductory Immunology	4	0	0	4	4	0	0	4	Core Course 7
2	3	BBI034B	Immunological Techniques Lab	0	0	2	2	0	0	1	1	
3	3	BBI035B	r-DNA technology	4	0	0	4	4	0	0	4	Core Course 8
4	3	BBI036B	Genetic Engineering Lab	0	0	2	2	0	0	1	1	
5	3		Department Elective 2	4	0	0	4	4	0	0	4	DE 2
6	3		Department Elective 2 Lab	0	0	2	2	0	0	1	1	
7	3	DCA004A	Advanced Spread Sheet Lab	0	0	2	2	0	0	1	1	
8	3	DEN003A	Life Skills1(Personality Development)	1	0	2	3	1	0	1	2	
9	3	DIN003A	Value Education and Ethics-1	1	0	0	1	1	0	0	1	
10	3	BBI091	Open Elective-I	3	0	0	3	3	0	0	3	

11	3	BBI037 A	Open Elective -II	3	0	0	3	3	0	0	3	
			Total	20	0	10	30	20	0	5	25	

B.Sc. Semester- III
Course-Introductory Immunology
Course Code-BBI033B
Lectures: 4 Hrs/week

UNIT 1	**Overview of Immune System**
UNIT 2	**Antigen and Antibody**
UNIT 3	**Antigen-Antibody Interaction and MHC**
UNIT 4	**Major Histocompatibility complex**
UNIT 5	**Vaccines**

Course outcome

CO-1 Students will demonstrate a basic concept of immunology at the cellular and molecular level, define central principles and concepts, outline, compare, contrast innate and adaptive immunity, and describe the different cell types and organs that make up the immune response.

CO-2 Students will illustrate various mechanisms that regulate immune responses and maintain tolerance; elucidate the genetic basis for immunological diversity and the generation of adaptive immune responses. They will outline key events and cellular players in antigen presentation and how the nature of the antigen will shape resulting effector responses and be able to apply basic techniques for identifying antigen-antibody interactions.

CO-3 Students will understand the principles governing vaccination and the mechanisms of protection against infectious diseases and will be able to elucidate the reasons for immunization and aware of different vaccination.

CO-4 Students will be able to communicate effectively in both oral and written formats, using appropriate vocabulary for immunology, response mechanisms, regulation, and genetic basis; apply scientific principles in interpreting responses and data; and understand immunology's roles in disease protection.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1	2			
CO2	3	1	2	3		1	
CO3	3	2	2	3			

CO4	3	3	3	2			

1-LOW, 2-MEDIUM, 3-HIGH

BBI033B: Introductory Immunology **Credit(s): 4**

Unit-I

Overviews of immune system: Historical perspectives. Types of immunity: Innate and acquired. Features of immune response: Memory, Specificity and recognition of self and non-self, Clonal nature of immune response; Hematopoiesis and differentiation; Cells andorgans of the immune system

Unit-II

Antigen: Immunogenicity v/s antigenicity, factors affecting immunogenicity, nature of immunogen, biological system, epitopes, haptens and antigenicity; Immunoglobulins: Structure of antibody, antibody mediated effector functions, antibody classes and biological activities; Monoclonal antibodies: Production and applications

Unit-III

Antigen-Antibody interactions: types: precipitation and agglutination reaction, radioimmunoassay, ELISA, chemiluminescence, ELISPOT assay, western blot, immune precipitation, immune fluorescence, flow cytometry and fluorescence.

Unit-IV

Major histocompatibility complex: General organization, MHC molecules: structure & genes, their mode of antigen presentation and interaction, cellular distribution of MHC, regulation of MHC expression and disease susceptibility. Complement system: Function, components, activation, regulation and deficiencies of complement.

Unit-V

Vaccines: Active and Passive Immunization Types of Vaccines – Inactivate Attenuated, Purified macromolecules and Recombinant-vector, DNA, Multivalent subunit Vaccines.

Text / Reference Books

1. Roitt I.M, Brostoff, J., Male D.K.; Immunology, Illustrated Publisher, Mosby.

2. T. J. Kindt, R.A. G. B. A. Osborne, J. Kuby; Immunology, W.H. Freeman and Company, New York.

3. Austyn, J.M., Wood, K.J; Principles of cellular and molecular immunology, 1993, Oxford University Press Inc. New York.

4. Paul, W.E; Fundamental immunology, Lippincott Williams & Wilkins.

5. Birch J.R., Lennox E.S; Monoclonal antibodies: Principles and applications, Wiley-Liss.

6. T.G. Parslow, D.P. Stites, A.I. Terr; Medical Immunology, Lange Medical Books/McGraw-Hill.

9. P.K. Gupta., Elements of Biotechnology, 1st Edition, 2001, Rastogi Publications.

BBI034B: Immunological Techniques Lab **Credit(s): 1**

1. To perform the Differential leucocytes count
2. To perform total leucocyte count
3. To perform the Total RBC count
4. To determine the Blood group
5. To perform RID
6. To perform Oucterlouny Double diffusion (ODD)
7. To perform Rocket Immuno-electrophoresis
8. To perform sandwich ELISA
9. To perform Dot ELISA.

Virtual Labs link

S. No.	Course Name	Source	Link
1.	Immunology Virtual Lab I	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/?sub=3&brch=69
2.	Immunology Virtual Lab II	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/?sub=3&brch=70

B.Sc. Semester-III
Course-r-DNA Technology
Course Code-BBI035B
Lectures: 4 Hrs/week

UNIT 1	**Expression of genes in prokaryotic and eukaryotic systems**
UNIT 2	**Tools used in r-DNA technique**
UNIT 3	**DNA sequencing**
UNIT 4	**Polymerase Chain Reaction**
UNIT 5	**Application of r-DNA Technology**

Course outcome

CO-1 Students will be able to explain term regulation, technical know-how on versatile tools and techniques in recombinant DNA technology.

CO-2 Students will be able to describe principle and technique of DNA sequencing.

CO-3 Students will be able to explain principle of PCR and site directed mutagenesis.

CO-4 Students will be able to acquire skills to understand application of genetic engineering techniques in basic and applied experimental biology.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	2	2	2
CO2	3	3	3	2	1	2	1
CO3	3	3	3	1	2	2	2
CO4	3	3	3	2	1	2	1

1 – LOW, 2- MEDIUM, 3-HIGH

BBI035B: r-DNA Technology **Credit(s): 4**

Unit-I

Expression of genes in prokaryotic and eukaryotic systems: Gene structure in prokaryotic and eukaryotic cells. Gene expression – concept of operon and related elements in the unit, regulatory and structural gene, post translational processing of mRNA, extra chromosomal DNA and its functions. Restriction endonuclease, Ribonucleases, taq DNA, SI nuclease, Alkaline phosphates, klenow enzyme, methyl transferase, restriction modification system

Unit-II

Preparation of desired gene by genomic DNA, from reverse transcriptase and by gene machine; Vectors: bacteriophages, cosmids, Triplasmids, yeast artificial chromosome, shuttle and binary vectors, DNA labeling radioactive and non-radioactive methods

Unit-III

DNA sequencing, Southern and Northern blotting in situ, DNA fingerprinting, Ligation method for gene transfer, Gene transfer technology cDNA and genomic DNA library, gene isolation and cloning, Selection of recombinants

Unit-IV

Polymerase chain reaction and site directed mutagenesis- Expression of cloned gene in recombinant cells, production of biochemicals with examples.

Unit-V

Application of rDNA technology Antisense and ribozyme technology, Human genome project and its application, Gene therapy prospect and future, DNA vaccine, Transgenic plants, Current production of rDNA products, Bio-safety measures and regulations for rDNA work.

Text / Reference Books

1. D.M. Glover; Genetic Engineering, Cloning DNA, Chapman and Hall, New York.

2. S. Mahesh and A.B. Vedamurthy; Biotechnology-4 (rDNA Technology, Environmental biotechnology, Animal cell culture), New Age publisher.

3. T. A. Brown; Genome 4, 4th Edition, Garland Science.

4. Sandy B. Primrose, Richard Twyman , Bob Old; Principles of Gene Manipulation: An Introduction to Genetic Engineering, 6th Edition, Wiley–Blackwell.

BBI036B: Genetic Engineering Lab **Credit(s): 1**

1. To Isolate the genomic DNA from bacteria
2. To perform Isolation of plasmid from bacteria
3. To perform Agarose gel electrophoresis for DNA separation
4. To perform Restriction Digestion DNA/plasmid
5. To perform DNA isolation from plant by CTAB method
6. To perform Ligation
7. To estimate DNA by DPA method
8. To determine the molecular weight of DNA
9. To estimate the amount of RNA by Orcinol method
10. To isolate DNA from Onion cell

SEMESTER-IV

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	4	BBI040B	Molecular Biology	4	0	0	4	4	0	0	4	Core Course 9
2	4	BBI041B	Molecular Biology Lab	0	0	2	2	0	0	1	1	
3	4	BBI042B	Plant Biotechnology	4	0	0	4	4	0	0	4	Core Course 10
4	4	BBI043B	Plant Biotechnology Lab	0	0	2	2	0	0	1	1	
5	4	BBI044B	Bioprocess Engineering and Technology	4	0	0	4	4	0	0	4	Core Course 11
6	4	BBI045B	Fermentation Technology Lab	0	0	2	2	0	0	1	1	
7	4	DCA005A	Python programming	2	0	0	2	2	0	0	2	
8	4	DCA006A	Python programming Lab	0	0	2	2	0	0	1	1	
9	4	DMA011A	Life Skills II (Aptitude)	1	0	2	3	1	0	1	2	
10	4	DIN004A	Value Education and Ethics-2	1	0	0	1	1	0	0	1	
11	4		Research Methodo	3	1	0	4	3	1	0	4	

			logy									
			Total	19	1	10	30	19	1	5	25	

B.Sc. Semester- IV
Subject- Molecular Biology
BBI040B
Lectures: 4Hrs/week

UNIT 1	**Nucleic Acids**
UNIT 2	**Transcription in prokaryotes and eukaryotes**
UNIT 3	**Translation in prokaryotes and eukaryotes**
UNIT 4	**Regulation of gene expression in prokaryotes**
UNIT 5	**Mutation**

Course outcome

CO-1 Students will be able to describe about structure of nucleic acid, replication process and mutation.
CO-2 Students will be able to learn the transcription in prokaryotes and eukaryotes.
CO-3 Students will be able to explains the translational process for prokaryotes and eukaryotes.
CO-4 Students will be able to analyze the regulation of gene expression in living organisms.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	1	2	2
CO2	3	3	3	2	1	1	1
CO3	3	3	3	1	2	1	1
CO4	3	3	3	2	1	2	1

1 – LOW ,2- MEDIUM , 3-HIGH

BBI040B: Molecular Biology **Credit(s): 4**

Unit-I

Nucleic Acids: as the genetic material, structure and aggregation of DNA and RNA, DNA double helix, different conformations of double helix, DNA super coiling, Denaturation and renaturation of DNA, C-value paradox, Cot value, chemical complexity; DNA replication:

Mechanism, Enzymes and accessory proteins involved, DNA damage, DNA mutagenesis and DNA repair (SOS and excision repair); Homologous recombination, site specific recombination and transposons.

Unit-II

Transcription in prokaryotes and eukaryotes: General and specific transcription factors, Regulatory elements and mechanism of transcription regulation, Modifications of RNA; Genetic code: deciphering the genetic code, nature of the code.

Unit-III

Translation in prokaryotes and eukaryotes: machinery- tRNA, Ribosomes, mRNA, aminoacyl-tRNA synthases and aminoacylation of tRNA; Mechanisms of initiation, elongation and termination, Regulation of translation, post translational modifications of proteins, protein localization, protein degradation.

Unit-IV

Regulation of gene expression in prokaryotes: lac, arabinose and trp operons - induction, repression and attenuation mechanism.

Unit-V

Mutation: Induced mutation, spontaneous mutation, frameshift mutation, point mutation, non sense mutations, site directed mutagenesis

Text / Reference Books

1. Glick, B.T and Pastermak J.J; Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.
2. Howe.C.; Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J.; Genetic Engineering, Academic Press Inc. Florida, USA.
5. Sambrook; Molecular Cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA
6. Walker J.M. and Gingold E.B.; Molecular Biology and Biotechnology, Indian Edition Royal Society of Chemistry, U.K.
7. Karp.G; Cell and Molecular Biology, 3rd Edition, John Wiley and Sons; INC.
8. P.K. Gupta; Cell and Molecular Biology, Rastogi Publishers, Meerut.
9. Bruce alberts; Molecular Biology of the Cell, 5th Edition, Garland Science, Taylor and Francis group.
10. Voet and Voet; Biochemistry, 2004, John Willey and Sons Inc.

12. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Inglis CSHLP; Molecular Biology of the Genes, 2007, Benjamin Cummings.
13. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, HiddePloegh, Paul Matsudaira; Molecular Cell Biology, 2007, Freeman & Co.

BBI041B: Molecular Biology Lab **Credit(s): 1**

1. To Isolate genomic DNA
2. To perform Gel electrophoresis
3. To perform SDS-PAGE
4. To perform Quantification of RNA
5. To perform Quantification of DNA
6. To perform transformation

Virtual Labs Link

S.No.	Course Name	Source	Link
1.	Molecular Biology Virtual Lab I	Amrita Vishwa Vidyapeetham	http://mbvi-au.vlabs.ac.in/
2.	Molecular Biology Virtual Lab II	Amrita Vishwa Vidyapeetham	https://mbvii-au.vlabs.ac.in/
3.	Biomedical and Signal Processing Laboratory	COEP, Pune	https://bmspcoep.vlabs.ac.in /List%20of%20experiments.html? domain=Biotechnology

B.Sc. Semester- IV
Subject- Plant Biotechnology
BBI042B
Lectures: 4Hrs/week

UNIT 1	**History and Aseptic techniques**
UNIT 2	**Tissue culture media, Cell and Suspension culture**
UNIT 3	**Protoplast technology**
UNIT 4	**Genetic Transformations**
UNIT 5	**Somo-clonal variation and micro-propagation; Conservation**

Course outcome

CO-1 Students will be able understand different plant tissue culture and sterilization techniques

CO-2 Students will be able to describe and compare different type's tissue culture media, cell and suspension cultures, genetic transformation and micro-propagation techniques

CO-3 Students will be able to distinguish different plant tissue culture techniques and able to grow callus

CO-4 Student will able to acquire skills to analyze the critical problems related to plant tissue culture

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	2	1	2
CO2	3	2	3	2	2	1	1
CO3	3	3	3	2	2	2	2
CO4	3	3	3	1	3	1	2

1 – LOW , 2- MEDIUM , 3-HIGH

BBI042B: Plant Biotechnology **Credit(s): 4**

Unit-I

History: Milestones in the history of plant tissue culture, Cellular totipotency: 'Explant' for plant tissue culture: Laboratory Requirements for plant tissue culture laboratory different work areas, equipments & instruments required, techniques, other requirements.

Aseptic techniques: Washing & preparation of glassware, packing & sterilization, media sterilization, surface sterilization, aseptic work station, precautions to maintain aseptic conditions;

Unit-II

Tissue Culture Media: Introduction, nutritional requirements of the explants, PGR's and their *in vitro* roles, media constituents, media selection, media preparation; Callus culture technique,

Micro propagation of medicinal plants found in Rajasthan

Cell and Suspension Culture: Introduction, principle, isolation of single cells, suspension cultures, culture of single cells, types, growth & growth measurement, synchronization,

Unit-III

Protoplast Technology: Protoplast isolation, culture and regeneration of cell wall, Somatic hybridization – Protoplast fusion techniques, selection of hybrids, production of symmetric & asymmetric hybrids & cybrid production. Application of protoplast culture

Unit-IV

Genetic transformations –*Agrobacterium* mediated transformations, direct DNA transfer methods – electroporation, microprojectile bombardment, and microinjection, use of marker genes, integration & expression of foreign DNA

Somatic embryogenesis, organogenesis, Haploid Plant Production: Anther, pollen, ovule and ovary culture, artificial seed, types, uses and advantages

Unit-V

Somaclonal variation and micropropagation Embryo rescue, embryo culture, Transgenic plant-Herbicide resistance plant, insect resistant plants, improving the quality of oils and fats, biodegradable plastic, Edible vaccine, Stress tolerance plants. Germplasm **Conservation:** Introduction, long-term storages, short or medium term storage, cryopreservation, Gene Bank

Text / Reference Books

1. John H. Dodds, Lorin W. Robert; Experiments in Plant Tissue Culture. Press syndicate of University of Cambridge.

2. S.S. Bhojwani and M.K. Razdan; Plant tissue Culture: Theory and Practice, 1996, Elsevier, Amsterdam.

3. H C Chawla; An Introduction to Plant Biotechnology, 2002, Oxford and IBH.

BBI043A: Plant Biotechnology Lab **Credit(s): 1**

1. To Prepare stock solution for M.S. media
2. To prepare and inoculate node and inter node
3. To culture callus
4. To perform suspension culture
5. To prepare media and inoculate shoot tip
6. To prepare media and inoculate root tip
7. To prepare media and inoculate anther
8. To Prepare the synthetic seeds
9. To perform Bergmann's cell plating technique for single cell culture
10. To determine the Composition of various plant tissue culture media
11. To Prepare stock solution for various growth hormones
12. To Prepare M.S. media for seed inoculation
13. To Inoculate seed in M.S. media for micro-propagation
14. **Preparation of Herbarium sheet using medicinal plants found in Rajasthan**

B.Sc. Semester- IV
Subject- Bioprocess Engineering and Technology
BBI044B
Lectures: 4 Hrs/week

UNIT 1	**Introduction to Bioprocessing techniques**
UNIT 2	**Microbial metabolism, selection and strain improvement**
UNIT 3	**Fermentation technology and upstream processing**
UNIT 4	**Downstream processing**
UNIT 5	**Enzyme technology**

Course outcome

CO-1 Students will use correct biological terms to describe and analyze phenomena/problems in bioprocesses, describe and explain the principles and processes involved in fermentation technology, investigate properties of microbes for product formation and their improvement.
CO-2 Students will analyze the characteristic of suitable media for product formation, formulation of media, selection of appropriate bioreactor models based upon bioproducts and cell lines, and other process criteria
CO-3 Students will be able to apply the concept in the field of industrial biotechnology and design a suitable scheme of bioproduct separations based upon the molecular characteristics of the product and other process criteria
CO-4 Students will be able to simplify the concepts and explain them through oral presentations

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3					1	
CO2	3		2		1	3	
CO3	3	2	2	2	3	1	
CO4	1	3					2

1-LOW, 2-MEDIUM, 3-HIGH

BBI044B: Bioprocess Engineering and Technology **Credit(s): 4**

Unit-I

Introduction, Objectives and Scope; Range of bioprocess, Basic principle components of

fermentation technology, Types of microbial culture–Batch, Fed batch and Continuous culture; Difference between Primary metabolite and secondary metabolites

Unit-II

Industrial microorganisms: selection of Microorganisms, industrial strains and strain improvement, strain stability, isolation and selection of microorganisms, production of stock culture.

Unit-III

Fermentation technology: definition, stages of fermentation, Inoculam development

Fermentation Media: formulation of medium, sterilization of medium,

Fermentation System: designing of bioreactors, Design of bioprocess vessels-Significance of Impeller, Baffles, Sparger; Introduction to oxygen requirement in bioprocess, mass transfer coefficient; factors affecting KLa, Bioprocess measurement andcontrol system with special reference to computer aided process control

Downstream processes: Cell harvesting, cell disruption, product recovery, Distillation, Finishing Steps

Unit-IV

Production of primary and secondary metabolites: -penicillin, tetracycline, ethanol, citric acid, single cell protein, Baker's Yeast, Xanthan Gum, Vitamins B12, Pigments (Shikonin)

Unit-V

Enzyme technology: enzyme versus catalyst, microbial production of enzyme, mechanisms of enzyme action, extraction and purification of enzymes, storage of enzyme, immobilization of enzyme, industrial application of microbial enzyme and production of industrial enzymes-glucose Isomerase, cellulase and lipases

Text / Reference Books

1. T.D. Brock; Biotechnology: A Text Book of Industrial Microbiology, 1990, Smaeur Associates.

2. L.E. Casida; Industrial Microbiology, 1989, Willey Eastern Ltd.

3. Prescott, Dunn; Industrial Microbiology, 1987, CBS Publishers.

4. Bioprocess Technology- fundamentals and applications, S O Enfors& L Hagstrom (1992), RIT, Stockholm.

5. E J. Dasilva, C Rutledge, A Sasson; Biotechnology, Economic & Social Aspects, Cambridge University Press, Cambridge.

6. W. Crueger and A. Crueger; Biotechnology - a handbook of industrial microbiology.

7. Channarayaappa; Microbial Biotechnology, 2003, University press, Hyderabad.

8. Gary Walsh; Protein: Biochemistry and Biotechnology, 2002, John Wiley & Sons Ltd.

9. S.N. Mukhopadhyay; Process Biotechnology Fundamentals, 2001, Viva Books Private Limited.

BBI045B: Fermentation Technology Lab **Credit(s): 1**

1. To perform Sauerkraut Production
2. To Prepare grape wine
3. To perform the Production of citric acid
4. To estimate the Production of citric acid by *Aspergilles niger*
5. To perform MBRT test
6. Primary screening for amylase producing potent microbial strain
7. To perform various biochemical tests (IMViC, Catalase, etc.)
8. Determination of bacterial growth by turbid metric method
9. Visit to a local Fermentation laboratory

SEMESTER-V

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	5	BBI047B	Proteomics and Genomics	4	0	0	4	4	0	0	4	Core Course 12
2	5	BBI048B	Bioinformatics Lab	0	0	2	2	0	0	1	1	
3	5		Department Elective-3	4	0	0	4	4	0	0	4	DE-3
4	5		Department Elective Lab-3	0	0	2	2	0	0	1	1	
5	5		Department Elective 4	4	0	0	4	4	0	0	4	DE-4
6	5		Department Elective Lab-4	0	0	2	2	0	0	1	1	
7	5	BBI092	Open Elective III	3	0	0	3	3	0	0	3	Inter-disciplinary
8	5	BBI071A	Project	0	0	12	12	0	0	6	6	Discipline specific
				15	0	18	33	15	0	9	24	

B.Sc Semester- V
Subject- Proteomics and Genomics
BBI048B
Lectures: 4Hrs/week

Course outcome

CO-1 Students will be able to understand the basics of Genomics
CO-2 Students will be able to illustrate different sequencing and mapping approach.
CO-3 Students will be able to explain the methods used for Proteome analysis
CO-4 Students will be able to describe application of genomics and proteomics

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	3	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	3	3	1	2	2	2

1-LOW, 2-MEDIUM, 3-HIGH

BBI047B: Genomics and Proteomics **Credit(s): 4**

Unit-I: Introduction to Genomics

Introduction: Genome, Genomics, Omics and importance, General features, Organization and structure of genomes, Genome size, Sequence complexity. Gene identification; gene prediction rules and software's; Genome databases; Annotation of genome. Genome diversity: taxonomy and significance of different model genomes.

Unit- II: Genome Sequencing and mapping

DNA sequencing methods – manual & automated, Next Generation Genome Sequencing Methods, Genome sequence assembly software, The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project, Genetic and Physical Mapping, Molecular Markers.

Unit-III: Introduction to Proteomics

Introduction to Proteomics – The Proteome, Mining proteomes, Bridging Genomics and Proteomics. Proteomics and the new biology. Protein structural genomics, determining gene function by sequence comparison and through conserved protein structure Global expression profiling – Introduction, traditional approaches to expression profiling.

Unit-IV: Analysis of Proteomes

Analysis of proteomes - Two-dimensional polyacrylamide gel electrophoresis, Mass spectrometry based methods for protein identification,2-DE gel electrophoresis coupled with mass spectrometry, Micro array techniques and advanced analytical techniques

Unit V: Applications of Genomics and Proteomics analysis

Analysis of Genomes – Human, Mouse, *Plasmodium falsiparum*, *Saccharomyces cerevisiae*, *Mycobacterium tuberculosis*. Application of proteome analysis- drug development and toxicology, Pharmaceutical Applications, Proteomics in drug Discovery in human, phage antibodies as tools, Proteomics in plant genetics and breeding.

Text / Reference Books

1. S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, 7 th Edition, Blackwell Publishing, 2006.
2. S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Plenum Publication, 1999.

REFERENCE/TEXT BOOKS

1. Andrezej K Konopka and James C. Crabbe, Compact Hand Book - Computational Biology, Marcel Dekker, USA, 2004.
2. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1 st edition, Academic Press, San Diego, 1996.
3- R. Amjesh and S.S. Vinodchandra, Bioinformatics for Beginners, Lambert Publisher, 2019.
4- Stephen Misener, Stephen A. Krawetz, Bioinformatics- Methods and Protocols, Humana Press, 2010

BBI048B: Bioinformatics Lab **Credit(s): 1**

1. To retrieve the sequence of the Human keratin protein from GenBank database and to interpret the results.
2. To retrieve the structure of a protein and viewing it in RASMOL viewer.
3. To find the similarity between sequences using BLAST
4. To find the similarity between sequences using FASTA
5. To align more than two sequences and find out the similarity between those sequences
6. To perform Sequence analysis
7. Detection of Open Reading Frames using ORF Finder
8. Software for Protein localization.

S. No.	Course Name	Source	Link
1.	Bioinformatics Virtual Lab I	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/index.php?sub=3&brch=273
2.	Bioinformatics Virtual Lab II	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/index.php?sub=3&brch=274

B.Sc. Semester-V
Course - Project
Course Code-BBI071A

BI071A: Project **Credit(s): 6**

Student has to undergo one month research training on any private or government institute on a chosen research topic decided by the advisor and has to prepare a report and a presentation.

Semester VI:

S. No.	Semester	Subject code	Subject	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits	Course Type
1	6		Department Elective 5	4	0	0	4	4	0	0	4	DE-5
2	6		Department Elective -5 Lab	0	0	2	2	0	0	1	1	
3	6		Department Elective 6	4	0	0	4	4	0	0	4	DE-6
4	6		Department Elective -6 Lab	0	0	2	2	0	0	1	1	
5	6		Department Elective 7	4	0	0	4	4	0	0	4	DE-7
6	6		Department Elective-7Lab	0	0	2	2	0	0	1	1	
7	6	BBI093	Open Elective-IV	3	0	0	3	3	0	0	3	Interdisciplinary
8	6	BBI094	Open Elective-V	3	0	0	3	3	0	0	3	Interdisciplinary
				18	0	6	24	18	0	3	21	

****Note: In 6th Semester Student have a Choice either he/she can go for offered Courses or he/she may avail Internship in some reputed Institute / Industry or in House Dissertation**

B.Sc. Biotechnology
Course – Department/Discipline Electives
Lectures: 4 Hrs/week

Track A: Industrial Biotechnology

Department Elective- 1A
Course Code: BBI100
Course Name: Fundamental of Industry Biotechnology

Course outcome
CO-1 Students will learn about bioprocessing techniques and explain techniques used for microbial culture for bioproduct formation
CO-2 Students will be able to analyse the process of development and recovery of bioproducts including primary and secondary metabolites as well enzymes
CO-3 Students will be apply the principles in the field of fermentation technology

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3			2		1	
CO2	2	1	2	1		2	3
CO3	1	2	3		2	2	

1-Low, 2-Medium, 3-High

Syllabus:

UNIT I. INTRODUCTION TO INDUSTRIAL BIOPROCESS
Fermentation – Definition, Process basic steps. Organisms involved in fermentation, applications. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheet – block diagrams, pictorial representation.

UNIT II. PRODUCTION OF PRIMARY METABOLITES
Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols.

UNIT III. PRODUCTION OF SECONDARY METABOLITES
Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

UNIT IV. PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS
Production of Industrial Enzymes, Bio-pesticides, Bio-fertilizers, Bio-preservatives, Biopolymers, Biodiesel. Cheese, Beer, SCP & Mushroom culture.

TEXT BOOKS

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.
2. Kumar, H.D. "A Textbook on Biotechnology" 2 nd Edition. Affiliated East West Press Pvt. Ltd., 1998. 3. Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt.Ltd., 2004.
4. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" 2 nd Edition Cambridge University Press, 2001.
5. Dubey, R.C. "A Textbook of Biotechnology" S.Chand & Co. Ltd., 2006.

REFERENCES

1. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.
2. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.
3. Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing, 2000. 4. Moo-Young, Murrey, "Comprehensive Biotechnology", 4 Vols. Pergamon Press, (An Imprint of Elsevier) 2004.
5. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 2 nd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
6. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999.
7. K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications.

Course Code: BBI101
Course Name: Industry Biotechnology Lab

1. Production of cheese
2. Production of wine
3. Mushroom cultivation

Department Elective- 2A
Course Code: BBI102
Course Name: Microbial Physiology
Lectures: 4 Hrs/week

UNIT 1	**Nutritional enzymes and bacterial genetics**
UNIT 2	**Energy Production and Metabolite Transport and Microbial metabolism**
UNIT 3	**Microbial nutrition and Photosynthesis and Inorganic Metabolism**
UNIT 4	**Nitrogen Metabolism**
UNIT 5	**Microbial Stress Responses and Host-parasite interactions**

Course outcome

CO-1 Students will be able to describe microbial enzymes and bacterial genetics.
CO-2 Students will be able to identify and explain energy production and metabolite transport in microbes and understand microbial metabolism.
CO-3 Students will be able to describe microbial nutrition, understand the process of microbial photosynthesis and inorganic metabolism

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3			2		1	
CO2	2	1	2	1		2	3
CO3	1	2	3		2	2	

1-Low, 2-Medium, 3-High

BBI102: **Microbial Physiology** **Credit(s):4**

Unit I

Bacterial Genetics: DNA exchange, Recombination, Mutagenesis and Repair-Transfer of Genetic Information in Prokaryotes, Plasmids-Plasmid Replication, Addiction Modules: Plasmid Maintenance by Host Killing: The ccd Genes; Conjugation-cis/trans complementation test, Conjugation and Pheromones in Enterococci, Conjugation, Cell–Cell Signaling, and Bacterial-Induced Tumors; Transformation-Gram-Positive and Gram-Negative Transformation, Transfection and Forced Competence; Transduction, Recombination-General Recombination, Genetics of Recombination, Restriction and Modification, Insertion Sequences and Transposable Elements, Mutagenesis, DNA Repair Systems

Unit II

Energy Production and Metabolite Transport: Energy Production-Substrate-Level Phosphorylation, Oxidative Phosphorylation, Measurement of PMF, Electron Transport Systems, Anaerobic Respiration, Conversion of PMF to Energy, Structure of F_1F_0 and the
ATP Operon, Energy Yield, Generating ATP in Alkalophiles, Energetics of Chemolithotrophs, pH Homeostasis; Metabolite Transport-Facilitated Diffusion, Mechanosensitive Channels,

Unit III

Microbial Nutrition: Nutritional categories of micro-organisms, Nutritional types (definition and example) - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria); Chemoorganotrophs, Nutritional classification of

microorganisms based on carbon, energy and electron sources, Chemolithotrophic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogen oxidizing bacteria and methanogens.

Unit IV

Nitrogen Metabolism: Biological Nitrogen Fixation, The Nitrogen Fixation Process-Components of the Nitrogenase System; Symbiotic Nitrogen Fixation; Inorganic Nitrogen Metabolism; Assimilation of Inorganic Nitrogen

Unit V

Microbial Stress Responses: Osmotic Stress and Osmoregulation-High Osmolality, Low Osmolality, Osmotic Control of Gene Expression; Aerobic to Anaerobic Transitions-Formate Nitrate Regulation, Nitrate Response, ArcAB System; Oxidative Stress-Regulation of the Oxidative Stress Response; pH Stress and Acid Tolerance; Thermal Stress and the Heat Shock Response; Nutrient Stress and the Starvation—Stress Response, Starvation—Stress Response, Stringent Control; Extremophiles

Text / Reference Books

1. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

2. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms.10th edition. Pearson/ Benjamin Cummings.

3. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.

4. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.

5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.

Course Code: BBI103

Course Name: Practicals of Microbial Physiology

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger* by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

Department Elective- 3A
Course Code: BBI104
Course Name: Microbial genetics and r-DNA technology
Lectures: 4 Hrs/week

Course Outcomes

CO-1 Students will improve the knowledge on genomic structure of microbe and various molecular tools used for genetic manipulation
CO-2 Students will utilize the knowledge for improving the products and production process in industries.
CO-3 Students will identify appropriate resources required for a project while observing safety and laboratory hygiene regulations and practices.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1		2		1	
CO2		2	2	1	1	2	
CO3			2		3	2	2

1-Low, 2-Medium, 3-High

UNIT I

Origin of Molecular Genetics-Structure of DNA-Mutations-Luria and Delbruck‟s Fluctuation Test-Spontaneous mutations-nonsense, missense, frame-shift mutations-Induced mutagenesis-Physical agents-UV,X-Rays-Chemical agents-NTG, Base Analogues etc., Reversion-AMES Test-DNA Replication-Messelson and Stahl‟s Experiment-Okazaki‟s fragment-DNA polymerases-DNA damage-SOS response-DNA repair.

UNIT II

Gene transfer in bacteria-Transformation-discovery and its significance-competence and factors involved-joint transformation and its uses-Conjugation-F+ and Fnature of E.coli Origin of Hfr and F‟ strains-Zygotic induction -Chromosome transfer by Hfr - circular nature of E.coli DNA - Use of Hfr strains in genetic mapping-Transduction - λ phage and specialized transduction -

UNIT III

Elucidation of genetic code- Benzer, Khorana and Crick‟s contributions-Triplet nature of the Genetic code and Adaptor hypothesis-Wobble hypothesis- Bacterial translation, Suppression of nonsense, missense and frame-shift mutations-Intragenic and extragenic suppressions of mutations-modern aspects-structure and function relationship

UNIT IV

Birth of r-DNA technology- Agarose Gel electrophoresis and its principle-Restriction enzymes and their role in r-DNA technology-Restriction-modification system of E.coli-Types of restriction enzymes - Plasmid vectors as cloning vehicles-Vectors for protein over expression, protein secretion and controlled expression

TEXT BOOKS

1. Principles of Gene Manipulation and Genomics-S.B.Primrose and R.M.Twyman, 2006.John Wiley & Sons Ltd.
2. Molecular Genetics: An introductory narrative, Second Edition - Gunther.S.Stent and Richard Calendar,2002. CBS Publishers and distributors.

REFERENCE BOOKS

1. A Short Course in Bacterial Genetics: A Laboratory Manual and Handbook for Escherichia coli and Related Bacteria- Jeffrey. H. Miller,1992.CSHL Press.
2. Fundamental Bacterial Genetics - Nancy Trun and Janine Trempy, 2004. Blackwell publishing
3. From Genes to Genomes: Concepts and Applications of DNA Technology, Second Edition- Jeremy.W.Dale and Malcolm Von Schantz, 2007. John Wiley & Sons Ltd.

Course Code: BBI105

Course Name: Microbial genetics Lab

1. Identification of food pathogen
2. Isolation of pathogen from patient
3. Haemolytic testing of bacteria
4. Differential test of Staphylococci through growth on agar plates (Mannitol agar, DNA agar plate and Coagulase test method)

Department Elective- 4A

Course Code: BBI106

Course Name: Pharmaceutical Chemistry

Lectures: 4 Hrs/week

Course Outcomes

CO-1 Students will encode information on drug designing, drug discovery and drug metabolism.
CO-2 Students will know the actual path of metabolism of drugs and drug discovery.
CO-3 Students will gain information that will help the students to formulate novel drugs.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	2	2	1	1	
CO2	3	1	2	2			
CO3	3			1	1	1	

1-Low, 2-Medium, 3-High

Syllabus

UNIT I

Introduction to Pharmaceuticals : Routes of drug administration, Pharmacokinetics: Absorbtion, Distribution, Metabolism- Oxidation, reduction, hydrolysis, conjugation and Elimination,

absorption enhancement / solubility factor/ bioavailability; Pharmacodynamics; Assay systems and models (e.g., Knock-out Mice); Inter species scaling.

UNIT II

Drug discovery: Need for developing new drugs: Substances derived from bacteria, plants, insects, and animals; Sources of active principles; Combinatorial Synthesis: Chemistry, Biology, and Biotechnology.

UNIT III

Drug designing: Procedure followed in drug design; Molecular modification of lead compounds and proteins; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR; Active site determination of enzymes; Design of enzyme inhibitors; Protein molecular modeling by computer: Docking studies; Structure based drug designing using software.

UNIT IV

Pharmaceutical products: Microbial products - Antibiotics (penicillin, streptomycin, tetracycline), vitamins, probiotics. Plant secondary metabolites -alkaloids, flavanoids, steroids, terpenoids. Animal vaccines. Clinical trials.

TEXT BOOKS

1. Daan Crommelin, Robert D Sindelar, "Pharmaceutical Biotechnology", Tailor andFrancis Publications, New york, 2002.
2. Remington‟s Pharamaceutial sciences, 18th edtion, Mack publishing & Co., Easton, PA (20th Ed, 2000).

REFERENCE

1. Heinrich Klefenz, "Industrial Pharmaceutical Biotechnology", WILEY-VCH Publication, Germany, 2002.
2. Jay P Rho, Stan G Louie, "Hand book of Pharmaceutical Biotechnology", Pharmaceutical products press, New York, 2003.
3. Lachman L Lieberman, HA, Kanig, J, "Theory and practice of industrial pharmacy", 3rd edition, Varghese publishing & Co, New Delhi, 1986.

Course Code: BBI107

Course Name: Pharmaceutical Chemistry Lab

1. Identification of food pathogen
2. Isolation of pathogen from patient
3. Haemolytic testing of bacteria
4. Differential test of Staphylococci through growth on agar plates (Mannitol agar, DNA agar plate and Coagulase test method).

Department Elective- 5A
Course Code: BBI108
Course Name: Bioprocess Engineering
Lectures: 4 Hrs/week

Course Outcomes

CO-1 Students will discuss fermenter design and its types and kinetics involved in the fermentation processes to manipulate for improvement.
CO-2 Students will illustrate the application of bioprocess engineering for development of improvised products.
CO-3 Students will be able to transmit complex technical information related to bioprocess engineering in a clear and concise manner in writing to in a simple language for better understanding.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3		1	1			
CO2	2	2	2	1	1	2	2
CO3	1	3				1	

1-Low, 2-Medium, 3-High

Syllabus

UNIT I

Types and design of bioreactor: Fermentor structure - Construction material, Basic components – Agitator, aerator, valves and steam traps, seals, stirrer glands. Measurement and control of parameters (on-line and off line sensors) – temperature, flow rate, pressure, pH, DO, gas analysis, computer control pathways. Fermentors - Air-lift, stirred tank, tower, fluidized bed, packed bed, pulsed, photo bioreactors

UNIT II

Process kinetics: Kinetics - batch, fed-batch and continuous process; Sterilization methods - batch sterilization, continuous sterilization of medium and air. Solid state and submerged; aerobic and anaerobic fermentation. Inoculum development – Development of inocula for yeast, bacterial, mycelial and vegetative fungal processes. Immobilization - immobilization of cells and co-immobilization; Transport phenomena - Mass transfer, heat transfer, oxygen transfer.

UNIT III

Downstream processing: Removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization. Quality analysis and product formulation -.

UNIT IV Application of transgenic plants for Stress tolerance: Herbicide resistance: phosphoinothricin and glyphosate; Insect resistance: Bt genes and alpha amylase inhibitor.

Disease resistance: chitinase and 1,3-beta glucanase; Virus resistance: coat protein mediated, nucleocapsid gene; Nematode resistanc;. Abiotic stress: Drought, cold and salt;

TEXT BOOKS

1. Fundamentals of Bioanalytical Techniques and Instrumentation, Ghosal and Srivastava, PHI Learning Pvt. Ltd., 2009.
2. Principles of Fermentation technology, Stanbury PF and Whitaker A. Pergamon Press, 1984.
3. Introduction to Biochemical Engineering, D.G.Rao, Tata McGraw Hill Publishers, 2005.
4. Bioprocess Engineering: Basic Concepts, 2nd edition, Shuler,M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs, 2001
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA. Bernard R. Glick and Jack J. Pasternak. ASM Press. 2010.
6. Plants, genes and agriculture by M.J. Chrispeels and D.F. Sadava.2000.The American Scientific Publishers, USA.
7. Biotechnoloical innovations in Animal productivity, BIOTOL Series, Butterworth – Heineman Ltd. Oxford, 1992

REFERENCES

1. Practical Application of Plant Molecular Biology by R.J. Henry.1997. Chapmans and Hall.
2. Plant Biotechnology and Transgenic Plants, Edited by Kirsi-Marja Oksman- Caldentey and Wolfgang H. Barz. 2002, Marcel Dekker, Inc. New York.
3. Plant Biotechnology (The genetic manipulation of plants) by Adrian Slater, Nigel W. Scott and Mark R. Fowler, 2003, Oxford University press, UK.
4. Molecular Plant Biology: A practical approach (Vol. I and II), Edited by Gilmartin and Bowler, 2002, Oxford University press, UK.
5. Instrumentation, measurement and analysis, II edition, Nakra BC and Chaudhry KK, Tata McGrawHill Publishing Co. Ltd., New Delhi, 2004
6. Fermentation Microbiology and Biotechnology , Mansi El-Mansi and Charlie Bryce, Taylor and Francis Ltd., 2002.
7. Manual of Industrial Microbiology and Biotechnology, III edition, Arnold L. Demain and Julian Davies, ASM press, Washington DC, 1999.

Course Code: BBI109

Course Name: Bioprocess Engineering Lab

1. Production of cheese
2. Production of wine
3. Mushroom cultivation
4. Colourant production

Department Elective- 6A
Course Code: BBI110
Course Name: Enzyme technology and Biotransformation
Lectures: 4 Hrs/week

Course Outcomes

CO-1 Students will describe and discuss enzymes, mode of action, illustrate principles of catalysis, kinetics of enzymes and their regulation.
CO-2 Students will explain the methods of enzyme purification, immobilization of enzymes and discuss the use of enzymes in industry.
CO-3 Students will able to employ critical thinking and efficient problem solving skills how enzymes and their potential can be harnessed for development of enzymatic assays.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2			
CO2	3	2		2		1	
CO3		1	3		1	2	1

1-Low, 2-Medium, 3-High

Syllabus

UNIT I. Introduction to enzymes

Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

UNIT II. Kinetics of enzyme action

Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions- mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod Changeux Wyman model, pH and temperature effect on enzymes & deactivation kinetics

UNIT III. Enzyme Immobilization And Biosensors

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages, design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

UNIT IV. Purification And Characterization Of Enzymes From Natural Sources

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays

REFERENCES

1. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.
2. James M. Lee, Biochemical Engineering, PHI, USA.
3. James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
4. Wiseman, Enzyme Biotechnology, Ellis Horwood Pub.

TEXT BOOKS

1. Trevor Palmer , Enzymes II ed Horwood Publishing Ltd
2. Faber K , Biotransformations in Organic Chemistry, IV edition , Springer

Course Code: BBI111

Course Name: Enzyme technology Lab

1. Production of cheese
2. Production of wine
3. Mushroom cultivation
4. Colorant production
5. Identification of food pathogen

Department Elective- 7A

Course Code: BBI112

Course Name: Industrial Manufacturing

Lectures: 4 Hrs/week

Course Outcomes

CO-1 Students will discuss industrial structure how raw materials are collected, how R&D is done and quality is assured, certifications are done.
CO-2 Students will explain how process is designed and validation of the design is done.
CO-3 Students will able to employ critical thinking and efficient problem solving skills by studying cases.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2		2			
CO2	3		2		2	1	
CO3	2	1	3	2	1		1

1-Low, 2-Medium, 3-High

Syllabus

Unit-I

Industrial Structure: Administrative department, Raw material department – collection of raw material, types of raw material, problems in collection of raw material, preservatives used in raw

material collections, R&D department, Quality control, Quality Assurance, Logistic, Supply chain management, Store & procurement department, Block diagram, Pictorial Representation.

Unit-II

Awareness of ISO system applicable for R&D department: Awareness of ISO 13485:2016 and ISO 9001:2015, Different clauses – applicable for R&D system, planning, Design input (DIP), Design output (DOP), Method of analysis, Batch Manufacturing Record, Master Formula Record, Review, Risk analysis, Verification, Validation, Design Transfer, Design and Development File, Design closure. **Studies of ISO certified company dealing with environment waste management in Rajasthan.**

Unit-III

Case Study-I (Manufacturing of cord blood protein marker: AFP): Alpha Feto Protein, Introduction, Biochemical properties, Functions, Applications, Laboratory setup for manufacturing of AFP, Raw material (RM), RM screening, DIP and DOP of AFP, Applicable method of manufacturing process, Yield profile

Unit-IV

Case Study-II (Manufacturing of Serum/Plasma protein: IgG-FC): FC fragment of Human Immunoglobulin-G (IgG), Introduction, Biochemical properties, Functions, Applications, Laboratory setup for manufacturing of IgG and IgG-FC, Raw material (RM), RM screening, DIP and DOP of IgG-FC, Applicable method of manufacturing process, Yield profile.

Text / Reference Books

[1] Shuler, Michael L. and Fikret Kargi, " Bioprocess Engineering ", Prentice Hall, 1992.

[2] Lydersen, Bjorn K. "Bioprocess Engineering Systems, Equipment and Facilities" John Wiley, 1994.

[3] Belter, P.A. E.L. Cussler And Wei-Houhu – "Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).

[4] Sivasankar, B. "Bioseparations : Principles and Techniques". PHI, 2005.

[5] R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).

[6] J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.

[7] R.K. Scopes – Protein Purification – Principles And Practice, Narosa Pub. (1994).

[8] Itay Abuhav - ISO 9001: 2015 - A Complete Guide to Quality Management Systems, CRC Press (Taylor & Francis Group) 2017.

[9] Itay Abuhav - ISO 13485:2016, A Complete Guide to Quality Management in the Medical Device Industry, Second Edition, CRC Press (Taylor & Francis Group) 2018

Course Code: BBI113
Course Name: Industrial Manufacturing Lab

1. Production of cheese
2. Production of wine
3. Mushroom cultivation
4. Colorant production
5. Identification of food pathogen

Track B: Agricultural Biotechnology

Department Elective- 1B
Course Code: BBI114
Course Name: Advances in Agriculture Biotechnology

Course outcome

CO-1 Students will be able to understand the basics and important tools in agricultural biotechnology.
CO-2 Students will be able to illustrate different gene transfer methods for plant.
CO-3 Students will be able to explain different blotting techniques
CO-4 Students will be able to describe different techniques used in agricultural biotechnology

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	3	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	3	3	1	2	2	2

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1

Introduction Definition, Classical vs modern biotechnology, Basic concepts and history of biotechnology, Different branches of biotechnology, Modern Biotechnology application in agriculture, Tools of Genetic Engineering: Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. Cloning Vectors: Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors, virus based vectors,

Unit 2

Methods of gene transfer: Transformation, transduction, Particle gun, Electroporation, liposome mediated, microinjection, Agro-bacterium mediated gene transfer, Preparation and application of molecular probes: DNA probes, RNA probes, Radioactive labeling, Non-radioactive labeling, use of molecular probes, DNA fingerprinting, Analysis and expression of cloned gene in host cells: Expression vectors

Unit 3

Restriction enzyme analysis, Southern blotting, Northern blotting, Western blotting, In-situ hybridization, Colony and plaque hybridization, Factors affecting expression of cloned genes, Reporter genes, Fusion proteins, Gene libraries - cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries, Identifying the products of cDNA clones, Isolation, Sequencing and synthesis of gene

Unit 4

Different methods of gene isolation, Techniques of DNA sequencing, Artificial DNA synthesis, Polymerase Chain reaction (PCR): Basic principles, modifications, applications, Modifying Genes: Site-directed mutagenesis, Insertion & Deletion Mutagenesis.

Course Code: BBI115
Course Name: Agriculture Biotechnology Lab

1. Isolation of DNA from Plant sample and bacteria
2. Isolation of RNA from plant sample
3. Restriction analysis of the plant DNA and bacterial DNA
4. Separation of DNA by Gel Electrophoresis methods
5. Application of Polymerase Chain reaction
6. Genetic transformation through Agro-bacterium

Reference Books

1. Biotechnology Vol I and VII by Rehm HJ and Reed G 1997. Verlg Chemic Weinheim, USA.
2. Elements of Biotechnology by Gupta PK 1999. Rastogi Publi cation, Meerut, India.
3. Biotechnology by Singh BD. Kalyani publishers, New Delhi.
4. Introduction to Plant Biotechnology by H.S. Chawala, 2002, Oxford IBH

Department Elective- 2B
Course Code: BBI116
Course Name: Agriculture Microbiology

Course outcome

CO-1 Students will be able to understand the basics agricultural microbiology
CO-2 Students will be able to illustrate different type of metabolism in bacteria
CO-3 Students will be able to explain soil microflora useful for crops
CO-4 Students will be able to evaluate the uses of different types of biofertilizer

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	3	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	3	3	1	2	2	2

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1
History of Microbiology: Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, Protection against infections, Applied areas of Microbiology

Unit 2
Metabolism in bacteria: ATP generation, chemoautotrophy, photo autotrophy, respiration, fermentation. Bacteriophages: structure and properties of Bacterial viruses – Lytic and Lysogenic cycles: viroids, prions.

Unit 3
Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of Rhizosphere and Phyllosphere microflora, microbes in composting. Microbiology of food: microbial spoilage and principles of food preservation.

Unit 4
Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases, Biodegradation, Biogas production, Biodegradable plastics, Plant – Microbe interactions.

Course Code: BBI117
Course Name: Agricultural Microbiology Lab

1- Familiarization with instruments, materials, glassware etc. in a microbiology laboratory
2- Methods of Sterilization and Preparation of media
3- Plating methods for Isolation and Purification of bacteria
4- Morphological examination of bacteria by Simple and Differential staining
5- Different biochemical tests for identification of bacterial culture

Reference Books

1. Agricultural Microbiology. 1998. G. Rangaswani and D.J. Bagyraj. Prentice Hall of India. , New Delhi.
2. An Int roduction to Microbiology. 1996. P. Tauro, K.K. Kapoor and K.S. Yadav. Wiley Eastern Ltd. , New Delhi.
3. Mi crobiology, 1986. M. J.Pelczar, E.C.S. Chan and N.L. Krieg. Mc Graw Hill 5th Edition, New York, USA.
4. Soil microorganisms and plant growth. 1977. N. S. . Subbarao Oxford & IBH Publ. Co. , New Delhi.

Department Elective- 3B
Course Code: BBI118
Course Name: Molecular Plant Breeding

Course outcome

CO-1 Students will be able to understand the basics of molecular plant breeding
CO-2 Students will be able to illustrate different type of pollination in crops
CO-3 Students will be able to explain Heterosis in crops
CO-4 Students will be able to evaluate different type of seed production

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	3	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	3	3	1	2	2	2

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1

Historical milestones in plant breeding, Aims and objectives of plant breeding Significance of plant breeding in crop development.

Unit 2

Various methods of plant breeding in self and cross pollinated crops, acclimatization, selection, pure line theory, Reproductive systems of plants, Flora biology, flower parts, Self and cross pollinated crops. Genetic consequences and differences between self and cross pollinated crops

Unit 3

Clonal selection, population improvement program, Heterosis, Genetics and physiological basis. Male sterility Types of male sterility combining ability-general and specific, its exploitation. Interspecific/ Intergeneric hybridization, Heterosis inbreeding depression, Polyploidy its types

Unit 4

Mutation breeding Gene actions, heritability, genotype and environmental interactions, its importance in plant breeding, Introduction to seed production (Nucleus, breeder, foundation , certified), Maintenance of genetic purity during seed production, Molecular markers and their application

Course Code: BBI119

Course Name: Molecular Plant Breeding Lab

1- Floral morphology of important crops
2- Emasculation-pollination techniques in self and cross pollinated crops
3- Pollen viability test through chemical tests
4- Hybridization study of male sterility and incompatibility in field

Reference books:

1. Principles of Plant Breeding by Allard R W 1960 .Kalyani Publishers, New Del hi
2. Principles of Plant Breeding by Singh B.D 1983 .Kalyani Publishers, New Delhi.
3. Principles of Genetics by Gardner E.J, M.J Simons and D. P Sanstad 1991.John Wiley and Sons Inc New York.
4. Plant Breeding by Lamkey and Lee 2006, Panima, N. Delhi.
5. Breeding Field Crops by Sleper and Poehlman 2007, Panima N. Delhi.

Department Elective- 4B

Course Code: BBI120

Course Name: Principles of Plant Physiology

Course outcome

CO-1 Students will be able to understand the basics of different plant-water relations and nutrition
CO-2 Students will be able to discuss the Photosynthesis and their role in crop productivity
CO-3 Students will be able to explain different plant hormones

CO-4 Students will be able to evaluate different stress related resistant mechanism in plants

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	3	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	3	3	1	2	2	2

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1

Definition, scope and introduction in agriculture, Osmosis, DPD, TP. Water absorption by plants; Ascent of sap. Transpiration-Mechanism, factors affecting it, Structure and function of stomata. Osmotic pressure, guttation. Plant Nutrition: Major and minor nutrients; their roles and deficiency symptom; Active and passive mineral uptake mechanisms.

Unit 2

Photosynthesis Structure and function of chloroplast; Light and dark reactions; Cyclic and non-cyclic electron transfer; C3, C4, Crassulacean acid metabolism and photorespiration.

Unit 3

Respiration types; R.Q. Hormones: types and role in agriculture biotechnology. Growth phases, photoperiodism, and vernalization.

Unit 4

Stress physiology (Drought, heat, frost and salinity); mechanism of resistance to above types. Physiological aspects and problems of cereals, pulses, oilseeds, cotton and sugarcane.

Course Code: BBI121
Course Name: Plant Physiology Lab

1- 1Plasmolytic method of cell sap determination.
2- Effect of osmotic pressure on rate of imbibition
3- Determination of dry matter content in leaves, stem and roots
4- Determination of transpiration by photometric---and cobalt chloride paper method.
5- Study of deficiency symptoms of major and minor plant nutrients

Reference Books:

1. A Text Book Plant Physiology by Verma V 1973 M.K publication house New Delhi
2. An Introduction to Plant Physiology of Field Crops by Shivraj A 1978 Oxford and I.B.H

publishing Co-operative PVT Ltd , New Delhi
3. Plant Physiologists by Pande S.N and Sinha B.K 1978 Vikas publishing house New Delhi.
4. Practical Plant Physiology by Amar Singh 1982 Kalyani publisher New Delhi
5. Useful techniques for plant scientist by Dhopte A.N and Levra N 1989 Publication of forum of plant physiologist Akola
6. Plant Physiology by Salisbury F and C. Ross 1990, Prentice Hall of India New Del hi

Department Elective- 5B
Course Code: BBI122
Course Name: Biotechnology for Biotic and Abiotic Stress Tolerance

Course outcome

CO-1 Students will be able to understand the different types of biotic and abiotic stress in plants
CO-2 Students will be able to discuss the different types of proteins in plant stress response
CO-3 Students will be able to explain different biotic stresses in plants
CO-4 Students will be able to evaluate different abiotic stresses in plants

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	3	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	3	3	1	2	2	2

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1

Prospects & Perspective of Biotic & abiotic stress resistant plants, Genetics of host-pathogen interactions, Mechanism of plant resistance. Role of jasmonates and salicylic acid in systematic resistance induction on wounding.

Unit 2

Insect pest resistance – Structural/morphological changes; Protease and amylase inhibitors; polyphenol oxidases; peroxidases; lectins; chitinase; seed proteins; their limitations and significance in multi-gene pyramiding. Vertical and Horizontal resistance to pathogens, Hypersensitive host response (HRGP) and apoptosis in relation to plant defense.

Unit 3

Virulence- Avirulence in host–pathogens interaction. Race specific Resistance Gene Analogues (RGAs). Pathogenesis related proteins – groups with examples (Glucanases; chitinases; osmotin,

chitin binding proteins; thaumatin like proteins; micro peptidal defensins; phytoallexins) and their role. Role of Phenylalanine ammonia lyase, callose synthases, detoxification for pathogen resistance.

Unit 4

Biochemical basis of abiotic stresses namely osmot ic (drought, salinit y), temperature, heavy metals, air and water pollutants, synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation. Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system. Role of calcium, nitric oxide and salicylic acid in plant development. Molecular strategies for imparting tolerance against biotic and abiotic stress.

Course Code: BBI123
Course Name: Plant Stress Lab

1. 1Meristem culture for virus elimination
2. Screening toxins and culture filtrate of fungi and bacteria for in vitro screening of host resistance
3. Agro-bacterium-mediated transformation protocol and selection of transformed regenerated plants
4. Determination of osmotic potential by vapour pressure and freezing point depression

Reference Books:

1. Basra AS. 1997. Stress Induced Gene Expression in Plants. Harwood Academi c Publ.
2. Chessin M, DeBorde D & Zipf A. 1995. Antiviral Proteins in Higher Plants. CRC Press.
3. Crute IR, Burdon JJ & Holub EB. (Eds.). 1997. Gene-for-Gene Relationship in Host Parasite Interactions. CABI.
4. Hopkins WG & Huner NPA. 2004. Introduction to Plant Physiology. John Wiley & Sons.
5. Salisbury FB & Ross C. 1992. Plant Physiology. 4t h Ed. Wadsworth Publ. Taiz L & Zeiger E. 2006. Pl ant Physiology. 4th Ed. Sinauer Associates.
6. Kosuge T & Nester EW. 1989. Plant-Microbe Interactions: Molecular and Genetic Perspectives. Vols I-IV. McGraw Hill.
7. Verma DPS & Kohn TH. 1984. Genes Involved in Microbe-Plant Interactions. Springer Verlag.
8. Molecular Plant-Microbe Interactions. Journal Published by APS.

Department Elective- 6B
Course Code: BBI124
Course Name: Biodiversity Conservation

Course outcome

CO-1 Students will be able to understand the basics of diversity and their importance for crops
CO-2 Students will be able to discuss the different types of Biodiversity centres of origin
CO-3 Students will be able to explain different factors for extinction of biodiversity
CO-4 Students will be able to evaluate various biodiversity conservation method

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	3	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	3	3	1	2	2	2

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1
Definition, Historical and geographical causes of diversity, Types of diversity- Genetic, Species and population diversity. Distribution of diversity in life forms.

Unit 2
Ecological diversity and stability. Biodiversity and centers of origins of plant. Hot spots in India. Principles of conservation biology. Biosphere concept, Genetical and evolutionary principles of conservation. Collection Maintenance and conservation of biodiversity.

Unit 3
Assessing and documenting of vulnerability and extinction of biodiversity; red list categories as per IUCN (International Union for the Conservation of Nature and Natural resources): Extinct, Extinct in the wild, Critically Endangered, Endangered, Vulnerable, Lower risk, Data deficient and Non Evaluated.

Unit 4
Bio- village concept: in situ and ex situ conservation. Community level Gene banks, Utilization of biodiversity. Global biodiversity system. Intellectual Property Rights and legal concerns of Bio-resources. Biodiversity and human welfare

Course Code: BBI125
Course Name: Biodiversity Conservation Lab

1. Collection of ITK (Flora) Study of species composition in surrounding areas
2. Morphological description of plant parts
3. Collection of seeds of rare species of forest and medicinal plants
4. List of important medicinal plants used in healthcare

Reference Books:

1. Biodiversity Utilization and conservation by Arunachalam,2008,Avishkar,Jaipur
2. Biodiversity conservation and legal aspects by Kandya,2007, Avishkar, Jaipur
3. Biodiversity conservation by Kumar M.S.2008
4. Biodiversity conservation and systematics by P. Singh, 2007

Department Elective- 7B
Course Code: BBI126
Course Name: Techniques in Biochemistry and Molecular Biology

Course outcome

CO-1 Students will be able to understand the need for molecular techniques for research in biotechnology
CO-2 Students will be able to discuss the different centrifugation and chromatographic techniques
CO-3 Students will be able to explain the electrophoresis and blotting techniques
CO-4 Students will be able to evaluate various molecular biology techniques

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	3	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	3	3	1	2	2	2

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1

General principles of biochemical investigations. Units in biochemistry and molecular biology. Principle methods of separation of biomolecules.

Unit 2

Centrifugation techniques – Basic principles, analytical and preparative centrifugation, their applications. Spectrophotometry: UV-visible spectrophotometer, fluorimetry. Chromatographic techniques – Basic principles, types adsorption, partition, ion exchange, molecular sieve, affinity, GLC and HPLC and mass spectrometry, flow cytometry and its application in DNA estimation.

Unit 3

Electrophoresis: theory and different types – PAGE, SDS-PAGE, capillary electrophoresis, and IEF. Radioisotope techniques: Nature, detection and measurement of radioactivity. Molecular biology techniques – Southern hybridization, northern hybridization, western blotting, microarray technology, complementation techniques.

Unit 4

Polymerase chain reaction (PCR); radioactive/ nonradioactive labeling, RFLP, AFLP, RAPD; RT-PCR and DNA sequencing.

Course Code: BBI127
Course Name: Molecular Biology Lab

11. Extraction of DNA from seeds of cereal, legume and oilseed plant material
2. Concentration of the proteins using ammonium sulfate precipitation, dry sephadex, dialysis, ultra filtration, and organic polymers.
3. Separation of the proteins by native – and SDS - PAGE
4. Separation and identification of amino acids by paper chromatography.
5. Restriction digestion of DNA.
6. Agarose gel electrophoresis of DNA

Reference Books:

1. Techniques in Molecular Biology by Walker J..M. and W. Gaastra. 1983. Croom Helm, London.
2. A biologist's Guide to Principles and Techniques of Practical Biochemi stry by Wilson K. and K.H. Goulding. 1992. 3rd edition, Cambridge University Press, Cambridge.
3. Standard methods of biochemical analysis. 1999. By Thimmaiah, S. R. Kalyani Publishers, Ludhiana
4. Methods in plant biochemist ry and molecular biology. 1997. By Dashek, W. V.CRC Press, Boca Raton, New York
5. Practical biochemistry – Principles and Techniques 2005. By Wilson, K. and Wal ker, J. Cambridge University Press, UK.
6. Rob Reed, David Holmes, Jonthan., Practical Skills in Bimolecular Sciences., Weyers and Allan Jones. Addison Wesley Longman Ltd. 1998.
7. Williams and Fleming, 1980. Spectroscopic Methods in Organic Chemistry

Track C: Environmental Biotechnology

Department Elective- 1C
Course Code: BBI128
Course Name: Environmental Biology

Course Outcomes:

CO-1 Students will be able to understand ecology and ecosystem.
CO-2 Students will be able to describe and compare different Ecological pyramids and biogeochemical cycles.
CO-3 Students will be able to explain and distinguish different population ecology and population interactions- Mutualism, Parasitism
CO-4 Students will be able to acquire skills to analyze major earth ecosystem and ecological model.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	1	2	1
CO3	3	3	3	2	1	2	2
CO4	3	3	3	2	2	2	2

1 – LOW , 2- MEDIUM , 3-HIGH

UNIT-I

Definition, principles and scope of ecology, human ecology and human settlements, evolution, origin of life and specification, Ecosystem stability-cybernetics and ecosystem regulation, evolution of biosphere.

UNIT - II

Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles, ecological succession, Ecads and ecotypes.

UNIT - III

Population ecology- density, natality, mortality, survivorship curves, age distribution, growth curves and models, r & k selection, population interactions- Mutualism, Parasitism, Predator-Prey relations, System Theory and Ecological Model.

UNIT - IV

Earths major ecosystem - terrestial and aquatic ecosystem, soil microorganism and their functions, coastal management with respect to Indian conditions, criteria employed for disposal of pollutants in marine ecosystem, coastal water system and man-made reservoirs, biology and ecology of reservoirs.

Course Code: BBI129
Course Name: Environmental Biology Lab

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).

Reference Books

1. Basic ecology - E. P. Odum
2. Ecology and field biology - R.L. Smith
3. Ecology - P.D. Sharma
4. Fundamentals of ecology -E.P. Odum
5. Principles of ecology – Rickleff

Department Elective- 2C
Course Code: BBI130
Course Name: Solid Waste Management

Course outcome

CO-1 Students will be able to understand solid waste and its management methods.
CO-2 Students will be able to describe hazardous waste and its treatment.
CO-3 Students will be able to explain and distinguish different handing rules amendments for hazardous waste management.
CO-4 Students will be able to acquire skills to analyze treatment of various effluents.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	1	2	2
CO2	3	3	3	2	2	2	1

CO3	3	3	3	2	1	2	2
CO4	3	3	3	2	2	2	1

1 – LOW , 2- MEDIUM , 3-HIGH

Unit-1

Sources, generation, classification & composition of solid wastes. Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermi composting, Incineration, energy recovery from organic waste.

Unit - 2

Solid Waste Management Plan, Waste minimization technologies, Hazardous Waste Management, Sources & Classification, physicochemical properties, Hazardous Waste Control & Treatment.

Unit - 3

Hospital Waste Management, Hazardous Waste Management & Handling rules, 1989 & 2000 (amendments), **Microbiological management of hazardous waste and waste lands management in Jaipur.**

Unit- 4

Disaster Management, Fly ash generation & utilization, Primary, secondary & tertiary & advance treatment of various effluents.

References:

1. Solid Waste Management CPCB. New Delhi.
2. Ecotechnology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr.
3. Basic Environmental Technology - J.A. Nathanson

Course Code: BB131
Course Name: Solid Waste management Lab

1- To study the legal aspects of solid waste disposal
2- To study various techniques to minimization of paint waste
3- To study the solid waste management in dumping ground

Department Elective- 3C
Course Code: BBI132
Course Name: Environmental Pollution

Course outcome

CO-1 Students will be able to understand pollution, its sources and treatment.
CO-2 Students will be able to describe hazardous waste and its treatment.

CO-3 Students will be able to explain and distinguish
CO-4 Students will be able to acquire skills to analyze quality of air, water and soil treatment of various effluents.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	1	2	2
CO2	3	3	3	2	2	2	1
CO3	3	3	3	2	1	2	2
CO4	3	3	3	2	2	2	1

1 – LOW , 2- MEDIUM , 3-HIGH

UNIT - I

Air pollution- natural and anthropogenic sources of pollution, primary and secondary pollutants, transport and diffusion of pollutants, gas laws governing the behaviour of pollutants in the atmosphere, Methods of monitoring and control of air pollution, SO_2, NO_2, CO, SPM.

UNIT - II

Water pollution - types sources and consequences of water pollution, physico-chemical and bacteriological sampling, Analysis of water quality, standards, sewage and wastewater treatment and recycling, water quality and standards.

UNIT - III

Soil pollution chemical and bacteriological sampling as analysis of soil quality, soil pollution control, industrial waste effluents and heavy metals and their interactions with soil components.

UNIT - IV

Noise pollution - sources of noise pollution, measurement and indices. Marine pollution, sources of marine pollution and its control. Effects of pollutants on human beings, plants, animals and climate. Air quality standards and air pollution.

Course Code: BBI133
Course Name: Environmental Pollution Lab

1. 1To determine Water holding capacity
2. To determine moisture content
3. Study the soil and their texture by sieve method.
4. To determine the pH of soil and water.
5. To estimate chloride in soil and water.

References

1. Air pollution and control - K.V.S.G. Murlikrishan
2. Industrial noise control - Bell & Bell

3. Environmental engineering -Peary
4. Introduction to environmental engineering and science - Gilbert Masters.

Department Elective- 4C
Course Code: BBI134
Course Name: Environmental Microbiology

Course outcome

CO-1 Students will be able to understand microorganism and their sampling, culture and cultivation.
CO-2 Students will be able to describe genetically modified organism.
CO-3 Students will be able to explain and distinguish aerobic and anaerobic fermentation and different microbial bioreactors.
CO-4 Students will be able to acquire skills to analyze environmental problems & environmental monitoring through microorganism.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	1	2	2
CO2	3	3	3	2	1	2	1
CO3	3	3	3	2	2	2	2
CO4	3	3	3	1	2	2	1

1 – LOW , 2- MEDIUM , 3-HIGH

Unit - I

Microbiology- organisms in nature & their importance, sampling, culture & cultivation of microorganisms, microbes in service of nature & mankind, batch culture & continuous culture of microbes for commercial use.

Unit - 2

Microbial Reactors, genetically modified microbes & their uses in Environmental management recycling & up gradation technologies, Production of products, energy form waste.

Unit - 3

Biogas technology, plant design, construction, operation, biogas form organic wastes, water weeds, landfills, microbiology of anaerobic fermentation.

Unit- 4 Biotransformation, bioconversion, bioremediation, phytoremediation technology, fermentation technology, development of stress tolerant plants, Environmental problems & Environmental monitoring through microorganism, microbiology of water, air and soil, microbes as pathological agent in plant, animal and man.

Course Code: BBI135
Course Name: Environmental Microbiology Lab

1. To study the different bioreactors.
2. To study between aerobic and anaerobic fermentation.
3. To prepare potato dextrose media
4. Identification of soil microorganisms through microscope and staining

References:

1. Principles of microbiology - Pelzar
2. Microbial bio technology - A.N.
3. Glazer Microbial ecology - R.M.
4. Atlas Molecular biology - H.D. Kumar
5. Environmental bio Technology - Sayler & Fox

Department Elective- 5C
Course Code: BBI136
Course Name: Biodiversity

Course outcome

CO-1 Students will be able to understand the term biodiversity and different flora and fauna in India.
CO-2 Students will be able to describe strategies for Biodiversity Conservation.
CO-3 Students will be able to explain and distinguish gene banks, tissue culture and artificial seed technology.
CO-4 Students will be able to acquire skills to analyze international convention and protocols for Biodiversity Conservation.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	2	2	2
CO2	3	3	3	2	1	2	1
CO3	3	3	3	2	2	2	2
CO4	3	3	3	1	1	2	2

1 – LOW , 2- MEDIUM , 3-HIGH

Unit - I

Biodiversity - definition, hot spots of Biodiversity, strategies for Biodiversity Conservation, National Parks, Sanctuaries and Biosphere reserves, gene pool with respect to Rajasthan.

Unit - 2

Aquatic common flora and fauna in India - phytoplankton, zooplankton and macrophytes, terrestrial common flora and fauna in India - forests, endangered and threatened species.

Unit - 3

Strategies for Biodiversity Conservation, cryopreservation, gene banks, tissue culture and artificial seed technology, new seed development policy 1988, conservation of medicinal plants.

Unit- 4

International conventions, treaties and protocols for Biodiversity Conservation, Biodiversity in the welfare of mankind, Species concept, Biological nomenclature theories of biological classification.

Course Code: BBI137
Course Name: Biodiversity Lab

1. 1Study any five endangered/ threatened species- one from each class.
2. To study the effect of plant biodiversity on population and ecosystem process
3. To study different flora native to your region.
4. To study the ecosystem impacts on species adaptation

References:

1. Global Biodiversity - W.R. L.IUCN
2. Ecology of natural resource - Ramade
3. Ecology - P.D. Sharma

Department Elective- 6C
Course Code: BBI138
Course Name: Microbial and Industrial application

Course outcome

CO-1 Students will be able to understand microbial diversity and their classification.
CO-2 Students will be able to describe microbial growth and physiology.
CO-3 Students will be able to explain and distinguish host–Pathogen interactions and various microbial infections.
CO-4 Students will be able to acquire skills to analyze role of microorganisms in natural system and artificial system and protocols for Biodiversity Conservation.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	1	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	1	2	2	2
CO4	3	3	3	1	1	2	2

1 – LOW , 2- MEDIUM , 3-HIGH

Unit I

Microbial Diversity & Systematics Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual.

Unit II

Microbial Growth & Physiology Ultrastructure of Archaea (Methanococcus); Eubacteria (E.coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell.

Unit III

Microbial Interactions and Infection Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence Microbes and Environment Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants.

Unit IV

Industrial Applications Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers.

Course Code: BBI139
Course Name: Industrial Microbial Lab

1. 1Isolation of microbes from soil.
2. Isolation of microbes from water sample.
3. Serial dilution.
4. Gram staining.
5. To study fed batch culture and Continuous culture.

References

1. Michael J. Pelczar, Microbiology, Tata McGraw-Hill

2. L.E Casida, JR, Industrial Microbiology, New Age International, PJ Limited, Publisher.
3. Prescott and Dunn, Industrial Microbiology, C BS Publisher and Distributor
4. Gerand J. Tortora, Berbell R. Funke, Christine L. Case, Microbiology, Pearson

Department Elective- 7C
Course Code: BBI140
Course Name: Bioremediation

Course outcome

CO-1 Students will be able to explain bioremediation and its types- in situ and ex situ.
CO-2 Students will be able to describe hazardous waste and its management.
CO-3 Students will be able to distinguish and explain phytoremediation and bioremediation and their techniques.
CO-4 Students will be able to acquire skills to analyze the techniques of bioremediation to remove the toxic elements from environment.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	1	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	1	2	2
CO4	3	3	3	1	1	2	2

1 – LOW , 2- MEDIUM , 3-HIGH

Unit I

Bioremediation- I Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation

Unit II

Bioremediation – II Solid phase bioremediation - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors.

Unit III

Hazardous Waste Management biotechnology application to hazardous waste management - examples of biotechnological applications to hazardous waste management- cyanide detoxification, detoxification of oxalate, urea etc., toxic organics, phenols. Case studies with respect to different Industries of Rajasthan.

Unit IV

Concept of bioremediation (in-situ & ex-situ), Bioremediation of toxic metal ionsbiosorption and bioaccumulation principles. Concepts of phytoremediation. Microbial leaching of ore-direct and indirect mechanisms. Mining and metal. Use of microorganisms in augmentation of petroleum recovery. Biotechnology-with special reference to Copper and Iron.

Course Code: BBI141
Course Name: Bioremediation Lab

1. Role of bacterial systems in decolourization of effluents.
2. Role of fungal systems in decolourization of effluents
3. Estimation of nitrates, carbonates and organic carbon in soil and water.
4. To determine Temporary Hardness.
5. To determine permanent hardness.

References:

1. Environmental Biotechnology by S. K. Agarwal
2. Biodegradation & Bioremediation (1999), Martin Alexander, Academic press.
3. Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications, 1989.
4. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 1987.
5. Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 1989.
6. Bioremediation engineering; design and application 1995 John. T. cookson, Jr. Mc Graw Hill.

Track D: Biostatistics
Department Elective- 1D
Course Code: BBI142
Course Name: Descriptive Statistics, Probability and Distributions

Course outcome

CO-1 Students will be able to exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics

CO-2 Students will be able to describe and understand the concepts involved in data presentation, analysis and interpretation.

CO-3 Students will get the exposure to presentation of data, probability distributions, parameter estimation and test of significance, regression and multivariate analytical techniques

CO-4 Student will able to acquire skills to analyze the critical problems related to statistics, hands on experience in the analysis of their research data.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	0	1	1
CO2	3	3	2	1	1	0	1
CO3	2	2	3	2	1	0	2
CO4	3	2	3	2	3	1	1

1-LOW, 2-MEDIUM, 3-HIGH

UNIT 1. Elementary concepts in Statistics: Concepts of statistical population and sample from a population; qualitative and quantitative data; nominal, ordinal, ratio, interval data; cross sectional and time series data; discrete and continuous data. Collection and scrutiny of data: Primary data; designing a questionnaire and a schedule; secondary data and sources of secondary data.

UNIT 2. Probability: Random Experiment; sample point; sample space; events; mutually exclusive and exhaustive events; frequency and classical definitions of probability. Axiomatic definition of probability; addition and multiplication theorems; conditional probability and independence; Bayes' theorem. Discrete and continuous random variables.

UNIT 3. Standard Univariate Distributions: Standard univariate discrete and continuous distributions- uniform; binomial; Poisson; geometric; negative binomial and hyper-geometric distributions. Uniform; exponential; normal; Laplace, gamma, beta, lognormal, logistic and Weibull distributions.(elementary properties and applications only)

UNIT 4. Sampling Distributions, Law of large numbers and Central Limit Theorem: Concepts of random sample and statistic; distribution of sample mean from a normal population; chi-square distribution; F and t statistics, distributions (no derivations) and their applications. Chi-square test.

References:

1. Dutta, N. K. (2004). Fundamentals of Biostatistics, Kanishka Publishers.
2. Gurumani N. (2005) . An Introduction to Biostatistics, MJP Publishers.
3. Daniel, W. W. (2007). Biostatistics- A Foundation for Analysis in the Health Sciences, Wiley.
4. Rao, K. V. (2007). Biostatistics – A Manual of Statistical Methods for use in Health Nutrition and Anthropology.
7. Pagano, M.& Gauvreau, K. (2007). Principles of Biostatistics.
8. Rohatgi, V.K.& Saleh, A.K.Md. (2001). An Introduction to Probability and Statistics, John

Wiley & Sons.
9. Sundaram, K.R.(2010) Medical Statistics-Principles & Methods, BI Publications,New Delhi

Course Code: BBI143
Course Name: Basics Biostatistics Lab

1- Introduction to graphical presentation data
2- Computations of Mean, Media and Mode.
3- Computation of Geometric Mean and Harmonic Mean
4- Computation of Mean Deviation.
5- Computation of Quartile deviation.
6- Computation of Variance.
7- Computation of Coefficient of Variation
8- To check the symmetry of the distribution by coefficient of Skewness.
9- To check the Shape of the distribution by coefficient of Kurtosis.

Department Elective- 2D
Course Code: BBI145
Course Name: COMPUTER PROGRAMMING IN C++ AND SAS

Course Outcomes
CO1: Demonstrate the use of algorithms and flowcharts to plan the solution of a computing problem.
CO2: Describe the object-oriented programming approach in connection with C++
CO3: Apply the concepts of object-oriented programming
CO4: Use different data structures and create / manipulate basic data files and developing applications for real world problems.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	0	1	1
CO2	3	3	2	1	1	0	1
CO3	2	2	3	2	1	0	2
CO4	3	2	3	2	3	1	1

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1: Fundamentals of Computer Programming.

Unit-2: Operating Systems- Windows, Linux, Internet, algorithms, Flow charts, data types and variables, Operators, Input Output statements, Control statements:- if, if-else, nested if-else, goto and switch statements.

Unit 3: Loops: for, while, do…while loops. Break, continue, exit ( ), Library functions. One dimensional, two-dimensional and multi-dimensional arrays.

Unit-4 Functions, definition and declaration, Illustrative examples from statistics. Pointers and references.

References

1. Balaguruswamy E. (1997). Object-Orinted Programming with C++, Tata McGraw-Hill Publishing Company Ltd.
2. Der, G. and Everitt, B.S.(2006). A Handbook of Statistical Analysis Using SAS, CRC Press.
3. Der, G. and Everitt, B.S.(2006). Statistical Analysis of Medical Data Using SAS, CRC Press.
4. Littell R.C., Stroup W.W. & Freud R.J. (2002). SAS For Linear Models, SAS Institute Inc.
5. Lora, D. and Susan, S.(2009)The Little SAS, support.sas.com

Course Code: BBI146
Course Name: Computer Programming Lab

1. WAP to print Hello World in C++.
2. WAP to add two numbers.
3. WAP to check whether the number is even or odd.
4. WAP to find largest among three numbers.
5. WAP To find reverse of a number.
6. WAP to find entered number is palindrome or not.
7. WAP to find that entered year is leap year or not.
8. WAP to find sum of two matrices.
9. WAP to swap two numbers using functions.
10. WAP to find factorial of a number using functions

Department Elective- 3D
Course Code: BBI147
Course Name: STATISTICAL GENETICS AND ECOLOGY

Course Outcomes

CO1 Student will able to understand about the genetics

CO2: Student will able to correlate between genetics and statistics

CO3: Student will able to describe the ecology and evolution

CO4: Student will able to apply the concepts of genetics

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	0	2	0	0	1
CO2	3	3	3	2	1	0	1
CO3	3	2	1	2	3	0	1
CO4	3	2	3	2	3	1	1

1-LOW, 2-MEDIUM, 3-HIGH

Unit 1: Basic biological concepts in genetics, Mendel's law, Hardy Weinberg equilibrium, estimation of allele frequency (dominant/co-dominant cases), Approach to equilibrium for X-linked gene. The law of natural selection, mutation, genetic drift.

Unit 2: Non-random mating, inbreeding, phenotypic assortative mating. I ,T,O matrices, identity by descent. Family data-estimation of segregation ratio under ascertainment bias, pedigree data : Elston – Stewart algorithm for calculation of likelihoods. Linkage, estimation of re-combination fraction, inheritance of quantitative traits.

Unit 3: Introduction to ecology and evolution, population dynamics: single species-Exponential, Logistic and Gompertz models, Leslie matrix model for age and stage Structured population, survivorship curves-Constant, monotone and bath tub shaped hazardrates.

Unit 4: Two species: Lotka-Volterra equations, isoclines. Abundance estimation: Capture –recapture, Nearest Neighbor, line transect sampling, indirect methods. Ecological Diversity: Species abundance curve, indices of diversity (Simpson's index, Shannon-Wiener index). Game theory in ecology – Evolutionarily stable strategy, its properties, simple games such as Hawk-Dove game, Prisoner's dilemma, etc. Preservation of ecology and biodiversity.

References:

1. Anil Gore & Sharayu Paranjpe (2001). A Course in Mathematical and Statistical Ecology, Kluwera academic Publishers

2. Gardner E.J. & Snustad D.P. Principles of Genetics, John Wiley & Sons Inc. Lange, K (2002). Mathematical and Statistical Methods for Genetic Analysis, Springer.

Department Elective- 4D
Course Code: BBI149
Course Name: Linear Algebra, Regression Techniques And Bioassays

Course Outcomes

CO1:-To understand the concept of Linear algebra.
CO-2. To analyze the concept of correlation and Regression.
CO-3 To calculate and apply estimation of Regression
CO4: To understand the concept of Linear Model and non-parametric tests

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	0	2	0	0	1
CO2	3	3	2	1	1	0	1
CO3	2	2	3	2	1	0	0
CO4	3	2	3	2	3	1	1

1-LOW, 2-MEDIUM, 3-HIGH

LINEAR ALGEBRA, REGRESSION TECHNIQUES AND BIOASSAYS

UNIT 1. Linear Algebra: Set operations, vectors and matrices, matrix operations, determinants, inverse of a square matrix; linear independence, rank of a matrix, generalized inverse and applications, linear equations, characteristic roots and vectors, quadratic forms and nature of definiteness.

UNIT 2. Analysis of Bivariate data: Scatter diagram, Principle of least squares; Karl Pearson's correlation coefficient; coefficient of determination; correlation ratio; rank correlation; partial and multiple correlations, Linear regression, Simple linear regression, multiple regression, fit of polynomials and use of orthogonal polynomials.

UNIT 3. Generalized linear models, analysis of binary and grouped data by using logistic models, large sample tests about parameters, goodness of fit, analysis of deviance, variable selection, introduction to Poisson regression, log-linear models, Random and mixed effect models, Nonparametric regression and generalized linear models.

UNIT 4. Bioassays: Types of biological assays, direct assays, ratio estimators, asymptotic distributions, regression approaches for estimating dose response relationships. Quantal responses, methods of estimation of parameters, dose allocation schemes, median dose, estimation of points on the quantal response function, Estimation of safe doses.

References:

1. Draper, N.R. and Smith, H (2003). Applied Regression Analysis, John Wiley & Sons.
2. Rossi R.J.(2010).Applied Biostatistics for Health Sciences, Wiley.

Course Code: BBI150
Course Name: Basics Algebra Lab

1. Determinants - by row and column operations, by partitioning.
2. Inverses of a matrix - by row and column operations, by partitioning
3. Rank of a matrix
4. Solutions of matrix equations
5. Characteristic roots and vectors of a matrix.
6. Solve the problems of Linear Correlation and Regression.

Department Elective- 5D
Course Code: BBI151
Course Name: Controlled Clinical Trials and Operations Research

Course Outcome

CO1 Student will able to understand about the medical practices and role of different regulatory bodies
CO2 Student will able to learn about the analysis and handling of data
CO3 Student will able to make the graphical presentation of statistical data
CO4 Student will able to acquire skills to analyze the critical problems related to statistics, hands on experience in the analysis of their research data

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	0	1	0	3	2
CO2	3	3	2	1	1	0	1
CO3	2	2	2	0	0	0	0
CO4	3	2	3	2	3	0	1

1-LOW, 2-MEDIUM, 3-HIGH

UNIT 1. Introduction to clinical trials: the need and ethics of clinical trials, Drug Development Process, ICH GCP, Relevant FDA and EMEA guidelines (Industry, TA-, phase-specific), data management, objectives and end points of clinical trials, bias and random errors in clinical studies, conduct of clinical trials, overview of phase I-IV trials, multi-center trials.

UNIT 2. Statistical Methods (Industry-, TA-, phase-specific),Defining objectives and end-points, Various study designs, Analysis data sets, Handling missing data, Handling multiplicity, Baseline and covariates, Sub-group analysis, Modeling treatment effects , Design of bio-equivalence trials, Understanding Protocol, Sample Size Determination, Inputs to Data Management Documents, Understanding Clinical Study Report, Randomization Methods, Statistical Analysis Plan, TLG Shells

UNIT 3: Analysis methods / models for continuous, categorical, binary, survival data, Repeated measures analysis, Quality of life data analysis, Interim analysis, Data Comprehension, Data Interpretation, Adaptive Trials, Meta Analysis.

UNIT 4: Introduction to Operations Research, linear programming problems (LPP), framing an LPP problem, graphical solution, feasible, basic feasible and optimal basic feasible solutions to an LPP, simplex method, dual of linear programming, transportation problems, assignment problems, simple numerical problems as illustration.

Reference books

1. Friedman L.M.,Furberg C.D. & Demets D.L.(1998). Fundamentals of clinical trials, Springer
2. Shein-Chung Chow and Jen-Pei Liu(2004). Design and Analysis of Clinical Trials: Concepts and Methodologies (2nd edition) Wiley-Interscience
3. Stuart J. Pocock (2010)Clinical Trials – A practical approach (Reprint), John Wiley & Sons
4. Stephen Senn (2009) Statistical Issues in Drug Development (2nd edition), John Wiley & Sons Ltd.
5. Alex Dmitrienko, Geert Molenberghs, Christy Chuang-Stein, Walter Offen(2005). Analysis of Clinical Trials Using SAS – A Practical Guide ,SAS Publishing
6. David Collett (2003) Modeling Binary Data (2nd edition), Chapman & Hall/CRC
7. Alan Agresti (2002) Categorical Data Analysis (2nd edition), Wiley-Interscience

Course Code: BBI152

Course Name: Clinical operations Lab

1. 1Mathematical formulation of L.P.P and solving the problem using graphical method,
2. Simplex technique and Charne's Big M method involving artificial variables.
3. Identifying Special cases by Graphical and Simplex method and interpretation
4. Degenerate solution
5. Unbounded solution
6. Alternate solution
7. . Infeasible solution
8. Allocation problem using Assignment model.

Department Elective- 6D
Course Code: BBI153
Course Name: Bioinformatics and Computational Biology

Course Outcomes

1. The student will be able to relate the biotechnology and informatics
2. The student will gain an understanding of bioinformatics databases, phylogenetic analysis and alignment
3. The student will able to distinguish different tools used in bioinformatics
4. Student will able to acquire skills to analyze the critical problems related bioinformatics
5. **Mapping of PO/CO**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	0	0	1
CO2	3	3	2	1	1	0	1
CO3	2	2	3	2	2	0	1
CO4	3	2	3	2	3	0	1

6. 1-LOW, 2-MEDIUM, 3-HIGH

BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

UNIT 1. Introduction to Bioinformatics: Bioinformatics Overview, Bioinformatics Concepts:- Functional Genomics, Comparative genomics, Structural biology, classification of protein structure, Medical information, Objectives of Bioinformatics. Applications, Challenges in Molecular biology, Careers in Bioinformatics, Major databases & tools, Bioinformatics in India.

UNIT 2. Genomics: Data Mining –ORF, Pubmed, Phylogenetic Analysis, MSA, Gen BANK, COG Cluster, OMIM, Gene Mapping, Sequence Assembly & Expression, Alignment of MS. Proteomics: Visualization & prediction of Protein Structure, Methods used in protein structure prediction, PROSITE, DNA Micro array (DNA chip).

UNIT 3. Tools in Bioinformatics: Web based Bioinformatics Applications, Desktop based softwares, Online Analysis Tools & Servers, PDB, SWISS-PROT, CATH, Annotation Systems-DAS, Homology Tools –BLAST, FASTA, Multiple Alignment-CLUSTALW, Molecular visualization software-Swisspdb viewer, Rasmol Gene Prediction Softwares- Genescan, Protein, Modelling software-SWISSMODEL.

UNIT 4. Computational Biology: Genetic Algorithms, HMMR, Dynamic Programming Algorithm. Local & Global Alignment Algorithm, Needleman- Wunsch Algorithm,

Heuristic Algorithm like BLAST, FASTA-Multiple Segment Alignment Algorithm, Protein secondary structure prediction Algorithm.

References:

1. Bergeron, B.(2003). Bioinformatics Computing, Prentice Hall of India.
2. Bozdogan, H (2003). Statistical Data Mining & Knowledge Discovery, CRC Press
3. Chen, Z (2001). Intelligent Data Warehousing, CRC Press
4. Ewens, W.J. and Grant, G.R. (2002). Statistical Methods in Bioinformatics, Springer.
5. Mount D.W. (2003). Bioinformatics – Sequence and Genome Analysis, CBS Publishers.
6. Rajan S.S. and Balaji R. (2002). Introduction to Bioinformatics, Himalaya Publishing.
7. Shanmughavel P. (2005). Principles of Bioinformatics, Pointer Publishers.
8. Waterman, M.S.(2000). Introduction to Computational Biology, CRC Press.
10. Xiong, J.(2006). Essential Bioinformatics, Cambridge University Press.
11. Deshmukh, S.R. and Purohit, S.G.(2007) Microarray Data: Statistical Analysis Using R, Alpha Science.

Course Code: BBI154
Course Name: Bioinformatics Lab

1. To retrieve the sequence of the Human keratin protein from GenBank database and to interpret the results.
2. To retrieve the structure of a protein and viewing it in RASMOL viewer.
3. To find the similarity between sequences using BLAST
4. To find the similarity between sequences using FASTA
5. To align more than two sequences and find out the similarity between those sequences
6. To perform Sequence analysis

Department Elective- 7D
Course Code: BBI155
Course Name: Design of Experiments and Quality Control

Course Outcomes:

CO-1: Student will able to understand the basic concept of ANOVA.
CO-2: Student will able to acquire the basic concepts of Experimental design and CRD
CO3: Student will able to differentiate between of RBD, LSD
CO4: Students will be able to distinguish SQC and control charts

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	0	2	0	1	1
CO2	3	3	2	1	1	0	1
CO3	2	2	3	2	1	0	0

CO4	3	2	3	2	3	1	1

1-LOW, 2-MEDIUM, 3-HIGH

DESIGN OF EXPERIMENTS AND QUALITY CONTROL

UNIT 1. Introduction to design of experiments: estimable linear parametric functions and their estimation, Gauss-Markov Theorem (meaning and statement only), testing of linear hypotheses, Basic principles of experimental design, uniformity trails, analysis of variance, CRD, RBD, LSD (equal and unequal number of observations, missing observations).

UNIT 2. Incomplete block designs, Balanced incomplete block designs (BIBD), group testing, PBIBD, hierarchical and nested designs. Split plot experiments, Analysis of Covariance.

UNIT 3. General factorial experiments, factorial effects, 2n and 3n factorial experiments in randomized block, Yate's method, complete and partial confounding, simple problems

UNIT 4. Quality and related concepts, ISO Certification, six-sigma, Statistical process control, theory of control charts, Shewhart control charts for variables – , R, sigma charts, attribute control charts – p, np, c charts, modified control charts.

References

1. Angela Dean & Daniel Voss (2006). Design and Analysis of Experiments, Springer Verlag
2. Campbell M.J, Machin D. & Walters S.J (2007). Medical Statistics – A Text Book for the Health Sciences, Wiley.
3. Cochran & Cox (2000). Experimental Designs, Wiley Asia
4. Das M.N. & Giri N.C. (2006). Design and Analysis of Experiments, New Age Publications
5.Montgomery, D.C. (2001). Design and Analysis of Experiments, Wiley.
6. Montgomery D. C. (2005) Introduction to Statistical Quality control, 5th edition, Wiley.

Course Code: BBI156

Course Name: Experimental Design Lab

1. Computations with one way analysis
2. Computations with Two way analysis
3. Computations with CRD
4. Computations with RBD

5. Computations with LSD
6. Computation of Variable Control Charts.
7. Computation for Mean and Range Control Charts.
8. Computation for p, np and c Control Charts.

B.Sc. Biotechnology
Course – Open Electives
Lectures: 3 Hrs/week

Open Elective- 1
Course Code: BBI091
Course Name: Basics of Bioinformatics

UNIT 1	**Introduction to Bioinformatics**
UNIT 2	**Biological Database**
UNIT 3	**Sequence Alignment**

Course outcome

CO-1 Students will be able to explain basics of bioinformatics including different tools and softwares.
CO-2 Students will be able to have knowledge of different databases
CO-3 Students will be able to perform alignment of sequences

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	L	M	M	L	M	M
CO2	M	L	L	M	L	L	L
CO3	H	M	M	L	M	M	M

L – LOW, M- MEDIUM, H-HIGH

Course- Open Elective-1 (Basics of Bioinformatics) **Credits-3**

Unit I

Introduction to bioinformatics and data generation, Bioinformatics and its relation with molecular biology, Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer). Data generation;

Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Application of Bioinformatics.

Unit II

Biological Database and its Types Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum)

Unit III

Sequence Alignments and Visualization Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).

Text / Reference Book

1- Xiong Jin, Essential Bioinformatics, Wiley-Blackwell Publisher, 2007
2- S.C. Rastogi, N. Mendiratta and P. Rastogi, Bioinformatics- Methods and Application, 2010.
3- R. Amjesh and S.S. Vinodchandra, Bioinformatics for Beginners, Lambert Publisher, 2019.
4- Stephen Misener, Stephen A. Krawetz, Bioinformatics- Methods and Protocols, Humana Press, 2010

Open Elective- 2
Course Code: BBI037B
Course Name: Medical Biotechnology

UNIT 1	**Gene therapy**
UNIT 2	**Stem cell culture technology**
UNIT 3	**Xenotransplantation**
UNIT 4	**Disease diagnosis techniques**

Course outcome

CO-1 Students will be able to explain basic concepts of gene therapy. Describe the expression of cloned proteins in animal cells. Explain methods and various types of gene delivery models.

CO-2 Students will be able to explain the concept of stem cell culture technology and tissue engineering. Describe application of stem cell culture in modern medical science.

CO-3 Students will be able to explain xenotransplantation technique and production.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	2	1	2
CO2	3	3	3	2	3	3	2
CO3	3	3	3	1	1	2	1
CO4	3	3	3	2	2	2	2

1 – LOW, 2- MEDIUM, 3-HIGH

BBI037B: Open Elective-2 (Medical Biotechnology) **Credit(s): 3**

Unit-I

Gene therapy-background, types of gene therapy (*ex vivo* & *in vivo*), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses, types of gene delivery, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics. Gene Delivery methods-Viral delivery (through Retroviral vectors, through Adenoviral vectors), Non-viral delivery,

Unit-II

Stem cell culture technology- introduction to stem cell types of stem cells, application of stem cells in modern medical science. Tissue Engineering – Skin, Liver, Pancreas,therapeutic Ribozymes, synthetic drugs.

Unit-III

Xenotransplantation – terminology, technology behind it, organ donors, social & ethical issues; Production of artificial tissues or organs; Cell Adhesion-based therapy- integrins, inflammation, cancer & metastasis; Drug designing, Drug delivery and targeting: conventional & new approaches to drug delivery.

Unit-IV

Disease diagnosis technique; ELISA, RIA, RIEP, ODD, RID, FISH, GISH, IMMUNO FLUORESCENCE

Text / Reference Book

1. R. Ananthanarayanan and C. K. JayaramPaniker; Text Box of Microbiology, Orient Longman.
2. Baron EJ, Peterson LR and Finegold SM Mosby; Bailey and Scott's Diagnostic Microbiology.
3. Roitt, I. M.; Essential immunology, 1995, Blackwell Scientific Publications Oxford.
4. W.E. Paul; Fundamental immunology, 1984, Raven Press, New York.
5. R.M. Coleman, M.F. Lombord and R.E. Sicarc; Fundamentals of immunology, 1992, 2nd Edition, C. Brown publishers.
6. D.M. Weir and J Steward; Immunology, 7th Edition, 1993.
7. Broude A.I.; Medical Microbiology and Infectious Diseases, W.B. Saunders & Co. Philadelphia.
8. Ian R. Tizzard ; An Introduction to Immunology, 4th Edition, Brooks/Cole.

Open Elective- 3
Course Code: BBI092
Course Name: Molecular Marker Technology

UNIT 1	**Molecular Markers Types**
UNIT 2	**Mapping Population**
UNIT 3	**Application of Molecular marker in breeding**

Course outcome

CO-1 Students will be able to explain different types of molecular markers
CO-2 Students will be able to describe the usage of molecular marker in gene mapping
CO-3 Students will be able to explain application of molecular markers

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	1	1
CO2	3	3	3	1	2	2	2
CO3	3	3	3	2	1	2	3

1 – LOW, 2- MEDIUM, 3-HIGH

Course- Open Elective-3 (Molecular Marker Technology- BBI092) Credits-3

UNIT I

Types of molecular markers- RFLP; PCR based markers like RAPD,SCAR, SSR, STS, CAPS, AFLP, SNP and their variants

UNIT-II

Uses of molecular markers: Application as a genetic tool for genotyping and gene mapping; Mapping populations: F2, DH, RILs, NILs; Bulked segregant analysis; Linkage maps; Physical maps.

UNIT III

Application of molecular markers: Assessing genetic diversity, variety protection; Marker assisted breeding for accelerated introgression of trait/transgene and quantitative traits; Human and animal health: Association with genetic-based diseases, Paternity determinations; Forensic studies.

Text / Reference Books

1. H. C. Chawla. An Introduction to Plant Biotechnology, Oxford and IBH, 2002.
2. S. Srivastava and A. Narula. Plant Biotechnology and Molecular markers, Springer, 2005.
3. Robert J. Henry. Molecular Markers in Plants, John Wiley & Sons, 2012
4. B.D. Singh. Biotechnology- Expanding Horizons, Kalyani

Open Elective- 4
Course Code: BBI093
Course Name: Biotechnology and Business management

UNIT 1	**Fundamental of Biotechnology and Genetic Engineering**
UNIT 2	**Drug discovery and Vaccine production**
UNIT 3	**Entrepreneurship and Commercialization**

Course outcome

CO-1 Students will be able understand the overview Biotechnology and Genetic engineering process

CO-2 Students will be able to acquaint with various drug discovery processes

CO-3 Student will be able to explain the entrepreneurship process and commercialization of product

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	1	1	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	3	2	1

1-LOW, 2-MEDIUM, 3-HIGH

BBI093- Biotechnology and Business Management **Credit- 3**

Unit 1

Basics of Biotechnology technology in plants, animals and medical field; Industrial Fermentation technology- definition, stages of fermentation, designing of bioreactors, fermentation products, amino acids, alcohols, organic acids, polysaccharides, Biofuels.

Application of rDNA technology, Human genome project and its application, Gene therapy prospect and future, DNA vaccine, Transgenic plants, Current production of rDNA products

Unit 2

Drug designing, Drug delivery and targeting: conventional & new approaches to drug delivery, Gene therapy- background, types of gene therapy (ex vivo& in vivo), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses, types of gene delivery.

Unit 3

Worldwide market scenario of Biotechnology based business, Biobusiness prospective in India, Management process & organization, general analysis of Indian Biobusiness, Project formulation and selection based on size, Technological assessment, Technical report, feasibility and commercial viability of project

Books/ References

1- A.L. Demain and N.A. Solomon, Manual of Industrial Microbiology and Biotechnology, 2008.
2- Craig Shimasaki, Biotechnology Entrepreneurship and Management, Academic Press.
3- Florentina Matei and Daniela Zirra, Introduction to Biotech Entrepreneurship: From Idea to Business, Springer
4- Benjamin E. Blass, Basic Principles of Drug Discovery and Development, Academic Press

Open Elective- 5
Course Code: BBI094
Course Name: Herbal Diet and Lifestyle

UNIT 1	**Introduction to Traditional system of medicine**
UNIT 2	**Health and Medicine**
UNIT 3	**Life Style with Herbs**

Course outcome

CO-1 Students will be able understand the overview Indian traditional medicine system

CO-2 Students will be able to acquaint with the relation with health and nutrition

CO-3 Student will be able to explain the importance of herbs in maintaining good life style

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	H	M	L	M	L	M	M
CO2	H	L	H	L	L	L	L
CO3	M	M	M	L	M	M	M

L-LOW, M-MEDIUM, H-HIGH

BBI094- Herbal Diet and Life Style **Credit- 3**

Unit 1

Introduction to Plants: Plants, India traditional system of medicine, classification, history, AYUSH and features, Indian Scenario, Global requirement and demand, Ayush industries in Rajasthan.

Unit 2

Usages and its application in human health: Health and Nutrition, Classification, benefits and uses, Yoga and Meditation, Food Habits values and supplements

Unit 3

Life style with Herbs: Nutritional supplements, Fruits/food supplement, Importance of balanced nutrition and diet. Vocal for local

Reference Books

1. Thirugnanasambantham, et al. (2012). Introduction to Herbal Entrepreneurship, Rohini Institute of Alternative Medicine, 40/41, Spartan Avenue, Mugappair East, Chennai

Course Name : Web Development
Course Code DCA001A

L (Hr.)	T (Hr.)	Pr (Hr.)	Credits
2	0	2	3

Course Objectives:

1. Students will be able to understand and be familiar with client server architecture.
2. Students will be able to understand and able to develop a web application using java technologies.
3. Students will be able to learn the skills and project-based experience needed for entry into web application.
4. Students will be able to learn the concepts of developing a dynamic webpage by the use of java script and CSS
5. Students will be able to learn the concept of XML, MySql and server side scripting.

Syllabus

Unit -1

HTML5 and CSS3 HTML5- Basic Tags, Tables,Forms.HTML5 Tags,HTML Graphics, HTML media, HTML Graphics,HTML APIs. CSS - Background, Borders,margin, Box model. Styling text, fonts,list,links,tables. CSS overflow,float,inline blocks, pseudoclasses,pseudoelements.CSS border images,rounded corners

Unit-2

Java Script Client side scripting using java script, Introduction to java script, internal and external Java script files, variables, control statements, loops, Arrays , string handling , How to write functions in JavaScript, inputting and outputting from form elements to JavaScript. DOM concept, creating html elements using java script. Drawing 2D shapes, handling events. Introduction to AJAX

Unit-3

Building Single page applications with Angular JS Single page application – Introduction , two way data binding, MVC in angular JS, controllers, getting user inputs , loops , Client side routing – accessing URL data , various ways to provide data in angular JS.

Unit -4

Server Side Programming Server side scripting, Difference between client side and server side scripting languages. Introduction to PHP, variables, control statements, loops, Arrays, string handling, PHP forms, Global variables in PHP, Regular expression and pattern matching, Database programming: inputting and outputting data from MySQL using PHP, insertion , deletion and updating data. State management in web applications, cookies, Application and session state.

Unit-5

Introduction to Xml, usage of XML, XML tags, elements and attributes, attribute type, XML validation: DTD and XSD, XML DOM Case study:-Application Development using Laravel framework

Textbook/Reference:

- The Complete Reference, HTML and CSS by Thomas A Powell latest edition

Course Outcomes (CO)

After the completion of the course the student will be able to:

CO1: To create a dynamic webpage by the use of java script and DHTML.
CO2: To create a well formed / valid XML document.
CO3: To connect a java program to a DBMS and perform insert, update and delete operations on DBMS table.
CO4. To create a server side java application called JSP to catch form data sent from client and store it on database.
CO5. To write a server side java application called servlet to catch form data sent from client, process it and store it on database

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2						
CO2	3						

CO3	2						
CO4	3						
CO5	2						

3 = Highly Related; 2 = Medium; 1 = Low

Course Name : Web Development Lab
Course Code DCA002A

L (Hr.)	T (Hr.)	Pr (Hr.)	Credits
0	0	2	1

Course Name: Project Management Lab
Course Code (DCA003A)

L (Hr.)	T (Hr.)	Pr (Hr.)	Credits
0	0	2	1

Course Objective

1. To learn to Create the project
2. To learn the Task Breakdown, and utilization of resources
3. To learn how to Assign resources, calculating costs

Lab Exercise based on given topic

1. Introduction to Project Libre and Project Management
2. Overview of Project Libre
3. Introduction to Project Management terminology
4. Tasks, Resources, and Costs
5. Installing Project Libre
6. Starting and Saving Projects
7. Navigation
8. Create a Project
9. Tasks
10. Resources
11. Cost

12. Calendars
13. WBS
14. RBS
15. Task Usage
16. Resource Usage
17. Baselines
18. Earned Value
19. Printing
20. Reporting

Course Outcome (CO)

After the completion of the course the student will be able to

CO1 Students will be able to identify basic concepts of Project Libre
CO2 Students will learn to describe the project, its cost etc.
CO3 Students will be able to create installing, creating a project.
CO4 Students will be able to identify task, and resource usages.
CO5 Students will be able to combine Project Libre tasks and will be efficiently use cost and effects.

Course Name: Advanced Spread Sheet Lab

Course Code (DCA004A)

L (Hr.)	T (Hr.)	Pr (Hr.)	Credits
0	0	2	1

Course Objective:

1. Students will be able to understand the basics of Excel.
2. Students will be able to understand the concepts of working with the functions of advanced excel.

Syllabus

Advanced Excel Course - Overview of the Basics of Excel

Customizing common options in Excel,Absolute and relative cells,Protecting and un-protecting worksheets and cells

Advanced Excel Course - Working with Functions

Writing conditional expressions (using IF),Using logical functions (AND, OR, NOT),

Using lookup and reference functions (VLOOKUP, HLOOKUP, MATCH, INDEX), VlookUP with Exact Match, Approximate Match, Nested VlookUP with Exact Match VlookUP with Tables, Dynamic Ranges, Nested VlookUP with Exact Match,Using VLookUP to consolidate Data from Multiple Sheets

Advanced Excel Course - Data Validations

Specifying a valid range of values for a cell, Specifying a list of valid values for a cell, Specifying custom validations based on formula for a cell

Advanced Excel Course - Working with Templates

Designing the structure of a template, Using templates for standardization of worksheets

Advanced Excel Course - Sorting and Filtering Data

Sorting tables, Using multiple-level sorting, Using custom sorting, Filtering data for selected view (AutoFilter),Using advanced filter options

Advanced Excel Course - More Functions

Date and time functions,Text functions,Database functions, Power Functions (CountIf CountIFS, SumIF, SumIfS)

Advanced Excel Course – Formatting

Using auto formatting option for worksheets, Using conditional formatting option for rows, columns and cells

Advanced Excel Course – Macros

Relative & Absolute Macros, Editing Macro's

Advanced Excel Course - WhatIf Analysis

Goal Seek, Data Tables, Scenario Manager

Advanced Excel Course - Charts

Using Charts, Formatting Charts, Using 3D Graphs,Using Bar and Line Chart together, Using Secondary Axis in Graphs,Sharing Charts with PowerPoint / MS Word, Dynamically,(Data Modified in Excel, Chart would automatically get updated)

Advanced Excel Course - Working with Reports

Creating subtotals, Multiple-level subtotals,Creating Pivot tables,Formatting and customizing Pivot tables, Using advanced options of Pivot tables, Pivot charts,Consolidating data from multiple sheets and files using Pivot tables, Using external data sources,Using data consolidation feature to consolidate data, Show Value As (% of Row, % of Column, Running Total, Compare with Specific Field), Viewing Subtotal under Pivot,Creating Slicers (Version 2010 & Above), Designing the structure of a template, Print Titles Repeat Rows /Coloumns

Analysis ToolPak

Use of the Analysis ToolPak to perform complex data analysis

Course Outcome(CO's)

CO1. Students will learn to use spreadsheet concepts and explore the Microsoft Office Excel environment.
CO2. Students will apply the concepts of to create, open and view a workbook.
CO 3. Students will Illustrate different advanced excel formatting.
CO 4. Students will be apply date and time functions
CO 5. Students will learn to describe basic uses of advanced excel functions

Course Name : Python programming

Course Code (DCA005A)

L (Hr.)	T (Hr.)	Pr (Hr.)	Credits
2	0	2	3

Course Objectives:

1. Student will be able to understand the basics concepts of Python.
2. Student will be able to learn the concepts of programming by using loops and conditional blocks.
3. Student will be able to demonstrate the use of complex data types , dictionary and codes.
4. Student will be able to describe the concepts of database.
5. Student will be able to understand the basics of python programming and packages.

Syllabus

Unit 1

Introduction to Python: Python variables, Python basic Operators, Understanding python blocks. Python Data Types, Declaring and using Numeric data types: int, float etc.

Unit 2

Python Program Flow Control Conditional blocks: if, else and else if, Simple for loops in python, For loop using ranges, string, list and dictionaries. Use of while loops in python, Loop manipulation using pass, continue, break and else. Programming using Python conditional and loop blocks.

Unit 3

Python Complex data types: Using string data type and string operations, Defining list and list slicing, Use of Tuple data type. String, List and Dictionary, Manipulations Building blocks of python programs, string manipulation methods, List manipulation. Dictionary manipulation, Programming using string, list and dictionary in-built functions. Python Functions, Organizing python codes using functions.

Unit 4

Python File Operations: Reading files, Writing files in python, Understanding read functions, read(), readline(), readlines(). Understanding write functions, write() and writelines() Manipulating file pointer using seek Programming, using file operations. Database Programming: Connecting to a database, Creating Tables,INSERT, UPDATE, DELETE and READ operations, Transaction Control,Disconnecting from a database, Exception Handling in Databases.

Unit 5

Python packages: Simple programs using the built-in functions of packages matplotlib, numpy, pandas etc. GUI Programming: Tkinter introduction, Tkinter and PythonProgramming, Tk Widgets, Tkinter examples. Python programming with IDE.

Text Book :

- Introduction to Computing and Problem Solving Using Python, E. Balagurusamy McGrawHill Publication

Reference Books:

- Wesley J. Chun, “Core Python Applications Programming”, 3rd Edition , Pearson Education, 2016
- Charles Dierbach, “Introduction to Computer Science using Python”, Wiley, 2015
- Jeeva Jose &P.SojanLal, “Introduction to Computing and Problem Solving with PYTHON”, Khanna Publishers, New Delhi, 2016
- Downey, A. et al., "How to think like a Computer Scientist: Learning with Python", John Wiley, 2015
- Mark Lutz, “Learning Python”, 5th edition, Orelly Publication, 2013, ISBN 978- 1449355739

Course Outcomes (CO)

After the completion of the course the student will be able to:

CO1. To understand python variables, operators and data types

CO2. To apply python control structures

CO3. To use python complex data types

CO4. To apply Python flies and databases

CO5. Student will apply python packages and GUI programming

Course Name: Python programming Lab
Course Code (DCA006A)

L (Hr.)	T (Hr.)	Pr (Hr.)	Credits
0	0	2	1

Course Objectives:
The purpose of this course is to enhance the practical knowledge based on prescribed theory course. The students will be able to enhance their analyzing and problem solving skills after implementation of all the given experiments.

List of Experiment

1. Write a program to display data of different types using variables and literals constants.
2. Write a program to reassign values to a variable.
3. Write a program to read variables from the user.
4. Write a program to exhibit indentation errors.
5. Write a program to enter a number and display its hex and octal equivalent and its square root.
6. Write a program to read and print values of variables of different data types.
7. Write a program to calculate area of triangle using Heron's formula.
8. Write a program to calculate the distance between two points.
9. Write a program to perform addition, subtraction, division and multiplication on two floating point numbers.
10. Write a program to perform addition, subtraction, division and multiplication on two integer point numbers.
11. Write a program to calculate average of two numbers. Print their deviation.
12. Write a program to calculate the total amount of money in the piggy bank given the coins of Rs 10, 5, 2, 1.
13. Write a program to convert degrees Fahrenheit into degrees Celsius.
14. Write a program to count all the prime and composite numbers entered by the user.
15. Write a program to find the greatest number from 3 numbers.
16. Write a program to take input from the user and then check whether it is a number or a character.
17. Write a program to separate two values printed on the same line using a tab.
18. Write a program to calculate the sum and average of first 10 numbers.
19. Write a program to find whether the given number is an Amstrong number or not.
20. Write a program to enter a number and then calculate the sum of its digits.
21. Write a program to enter a binary number and convert it into decimal number.
22. Write a program to calculate GCD of 2 numbers.
23. Write a program to print the reverse of a number.
24. Write a program to print the multiplication table of n, where n is entered by the user.
25. Write a program using for loop to calculate the average of first n natural numbers.
26. Write a program using for loop to calculate factorial of a number.
27. Write a program to classified a given number as prime or composite.
28. Write a program to sum the series--- 1+1/2+…….+1/n.

29. Write a program using while loop to read the numbers until -1 is encountered. Also count the numbers of prime numbers and composite numbers entered by the user.
30. Write a program to demonstrate the continue statement.
31. Write a program to write a function that displays a string repeatedly.
32. Write a program to demonstrate the mismatch between function parameters and arguments.
33. Write a program to demonstrate the use global statement.
34. Write a program to demonstrate name clash of local and global variable.
35. Write a program to demonstrate access of variables in inner and outer functions.
36. Write a program to demonstrate flow of control after the return statement.
37. Write a program to write another function which returns an integer to the caller.
38. Write a program that adds two numbers using the syntax of lambda functions.
39. Write a program to use a lambda function with an ordinary function.
40. Write a program to add two numbers using lambda function.