V.B.S. PURVANCHAL UNIVERSITY, JAUNPUR 222003

Syllabus

Bachelor of Science(Hons.) in Biotechnology

B. Sc.(Hons.) Biotechnology

Designed as per Syllabus Development Guidelines of National Education Policy-2020 (NEP-2020)

Year	Sem	Paper Code	Paper Title	Theory/ Practical	Credits
B.Sc. I	I	B100101T	Biochemistry	Theory	4
		B100101P	Biochemistry Lab	Practical	2
		B100102T	Cell Biology	Theory	4
		B100102P	Cell Biology Lab	Practical	2
		B100103T	Genetics	Theory	4
		B100103P	Genetics Lab	Practical	2
			Minor Elective (Other faculty)	Theory	4*
		I	Vocational Skill Development course	Theory	3
		H	Co-Curricular	Theory	
					25
B.Sc. I	II	B100204T	Molecular Biology	Theory	4
		B100204P	Molecular Biology Lab	Practical	2
		B100205T	General Microbiology	Theory	4
		B100205P	General Microbiology Lab	Practical	2
		B100206T	Immunology	Theory	4
		B100206P	Immunology Lab	Practical	2
		I	Vocational Skill Development course	Theory	3
		H	Co-Curricular	Theory	
					21
B.Sc. II	III	B100307T	Bioinformatics &Biostatistics	Theory	4
		B100307P	Bioinformatics &Biostatistics Lab	Practical	2
		B100308T	Animal Physiology	Theory	4
		B100308P	Animal Physiology Lab	Practical	2
		B100309T	Plant Physiology	Theory	4
		B100309P	Plant Physiology Lab	Practical	2
			Minor (Other Faculty)	Theory	4*
		I	Vocational Skill Development course	Theory	3
		H	Co-Curricular	Theory	-
					25
B.Sc. II	IV	B100410T	Bioprocess Technology	Theory	4

		B100410P	Bioprocess Technology Lab	Practical	2
		B100411T	Environmental Biotechnology	Theory	4
		B100411P	Environmental Biotechnology Lab	Practical	2
		B100412T	Recombinant DNA Technology	Theory	4
		B100412P	Recombinant DNA Technology Lab	Practical	2
		I	Vocational Skill Development course	Theory	3
		H	Co-curricular course (Qualifying)	Co-curricular course (Qualifying)	
					21
		Core Papers			
B.Sc. III	V	B100513T	Biochemical Engineering	Theory	4
		B100513P	Biochemical Engineering Lab	Practical	2
		B100514T	Plant Biotechnology	Theory	4
		B100514P	Plant Biotechnology Lab	Practical	2
		B100515T	Animal Biotechnology	Theory	4
		I	Co-curricular course (Qualifying)		
		B100516R	Industrial Training/Surveys/Research Project (Qualifying)	Theory	
		Elective Papers			
		B100517T	Basics of Forensic Science	Theory	4
		B100518T	Molecular Diagnostics	Theory	4
					20
		Student must opt for any One of the 2 elective courses			
		Core papers			
B.Sc. III	VI	B100619T	IPR, Bioethics and Biosafety	Theory	4
		B100619P	IPR, Bioethics and Biosafety Lab	Practical	2
		B100620T	Entrepreneurship	Theory	4
		B100621T	Food Biotechnology	Theory	4
		B100621P	Food Biotechnology Lab	Practical	2
		I	Co-curricular-Minor		
		B100622R	Industrial Training/Surveys/Research Project (Qualifying)		
		Elective papers			
		B100623T	Genomics and proteomics	Theory	4
		B100624T	Enzymology	Theory	4
					20
Student must opt for any One of the 2 elective courses					

Programme/Class: Certificate /B. Sc. (Hons) (I)	Year:First (I)	Semester:First (I)
Subject: Biotechnology		
Couse Code: B100101T	Course Title: BIOCHEMISTRY	

Course Outcomes (COs)

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

- understand the significance of Biochemistry.
- learn the chemistry of carbohydrates, lipids, proteins and amino acids.
- understand the basics of enzymes.
- understand the metabolism of carbohydrate and proteins
- know the chemical structure of nucleotides including their components , describe primary, secondary structure of DNA and RNA

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction and history of Biotechnological science with special reference to contribution of Indian scholars in biological sciences A historical prospective.	2
II	Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. DifferentLevel of structural organization of proteins, Fibrous and globular proteins. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides.	10
III	Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines &pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.	12
IV	Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.	12
V	Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metallozymes, monomeric &oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity.	12

Suggested Reading

1. Harper's Illustrated Biochemistry. – R.K. Murray, D.K. Garner, P.A. Mayers& V.W. Rockwell, **Pub:** McGraw Hill International Edition.
2. Principles of Biochemistry –Lehninger, Nelson & Cox. **Pub:** Macmillan
3. Biochemistry – G. Zubay., **Pub:** Wm. C. Brown Pub.
4. General Biochemistry – Weil, **Pub:** New Age Intl. Ltd.
5. Biochemistry – LubertStryer. **Pub:** W.H. Freeman & Com., NY.
6. Biochemistry – D. Voet and J.G. Voet**Pub:** John Willy & Sons
7. Biochemistry – West & Todd **Pub:** Oxford IBH,
8. Biochemistry – Debjyoti Das.–**Pub:** Academic Publishers Kollkata

Other ccourse books published in Hindi must be prescribed by the University/College

Suggested link

- https://ocw.mit.edu/courses/findbytopic/#cat=science&subcat=biology&spec=biochemistry
- https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=spectroscopy
- https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-4/
- https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecture-videos/lecture-4-enzymes-and-metabolism/
- https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-3/
- https://nptel.ac.in/courses/104/105/104105076/
- https://nptel.ac.in/courses/102/106/102106087/

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:**First (I)	**Semester:**First (I)
Subject: Biotechnology		
Couse Code: B100101P	**Course Title: Biochemistry Lab**	
Credits: 2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

Topics	No. of Lectures
1. Preparation of normal and molar solutions 2. Preparation of buffers. 3. To study activity of any enzyme under optimum conditions. 4. To study the effect of pH, temperature on the activity of salivary amylase enzyme. 5. Estimation of blood glucose by glucose oxidase method. 6. Spectrophotometer/colorimeter(Beer-Lambert's law) Estimation of Protein by UV-vis Spectrometer (i)Lowry et al. method for estimation of protein (ii)Biuret method for estimation of protein 7. Spectroscopic estimation of DNA (UV) 8. Electrophoresis (a)Electrophoresis of red blood cell proteins (b) Electrophoresis of DNA 9. Separation of Amino acids by paper chromatography. 10. Qualitative tests for Carbohydrates, lipids and proteins 11. Estimation of DNA by Diphenylamine and RNA by Orcinol methods. 12. Estimation of reducing and total sugar by DNS and H_2SO_4-phenol methods. 13. Effect of pH and temperature on enzyme activity. Determination of pK_a value of a weak acid by titrating with strong base.	60

Course prerequisite

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Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (I)	**Semester:** First (I)
	Subject: Biotechnology	
Couse Code: B100102T	**Course Title: Cell Biology**	

Course Outcomes (COs)

This course introduces the principles of cell biology and genetics. After completion of this course, students will be able to-

- learn different areas of cell biology including the structure and functions of cell, its organelles such as mitochondria, nucleus etc.
- understand the role of cytoskeleton and its remodelling including the diseases associate with improper remodelling.

- earn how the synthesized proteins are transported to different organelles.
- understand Chemical components of biological membranes and membrane transport
- understand molecules that mediate cell adhesion

Credits: 4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Origin of life, History of cell biology, Evolution of the cell: endosymbiotic theory, treeof life, General structure and differences between prokaryotic and eukaryotic cell;Similarities and distinction between plant and animal cells; different kinds of cells inplant and animal tissues.	10
II	Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.	12
III	Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation.Golgi complex: Structure, biogenesis and functions.	7
IV	Lysosomes: Vacuoles and micro bodies: Structure and functionsRibosomes: Structures and function, Mitochondria: Structure and function,Chloroplasts: Structure and function, Nucleus: Structure and function, chromosomes and their structure.	14
V	Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis.	12

Suggested Reading

1. Molecular Biology of The Cell, – Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts & Peter Walter, **Pub:** G.S. Garland Science Taylor & Francis Group NY 10001-2299
2. Cell and Molecular Biology, – G. Karp, **Pub:** Johnwiley& Sons, Inc. NY
3. Molecular Biology of the Gene – J.D. Wastson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick, **Pub:** Pearson Education (Singapore) Pvt. Ltd. Delhi
4. Molecular Cell Biology, H. Lodish, A. Berk P. Matsudaira Chris A. Kaiser, M.Krieger, M. P. Scott, L. Zipursky, J. Darnell. **Pub:** W.H. Freeman & Com., NY.
5. कोशिका विज्ञान एवम अनुवांशिकी, पी के गुप्ता, रस्तोगी पब्लिकेशन्स
6. आधुनिक कोशिका विज्ञान, गायत्री स्वरंकार ऐवम के सी सोनी

Other ccourse books published in Hindi must be prescribed by the University/College

Suggested link

- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=cellbiology
- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=genetics
- https://nptel.ac.in/courses/102/103/102103012/
- https://nptel.ac.in/courses/102/106/102106025/
- https://nptel.ac.in/courses/102/103/102103015/

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:**First (I)	**Semester:**First (I)
Subject: Biotechnology		
Couse Code: B100102P	**Course Title:**Cell Biology Lab	
Credits:2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

	Topics	**No. of Lectures**
	1. Introduction to safety measures in Laboratories 2. Preparation of solutions and buffers 3. Equipment handling and pipetting 4. Study of structure of any Prokaryotic and Eukaryotic cell. 5. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney etc. 6. Cell division in onion root tip/ insect (grasshopper) gonads. 7. Vital Staining of Mitochondria with Janus green B. 8. Demonstration of diversity of cell types (Muscle, Neuron) 9. Demonstration of Sex chromatin in buccal smear. 10. Karyotype preparation. 11. Preparation of polytene chromosomes from salivary gland of Chironomous larvae.	60

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods
Total marks: 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions
Further Suggestions: None

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (I)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code: B100103T	**Course Title:** Genetics	

Course Outcomes (COs)

On successful completion of this course, student will be able :

1. Describe fundamentals of genetics;
2. Understand relationship between phenotype and genotype in human genetic traits;
3. Understand Chromosome and genomic organization
4. Describe the basics of genetic mapping;
5. Understand how gene expression is regulated.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week) L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis. Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybridcrosses, test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity	15
II	Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis(dominant& recessive), duplicate genes and inhibitory genes.Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequencecomposition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, Genetic organization of prokaryotic and Eukaryotic genome. Chromosome morphology, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.	12
III	Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, Structural and numerical changes in chromosomes, chromosomal aberrations, Sex determination and sex linkage. Environmental factors and sex determination, sex	12

	differentiation, Barr bodies, dosage compensation, genetic balance theory. Sex linked inheritance.	
IV	Genetic linkage, crossing over and chromosome mapping, Extra chromosomal inheritance: Rules of extra nuclear inheritance,	9
V	Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.	12

Suggested Reading

1. Hartl, D. L., & Jones, E. W. (1998). *Genetics: Principles and Analysis*. Sudbury, MA: Jones and Bartlett.
2. Pierce, B. A. (2005). *Genetics: a Conceptual Approach*. New York: W.H. Freeman.
3. Tamarin, R. H., & Leavitt, R. W. (1991). *Principles of Genetics*. Dubuque, IA: Wm. C. Brown.
4. Smith, J. M. (1998). *Evolutionary Genetics*. Oxford: Oxford University Press.
5. Principles of Genetics – Gardner et al.

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Further Suggestions: None

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (1)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code: B100103P	**Course Title: Genetics Lab**	
Credits: 2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week) L-T-P: 4-0-0		

Topics	No. of Lectures
1. Genetics problems based on : (i) Mendel's law (ii) Gene mapping and (iii) Transposable elements. 2. Ames test for mutagenesis. 3. Genetic experiment – Drosophila model 4. Pedigree charts of some common characters like blood group, color blindness.	60

5. Study of polyploidy in onion root tip by colchicine treatment.		
Programme/Class: Certificate/B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code:	**Course Title: Minor Elective (Other faculty)**	
Credits: 4	**Core Compulsory**	
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms	

Programme/Class: Certificate/B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code: I	**Course Title: Vocational Skill Development course**	
Credits: 3	**Core Compulsory**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: Certificate/B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester: First** (I)
Subject: Biotechnology		
Couse Code: H	**Course Title:** Co-Curricular	
Credits: As per University norms	**Core Compulsory**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (I)	**Semester:** Second (II)
Subject: Biotechnology		
Couse Code: B100104T	**Course Title: Molecular Biology**	
Course Outcomes (COs)		
After completion of the course the students CO1 Will be acquainted with the structure of various types of DNA and RNA as well as their organization as genetic material in various living organisms. CO2: Understand DNA replication mechanisms in prokaryotes and eukaryotes, enzymes and proteins involved in replication. CO3: Will have learnt the fundamental principles of transcription in prokaryotes and eukaryotes, including the RNA polymerases and general transcription factors involved. CO4 Will be able to distinguish between the process in prokaryotes versus eukaryotes		

Programme/Class:Certificate/ B. Sc. (Hons) (I)	Year:First (I)	Semester: Second (II)
Subject: Biotechnology		
Couse Code: B100104T	Course Title:Molecular Biology	

Course Outcomes (COs)

After completion of the course the students

CO1 Will be acquainted with the structure of various types of DNA and RNA as well as their organization as genetic material in various living organisms.

CO2: Understand DNA replication mechanisms in prokaryotes and eukaryotes, enzymes and proteins involved in replication.

CO3: Will have learnt the fundamental principles of transcription in prokaryotes and eukaryotes, including the RNA polymerases and general transcription factors involved.

CO4 Will be able to distinguish between the process in prokaryotes versus eukaryotes

Credits: 4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
	, Genomics.	
I	Nucleic Acids convey Genetic Information: DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis DNA as genetic material,	9
II	Structure of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.	12
III	DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair:Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesionsynthesis, recombinational repair, nonhomologous end joining. Homologous recombination:models and mechanism.	12
IV	RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase,role of sigma factor, promoter, Initiation, elongation and termination of RNA chainsTranscription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters,enhancers, mechanism of transcription initiation, promoter clearance and elongation RNAsplicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing,rRNA and tRNA splicing.	15
V	Regulation of gene expression in prokaryotes: Operon concept (inducible and repressiblesystem), Genetic code and its characteristics, Prokaryotic	12

	and eukaryotic translation: ribosomestructure and assembly, Charging of tRNA, aminoacyltRNAsynthetases, Mechanism ofinitiation, elongation and termination of polypeptides, Posttranslational modifications of proteins.	

Suggested Reading

1. Molecular Biology of The Cell, – Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts & Peter Walter, **Pub**: G.S. Garland Science Taylor & Francis Group NY 10001-2299
2. Cell and Molecular Biology, – G. Karp, **Pub**: Johnwiley& Sons, Inc. NY
3. Molecular Biology of the Gene – J.D. Wastson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick, **Pub:** Pearson Education (Singapore) Pvt. Ltd. Delhi
4. Molecular Cell Biology, H. Lodish, A. Berk P. Matsudaira Chris A. Kaiser, M.Krieger. M. P. Scott, L. Zipursky, J. Darnell. **Pub:** W.H. Freeman & Com., NY.
5. Cell and Molecular Biology – P.K. Gupta **Pub**: Rastogi Publication India.

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Certificate	**Year:**First (I)	**Semester:** Second (II)
Subject: Biotechnology		
Couse Code: B100101T	**Course Title: Molecular Biology Lab**	
Credits: 2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week) L-T-P: 0-0-4		

	Topics	No. of Lectures
	1. Estimation of DNA by Di-Phenylamine/C-TAB method. 2. Estimation of RNA by Orcinol method. 3. Study of conjugation in E. coli 4. Study of transduction in E. coli	30

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test

10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class:Certificate/ B. Sc. (Hons) (I)	Year:First (I)	Semester: Second (II)
Subject: Biotechnology		
Couse Code: B100105T	Course Title:General Microbiology	

Course Outcomes (COs)

After completion of the course the students will be able to

1. Understanding the basics of microbiology and microbial classification
2. To culture different bacteria and know how to preserve them
3. Acquaintance with culturing of viruses and viral pathogenesis
4. Critical understanding of general characteristics and classification of algae, fungi and protozoa

Retrieve and use cotemporary information related to microbial world

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecularapproaches, Microbial phylogeny and current classification of bacteria.	12
II	Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells,Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi,Protozoa and Unique features of viruses.	12
III	Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms,methods of isolation, Purification and preservation.Control of Microorganisms: By physical, chemical and chemotherapeutic Agents	12
IV	Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture,measurement of growth and factors affecting growth of bacteria.Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways. Genetic recombination in bacteria: Transformation, Transduction and Conjugation.	12
V	Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewagecomposition and its disposal.Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria.Major food born infections and intoxications, Preservation of various types of foods. FermentedFoods. Introduction to microbial ecology.	12

Suggested Reading

1. PelczarMi J., Chan, E.C.S., Krieg, NR, (2009). Microbiology, McGraw-Hill publisher
2. Willey, J. Sherwood L, Woolverton C, (2016), Prescott Microbiology. 10th Edition, McGraw Hill Publisher, Columbus, OH
3. Ananthanarayan and Paniker (2017) A text book of Microbiology, :10th Edition. Orient Blackswan Publisher, Delhi
4. Dubey R. C. and D. K. Maheshwari (2004). A Text book of microbiology, 1st Edition; S. Chand and Company Ltd.
5. General Microbiology by Stanier, R.Y, J.L. Ingrahm, M.L. Wheel is & P.R. Painter.

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Certificate	**Year:**First (1)	**Semester:** Second (II)
	Subject: Biotechnology	
Couse Code: B100105P	**Course Title: General Microbiology Lab**	
Credits:2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

	Topics	**No. of Lectures**
	1. Sterilization, disinfection, safety in microbiology laboratory 2. Preparation of media for growth of various microorganisms 3. Identification and culturing of various microorganisms 4. Staining and enumeration of microorganisms 5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen sources 6. Determination of bacterial cell size by micrometry. 7. Enumeration of microorganism - total & viable count. 8. Isolation of enzyme producing microorganisms	60

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:**First (1)	**Semester:** Second (II)
	Subject: Biotechnology	
Couse Code: B100106T	**Course Title: Immunology**	
	Course Outcomes (COs)	

This course introduces the basic principles of Immunology and after completion of this course, students will be able to-

CO 1: Understand the basic principles of immune system
CO 2: Understand the nature of antigen and antibodies, and antigen
CO 3: Understand the basic techniques to identify antigens.
CO 4: Understand the basis of allergy and allergic diseases
CO 5: Understand the importance of vaccines

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Immune Response - An overview, components of mammalian immune system, molecularstructure of Immuno-globulins or Antibodies, Humoral& Cellular immune responses, Tlymphocytes& immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cellreceptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinitymaturation class switching, assembly of T-cell receptor genes by somatic recombination.	15
II	Basic immunology: Historical perspectives, Cells and organs of the immunesystem	9
III	Regulation of immunoglobulin gene expression – clonal selection theory, allotypes&idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis ofantibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.	12
IV	Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing.Immunity to infection – immunity to different organisms, pathogen defense strategies,avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.	12
V	Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterialvaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization.Introduction to immunodiagnostics – RIA, ELISA.	12

Suggested Reading

1. Kindt TJ, Goldsby RA and Osborne BA (2007) KubyImmunology .W.H. Freeman and Co., New York, 6th Ed.
2. Abbas AK, Lichtman AH and Pillai S (2011) Cellular and Molecular Immunology. Elsevier, USA, 7th Ed.
1. Coico R and Sunshine G (2009) Immunology: A Short Course. Wiley – Liss, 6th Ed.
2. Delves PJ, Martin SJ, Burton DR and Roitt IM (2011) Roitt's Essential Immunology. Wiley-Blackwell, 12th Ed.

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.
Suggested Continuous Internal Evaluation (CIE) methods
Total marks: 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions
Further Suggestions: None

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (I)	**Semester:** Second (II)
Subject: Biotechnology		
Couse Code: B100106P	**Course Title: Immunology Lab**	
Credits:2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

Topics	No. of Lectures
Differential leucocytes count 2. Total leucocytes count 3. Total RBC count 4. Haemagglutination assay 5. Haemagglutination inhibition assay 6. Separation of serum from blood 7. Double immunodiffusion test using specific antibody and antigen. 8. ELISA.	60

Programme/Class: Certificate/B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester: Second (II)**
Subject: Biotechnology		
Couse Code: I	**Course Title: Vocational Skill Development course**	
Credits:3	**Core Compulsory**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: Certificate/B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester: Second (II)**
Subject: Biotechnology		
Couse Code: H	**Course Title:** Co-Curricular	

Credits:4	Core Compulsory
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms

Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Third(III)
	Subject: Biotechnology	
Couse Code: B100107T	**Course Title:Bioinformatics &Biostatistics**	

Course Outcomes (COs)

After completion of the course, students will be able to -

- learn the need of statistical approach, identify the different axiomatic approach.
- learn to study the variability of observation.
- know effective use of Office package –word, excel, ppt and publisher etc
- understand simple calculation using excel
- understand the basic theories and practicals of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
- critically analyse and interpret results of their studies with the help of bioinformatical and biostatistical tools.

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	N0. of Lectures
I	History of Bioinformatics. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. Components of a computer system, input and output devices. Computers in biology and medicine	2
II	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)File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).	7
III	Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).Introduction to BLAST, using it on the web, Interpreting results, Phylogenetic Analysis.	10
IV	Primary and Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.	9

V	Definition of probability, Theorems on total and compound probability Elementary ideas of Binomial, Poisson and Normal distributions.Problems on test of significance, t-test, chi-square test. Correlation and Regression	7

Suggested Reading

1. Biostatistics – Garret
2. Encyclopedia of Biostatistics – Peter Armitage& Theodore Colton
3. Statistics – Schaum's Series Publication.
4. Statistical analysis – A computer oriented approach IInd Ed. Academic Press New York
5. Fundamentals of statistics – D.N. Elhance
6. Statistical methods for research workers – Central publisher Ludhiana.
7. Bioinformatics: A practical guide to the analysis of genes & Proteins – Ed. Andreas,
8. Computer – Schaum Series Publication.

Suggested link

- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092-bioinformatics-and-proteomics-january-iap-2005/lecture-notes/
- https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/
- https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/lecture-slides/

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Further Suggestions: None

Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:**Third (III)
Subject: Biotechnology		
Couse Code: B100107P	**Course Title: Bioinformatics &Biostatistics Lab**	
Credits:4	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

	Topics	N0. of Lectures
	1. Sequence information resource 2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,	60

	3. Protein information resource (PIR) 4. Understanding and using: PDB, Swissprot, TREMBL 5. Using various BLAST and interpretation of results. 6. Retrieval of information from nucleotide databases. 7. Sequence alignment using BLAST. Practicals 1. Based on graphical Representation 2. Based on measures of Central Tendency & Dispersion- 3. Based on Distributions Binomial Poisson Normal 4. Based on t, f, z and Chi-square	

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:**Second(II)	**Semester:**Third (III)
Subject: Biotechnology		
Couse Code: B100108T	**Course Title: ANIMAL PHYSIOLOGY**	
Course Outcomes (COs)		
After completion of the course, students will be able to CO1 Understand the Mechanism of digestion & absorption CO2 Understand the Composition of blood and functions of heart CO3 understand the mechanism of muscle contraction CO4 understand the Nervous and endocrine coordination mechanism CO5 understand the functions of Different endocrine glands		
Credits:4	**Core Compulsory**	
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

Unit	Topics	No. of Lectures
I	Digestive system:Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice. Respiratory system: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.	2
II	Circulatiory system: Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.	7

III	Muscular system: physiology and osmoregulation, Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None principle, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Functions of nephron and Mechanism of urine formation.	10
IV	Nervous and endocrine coordination mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters	9
V	Mechanism of action of hormones (insulin and steroids) Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.	7

Suggested Reading

1. "Animal Physiology" by N Arumugam and A Mariakuttikan
2. "Essentials of Animal Physiology" by S C Rastogi
3. Ganong's Review of Medical Physiology, 26e Kim E. Barrett, Susan M. Barman, Heddwen L. Brooks, Jason X.-J. Yuan
4. "Principles of Animal Physiology" by Moyes/Schulte
5. "Animal Physiology" by Schmidt-Nielsen

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Further Suggestions: None

Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:**Second (II)	**Semester: Third** (III)
Subject: Biotechnology		
Couse Code: B100108P	**Course Title: ANIMAL PHYSIOLOGY Lab**	
Credits:4	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

	Topics	**N0. of Lectures**
	1. Demonstration of aseptic technique: Work place for aseptic handling; packing glassware (flasks, test tubes, pipettes, petri dishes) for sterilization; aseptic transfer of liquids (pipetting from flask to test tube).	60

2. Determination of activities of digestive enzymes viz. Amylase, Pepsin, Trypsin, Lipase etc. 3. Study of effect on activity of any enzyme of various factors like pH, Temperature, Activator, Inhibitor 4. Routine human blood tests like RBC, WBC, DWBC, Hb content, blood sugar.	

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:**Third (III)
Subject: Biotechnology		
Couse Code: B100109T	**Course Title: PLANT PHYSIOLOGY**	

Course Outcomes (COs)

After completion of the course the student will be able to

CO1 understand the organization of plants from the level of cells through tissues, tissue systems, and organs

CO2 understand the physiological mechanisms involved in the uptake and transport of water and the translocation of food by plants

CO3 to Assess the role of phytohormones and nutrients in plants

CO4 understand the fundamentals of Photosynthesis

CO5 Understand the role of seed dormancy

Credits:4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	N0. of Lectures
I	Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport,	9
II	Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system).	12
III	Phytohormones: Biosynthesis, Mode and Mechanism of Action, Biological functions, Perception and Signalling (Auxins, Cytokinins, Gibberellins, Ethylene, Absicic Acid, Brassinosteroids)..	15
IV	Photosynthesis: Photosynthetic pigments, concept of photo systems,cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation:C3, C4 and CAM cycles, photorespiration, physiology of bacterial photosynthesis.	12
V	Nitrogen metabolism: Nitrogen fixation, nitrate reduction and ammonium assimilation in plants. phytohormones (auxins,	12

	gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization.	

Suggested Reading

1. Biochemistry & Molecular Biology of Plants. Authors: Buchanan BB, Gruissem W and Jones RL (2000), American Society of Plant Physiologists.
2. Lehninger Principles of Biochemistry, Authors: David L. Nelson and Michael M.Cox.
3. Plant Physiology. Authors: Taiz L, and Zeizer E, (2006), Sinauer Associates, Inc. Biochemistry. Authors: Berg JM, Tymoczko, JL, and Stryer L (2006). W. H. Freeman.
4. Plant Pathology. Authors: Agrios GN 5 ed; 2005, Elsevier Academic Press, 2005.

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Further Suggestions: None

Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester: Third (III)**
Subject: Biotechnology		
Couse Code: B100109P	**Course Title: PLANT PHYSIOLOGY LAB**	
Credits: 2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

	Topics	**N0. of Lectures**
	Osmosis – by potato osmoscope experiment 2. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of Rhoeo / Tradescantia. 3. Structure of stomata (dicot & monocot) 4. Determination of rate of transpiration using cobalt chloride method. 5. Demonstration of transpiration by Ganongs' photometer 6. Demonstration of ascent of sap/Transpiration pull. 6. Effect of Temperature on membrane permeability by colorimetric method.	60

Programme/Class: Diploma/B. Sc. (Hons.) (II)	**Year:** Second (II)	**Semester: Third (III)**
Subject: Biotechnology		
Couse Code:	**Course Title: Minor Elective (Other faculty)**	

Credits:4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Programme/Class: Diploma/B. Sc. (Hons.) (II)	**Year:** Second (II)	**Semester: Third** (III)
Subject: Biotechnology		
Couse Code: I	**Course Title: Vocational Skill Development course**	
Credits:3	**Core Compulsory**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: Diploma/B. Sc. (Hons.) (II)	**Year: Second** (II)	**Semester: Third** (III)
Subject: Biotechnology		
Couse Code: H	**Course Title:** Co-Curricular	
Credits: As per University norms	**Core Compulsory**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: Diploma/B. Sc. (Hons) (II)	Year: Second (II)	Semester: Fourth (IV)
Subject: Biotechnology		
Couse Code: B100110T	Course Title:Bioprocess Technology	

Course Outcomes (COs)

After completion of the course the students will be able to .
CO 1: Understand Range of bioprocess technology
CO 2: understand the Basic principle components of fermentation technology.
CO 3: understand the Principles of upstream and downstream processing..
CO 4: understand the oxygen requirement in bioprocess.
CO 5 understand the Microbial production alcohol

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	N0. of Lectures
I	Introduction to bioprocess technology. Range of bioprocess technology andits chronological development.	12
II	Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.	12
III	Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Mechanically andd non-mechanically agitated reactors and their application. Principles of upstream and down stream processing.	12
IV	Introduction to oxygen requirement in bioprocess; mass transfer coefficient; determination of KLa value, factors affecting KLa value. Bioprocess measurement and control system.	12
V	Microbial production of ethanol, amylase, lactic acid andSingle Cell Proteins.Effluent treatment.	12

Suggested Reading

1. Biotechnology – A text book of Industrial Microbiology – Crueger&Crueger, Pub: Panima Publishing Corp., New Delhi.
2. Microbial Biotechnology – Fundamental & Applied Microbiology – Glazier &Nikaido.**Pub:** Freeman & Comp., NY
3. Industrial Microbiology: An introduction (2001) Waites& others. **Pub:** Blackwell Science
4. Manual of Industrial Microbiology & Biotechnology– Demain&Davies ,**Pub:** ASM Press, Washington DC.
5. Principles of Fermentation Technology - Stanbury PF & Whitaker **Pub:** (Pergamon press Oxford), Aditya Book Pvt. Ltd, N. Delhi.
6. Process Biotechnology Fundamental – S.N. Muckhopadhyay, **Pub:** Viva Books Pvt Ltd
7. Bioprocess Engineering – Wolf R. Vieth., **Pub:** John Willey Inc.

Modified in BOS Meeting, May 19, 2022

Course prerequisite
The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.
Suggested Continuous Internal Evaluation (CIE) methods
Total marks: 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Fourth (IV)
Subject: Biotechnology		
Couse Code: B100410P	**Course Title: Bioprocess Technology Lab**	
Credits: 2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

	Topics	**No. of Lectures**
	1. Isolation and screening of bacteria/fungi & industrial importance from soil 2. Demonstration of replica plating techniques. 3. Demonstration of surface and submerged fermentations. 4. Study of design and working of a typical fermenter (lab scale)	60

Course prerequisite
The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.
Suggested Continuous Internal Evaluation (CIE) methods
Total marks: 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions
Further Suggestions: None

Programme/Class: Diploma/B. Sc. (Hons) (II)	Year: Second (II)	Semester: Fourth (IV)
Subject: Biotechnology		
Couse Code: B100411T	Course Title: Environmental Biotechnology	

Course Outcomes (COs)

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

- learn fundamentals of Environmental Biotechnology
- understand the importance of clean (pollution free) environment
- Understand Treatment of municipal waste and Industrial effluents.
- Understand the role of symbiotic and asymbiotic nitrogen fixing bacteria
- Understand biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling.

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol	12
II	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinated hydrocarbons and petroleum products.	12
III	Treatment of municipal solid waste and Industrial effluents. Sewage treatment and biofertilizers: Treatment of municipal waste and Industrial effluents.	12
IV	Bio-fertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM) Bio-fertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Fungal and cynobacterial biofertilizers.	12
V	Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes in environmental cleanup, Zoo-remediation.	12

Suggested Reading

1. Fundamentals of Ecology – Odum, **Pub**: Nataraj Publication.
2. Ecology: Principal & Application – Chapman, **Pub**: Cambridge Univ. Press.
3. Encyclopedia of Environment & Pollution - **Pub**: Jaico Publication House.
4. Plant Ecology - Ambast and Ambast., **Pub**: CBS Publication
5. Environment & Pollution - Ambast and Ambast., **Pub**: CBS Publication

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.
Suggested Continuous Internal Evaluation (CIE) methods **Total marks:** 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions
Further Suggestions: None

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year: Second (II)**	**Semester: Fourth (IV)**
Subject: Biotechnology		
Couse Code: B100411P	**Course Title: Environmental Biotechnology Lab**	
Credits:2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topics	**No. of Lectures**
	1. Color determination of water sample by Platinum-Cobalt method. 2. Determination of transparency and turbidity of water sample. 3. Calculation of total solids and total dissolved solids in water sample. 4. Determination of dissolved oxygen (DO) by Winkler's method and free CO_2 in water sample. 5. Determination of BOD and COD of water sample.	60

Programme/Class: Diploma/B. Sc. (Hons) (II)	Year: Second (II)	Semester: Fourth (IV)
Subject: Biotechnology		
Couse Code: B100412T	Course Title: Recombinant DNA Technology	

Course Outcomes (COs)

Student will be able to-

CO1 gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.

CO2 understand gene concept, plasmids, and wide range of techniques, especially modern molecular tools in diagnosis.

CO3 acquainted with various techniques of genetic engineering and their applications in biological research, diagnostics as well as in biotechnology industries.

CO4 understand the basic principles of PCR

CO5 understand the Strategies for gene transfer to plant cells

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Molecular tools and applications -Restriction and modification system (restriction enzymesligases, polymerases, alkalinephosphatase), restriction mapping. Cloning vectors: Episomes, Plasmids andother cloning vectors (Bacteriophage-derived vectors, artificial chromosomes),	2
II	DNA delivery methods: Transformation, Microinjection, Electroporation, Biolistics. Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR	
III	Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in medical, agriculture and environment.	7
IV	Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis,	10
V	Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A.rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.	9

Suggested Reading

1. DNA Cloning: a Practical Approach, D.M. Glover and B.D. Hames, **Pub:** IRL Press, Oxford.
2. Molecular Cloning: A laboratory Manual Vol. 1-3, - J. Sambrook & Russel. **Pub:** Cold Spring Harbor Laboratory Press, NY.
3. Molecular Biotechnology,– S.B. Primrose, **Pub:** Blackwell Scientific Publishers, Oxford

4. Principals of Gene Manipulation – S. Primrose, R. Twyman & Bob Old Pub: Blackwell Scientific Publishers, Oxford
5. Essential Molecular Biology: A practical Approach, Vol. 1,2 – T.A. Brown.
6. Molecular Biology: A Project Approach – Susan J. Karcher.
7. Gene Cloning: An Introduction – T.A. Brown.

Course prerequisite

he candidate should have passed 10+2 (class XII) Examination or its equivalent froma cognized Board/ University with any of the three subjects out of Physics, Chemistry, iology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

otal marks: 25
0 marks for Test
0 marks for presentation along with assignment
5 marks for Class interactions

urther Suggestions: None

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year: Second** (II)	**Semester: Fourth (IV)**
Subject: Biotechnology		
Couse Code: B100412P	**Course Title: Recombinant DNA Technology Lab**	
Credits: 2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

	Topics	No. of Lectures
	1. Preparation of bacterial growth medium (L.B., 2XYT) 2. Preparation of competent bacterial cell. 3. Transformation of *E.coli.* cells (color selection of transformants – with or without inserts) X – gal and IPTG. Mini plasmid DNA preparation (this DNA can be digested and religated) 4. Concentration estimation by agarose gel electrophoresis. Restriction digestion.	60

Programme/Class: Diploma/B. Sc. (Hons.) (II)	**Year:** Second (II)	**Semester: Fourth** (IV)
Subject: Biotechnology		
Couse Code: I	**Course Title: Vocational Skill Development course**	
Credits:3	**Core Compulsory**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: Diploma/B. Sc. (Hons.) (II)	Year: Second (II)	Semester: Fourth (IV)
	Subject: Biotechnology	
Couse Code: H	Course Title: Co-Curricular	
Credits: As per University norms	Core Compulsory	
Maximum Marks: As per University norms	Minimum Passing Marks: As per University norms	

Programme/Class: B.Sc. (Hons)(III)	Year: Third (III)	Semester: Fifth (V)
	Subject: Biotechnology	
Couse Code: B100513T	Course Title: Biochemical Engineering	
	Course Outcomes (COs)	
After completion of the course the students will be able to CO1 understand fundamentals of Microbial Growth Kinetics CO2 understand Basic concepts of bioreactors CO3 understand Kinetics and Engineering of Sterilization CO4 understand Mass Transfer and Downstream Processing CO5 understand Recovery and purification of products		
Credits:4	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

Unit	Topics	No. of Lectures
I	Microbial Growth Kinetics: Thermodynamic principles, Stationary cell growth, Growth yield, Specificgrowth rate, Product yield, Saturation constant, Biomass energetics, Yield equations based on YG, YO2, YATP, Maintenance energy, Growth kinetics of batch, fed-batch, plug flow and continuous culture, High cell densitycultures; Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth andnon-growth associated product synthesis.	12
II	Bioreactors and Scale up: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fedbatch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, Reactor Dynamics and reactors with non-ideal characteristics; Translation of laboratory, pilot and plant scale data, Criteria for translation between two scale of operation, Scale-up practices; Manual and automatic control	12

	system, on-line and off-line analytical instruments.	
III	Kinetics and Engineering of Sterilization: Kinetics of media sterilization, design of batch sterilizationprocess,D-time, Z-value and F-value, calculation of Del-factor and holding time, Richards rapid method fordesign of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect ofair velocity and bed depth on filtration.	12
IV	Mass Transfer and Downstream Processing: Fluids and its properties, Non-Newtonian fluids, introductionto transport phenomena, Gas-liquid mass transfer, mass transfer resistances, and determination of oxygentransfer coefficient;	12
V	Recovery and purification of products from fermentation broth, Main Unit Operations indownstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells.	12

Suggested Reading

1. Biochemical Engineering: Aiba and Hemphery
2. Biochemical Engineering Fundamentals: J. E.Bailey and D. F.Ollis
3. Principles of Microbes and Cell Cultivation: S. John Pirt
4. Bioprocess Engineering Principles: Pauline M. Doran
5. 5. Principles of fermentation technology: P.F. Stanbury and A. Whitekar

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: B.Sc. (Hons)(III)	Year: Third (III)	Semester: Fifth (V)
Subject: Biotechnology		
Course Code: B100513P	Course Title: Biochemical Engineering Lab	
Credits:2	Core Compulsory	
Maximum Marks: 50	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

Unit	Topics	No. of Lectures
I	1. Microbial Growth kinetics-Determination of specific growth rate (• max), saturation constant (KS) and 2. growth yield (YX/S) for Saccharomyces cerevisiae in batch culture. 3. Determination of KLa by sulphite oxidation method. 4. Determination of thermal death rate constant and decimal reduction time for E. coli. 5. Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein. 6. Bio-transformation of sucrose into high fructose syrup by immobilized cell of Saccharomyces cerevisiae	2

Programme/Class: B.Sc. (Hons)(III)	**Year: Third** (III)	**Semester: Fifth (V)**
Subject: Biotechnology		
Couse Code: B100514T	**Course Title: Plant Biotechnology**	

Course Outcomes (COs)

After completion of this course, students will be able to-

1. Have a strong foundation of basics of Plant Biotechnology
2. Understand Embryo, Callus, Organs, Cell and Protoplast culture
3. Be acquainted with theIn vitro haploid production.
4. Understand the principles, practices and applications of, transgenic plant generation, plant tissue culture, plant genomics, and genetic transformation.
5. Gain knowledge about Plant Growth Promoting Bacteria

Credits:4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction to Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation: advantages and disadvantages of micropropagation, Axillary bud proliferation, Meristem and shoot tip culture, organogenesis and embryogenesis,.	12
II	In vitro haploid production, Anther culture, significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.	12
III	Protoplast Isolation, Viability and fusion Methods, Protoplast development, regeneration frequency,	12
IV	Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization and limitations. Somaclonalvariation and its applications.	12
V	Plant Growth Promoting bacteria: direct and indirect methods for plant growth promotion.	12

Suggested Reading

1. An Introduction to Plant Tissue Culture: M K Razdan. , Pub: Oxford(India).
2. Plant Tissue Culture H D Kumar, , Pub: Agro Bios. India
3. Plant Tissue Culture: Kalyan Kumar De: Pub: The New Central Book Agency, Calcutta, India
4. Fundamentals of Plant Biotechnology – AmlaBatra, Pub: Capital Publishing Co.

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions

Programme/Class: B.Sc. (Hons)(III)	**Year: Third** (III)	**Semester: Fifth (V)**
	Subject: Biotechnology	
Couse Code: B100514P	**Course Title:Plant Biotechnology Lab**	
Credits:2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

	Topics	N0. of Lectures
	1. Preparation of stock solutions of MS (Murashige & Skoog, 1962) basal medium 2. To prepare MS media with different concentration of 6- Benzyl amino purine (BAP) for regeneration from leaf of Tobacco 3. Surface sterilization and inoculation of tobacco leaf explants on MS medium for shoot regeneration. 4. Isolation of plant genomic DNA by modified CTAB method	60

Programme/Class: B.Sc. (Hons)(III)	Year: Third (III)	Semester: Fifth (V)
Subject: Biotechnology		
Couse Code: B100515T	**Course Title: Animal Biotechnology**	

Course Outcomes (COs)

After completion of this course, students will be able to-

- understand the principles, practices and application of animal biotechnology in Transgenesis, Tissue Engineering, and biopharmaceuticals.
- Understand applications of stem cells and tissues engineering.
- learn different gene delivery methods to deliver foreign gene in plants and animals
- know about different products of transgenic animals
- understand the principles of gene therapy

Credits:4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Gene transfer methods in Animals: Microinjection, Embryonic Stem cell, Viral mediated gene transfer	12
II	Introduction to transgenesis. Transgenic Animals: Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases: Footand mouth disease, Coccidiosis, Trypanosomiasis and role of biotechnology in disease control.	12
III	Animal propagation – Artificial insemination, Animal Clones. Conservation Biology: Embryo transfer techniques.	12
IV	Introduction to Stem Cell Technology and its applications.	12
V	Genetic modification in Medicine: gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.	12

Suggested Reading

1. Culture of Animal Cells, R. I Freshney, **Pub:** Wiley-Liss. John W. & Sons.
2. Animal Cell Culture-Practical Approach. Ed. John R. W. Masters,**Pub:** OXFORD
3. Animal Cell Culture Techniques Ed. Martin Clynes. **Pub:** Springer

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: B. Sc. (Hons.) (III)	Year: Third (III)	Semester: Fifth (V)
Subject: Biotechnology		
Couse Code: H	Course Title: Co-Curricular	
Credits: As per University norms	Core Compulsory	
Maximum Marks: As per University norms	Minimum Passing Marks: As per University norms	

Programme/Class: B. Sc. (Hons.) (III)	Year: Third (III)	Semester: Sixth (VI)
Subject: Biotechnology		
Couse Code: H	Course Title: Co-Curricular	
Credits: As per University norms	Core Compulsory	
Maximum Marks: As per University norms	Minimum Passing Marks: As per University norms	

Programme/Class: B.Sc. (Hons)(III)	Year: Third (III)	Semester: Fifth (V)
Subject: Biotechnology		
Couse Code: B100517T	Course Title: Basics of Forensic Science	
Course Outcomes (COs)		
After Completion of the course the students will be able to know 1. The significance of forensic science to human society. 2. The fundamental principles and functions of forensic science. 3. The divisions in a forensic science laboratory. 4. The application of DNA profiling in forensic 5. The significance of criminal profiling to mitigate crime		
Credits:4	Elective	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

Unit	Topics	No. of Lectures
I	Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation.	
II	Classification of injuries and their medico-legal aspects, method of	

	assessing various types of deaths.	
III	Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.	
IV	Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,	
V	Principle of DNA fingerprinting, application of DNA profiling in forensic science, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.	

Suggested Reading

1. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
2. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
3. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
4. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
5. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
6. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013)

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: B.Sc. (Hons)(III)	**Year: Third** (III)	**Semester: Fifth (V)**
	Subject: Biotechnology	
Couse Code: B100518T	**Course Title: Molecular Diagnostics**	

Course Outcomes (COs)

After Completion of the course the students will be able to know
1. The significance of Enzyme Immunoassays.
2. The fundamental principles ofRFLP, RAPD,.
3. The Laboratory tests in chemotherapy.
4. The applications. Immunodiagnostic tests

5 The basics of Electron microscopy	
Credits:4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes, immuno blotting. histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in disease diagnosis.	
II	Applications of PCR, RFLP, RAPD, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology	
III	Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures.	
IV	Automation in microbial diagnosis, standardization of antigen and specific antibodies, Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.	
V	GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.	

Suggested Reading

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. VanImpe,Kluwer Academic
3. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by PanikerCKJ). University Press Publication.
4. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: B.Sc. (Hons)(III)	**Year: Third** (III)	**Semester: Sixth (VI)**

Subject: Biotechnology

Course Code: B100619T	**Course Title:** IPR, Bioethics and Biosafety

Course Outcomes (COs)

After Completion of the course the students will be able to

1. Develop an understanding of concept of Intellectual Property and its types
2. have broad knowledge on of various types of IPRs, its protection and infringement
3. demonstrate the understanding of International treaties and case studies
4. have a knowledge of Biosafety, GMOs and various Institutional committees
5. demonstrate a clear understanding of Bioethics and its legal implications

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction of Intellectual properties and rights conferred. Integration of Intellectual Property, Bioethics and Biosafety for biological and applied sciences in research and academia	12
II	Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.	12
III	International Agreements and Treaties: International IP treaties (Madrid Agreement, Trademark law treaty, Patent Law treaty etc.) WIPO, EPC, WTO, and TRIPS. International agreements relevant to biotechnology-associated IP	12
IV	Bioethics: Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.	12
V	Biosafety: Introduction to biosafety cabinets and health hazards concerning biotechnology. Introduction to the concept of containment level.and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	12

Suggested Reading

1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy*. New Delhi: Tata McGraw-Hill Pub.
2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
5. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
6. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu,

I. (2009). *Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants.*

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: B.Sc. (Hons)(III)	**Year: Third** (III)	**Semester: Sixth (VI)**
Subject: Biotechnology		
Couse Code: B100619P	**Course Title: IPR, Bioethics and Biosafety Lab**	
Credits:2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

Topics	**No. of Lectures**
1. The designing and use of the Bioethics Consultation Form 2. Handling of biological safety cabinets; primary containment for biohazards 3. Filling of Patents(Demo) 4. Group Activity: Ideas, discussion about national international patenting-requirement, procedures Case Studies of patents, trademarks, copyright.	60

Programme/Class: B.Sc. (Hons)(III)	**Year: Third** (III)	**Semester: Sixth (VI)**
	Subject: Biotechnology	
Couse Code: B100620T	**Course Title: Entrepreneurship**	

Course Outcomes (COs)

After Completion of the course the students will be able to
1. Understand the scope, importance of biotechnology and allied fields.
2. Role of entrepreneurship in economic development of industry
3. Learnt to do Market survey and assessment
4. Preparation of Business Plan; learn Forms of business organization/ownership.
5. Case study of any top three Biotechnology Companies (start up, various stages in establishment, .etc.,)

Credits:4	**Core Compulsory**
Maximum Marks: 100	**Minimum Passing Marks:** As per University norms

(75(UE)+25(CIE))		
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		
Unit	Topics	No. of Lectures
I	Introduction to Biotechnology & Applications: Biotechnology – definition, history, thrust areas of biotechnology; Elements of Bio-Process Engineering; Biotech Industries; Basic concepts of GLP, GMP and FDA; Scope and Importance of Biotechnology and allied fields.	12
II	Definition of Bioentrepreneurship, traits of an entrepreneur; Copyright, Patents, trademark, plant breeders and farmers' rights, biodiversity related issues; Biopiracy, International and Indian business policies with the focus on Bio and Pharmaceutical products.	12
III	Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.	12
IV	Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.	12
V	Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership. Case study of any top three Biotechnology Companies (startup, various stages in establishment, .etc.,)	12

Suggested Reading

1. G.G. Meredith, R.E.Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004. 3.
3. Patzelt, Holger, Brenner, Thomas (Eds.). Handbook of Bioentrepreneurship. Springer, 2008.
4. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
5. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013. 6. Lee, James W., 2013.
6. Advanced Biofuels and Bioproducts. Springer New York, 7. C. T. Hou, Jei-Fu Shaw, 2008. Biocatalysis and Bioenergy Wiley

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25

10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: B.Sc. (Hons)(III)	Year: Third (III)	Semester: Sixth (VI)
	Subject: Biotechnology	
Couse Code: B100621T	Course Title: Food Biotechnology	

Course Outcomes (COs)

After Completion of the course the students will be able to

1. Able to learn the mechanisms of preservation methods applied to different food products.
2. To understand different bioprocesses involved in food production.
3. To provide knowledge of different streams of agriculture having biotechnological interventions.
4. Able to apply knowledge and analyze the problems associated with food and agricultural biotechnology
5. Able to apply these methodologies and techniques for developing modified crops and agricultural products

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Historical Background, Composition of Food, Improvement of food resources through Biotechnology (e.g. Golden Rice, Flavor savor tomato), Traditional fermented foods (meat, fish, bread, sauerkraut, tea)	12
II	Food Fermentations: Fermented milk, Cheese, Butter, Yoghurt. Alcoholic beverages (Beer, Wine, distilled beverages), Pickles, Soy products.	12
III	Value addition products: High Fructose Corn Syrup, Invert Sugars, Edible fungus: Mushrooms. Concept of pre and Probiotics. Food preservation and storage.	12
IV	Growth of microorganisms in food: Intrinsic and extrinsic factors. Food Spoilage (microbial and non-microbial) Control mechanisms of food spoilage: Physical and Chemical.	12
V	Food and water borne diseases: Gastroenteritis, Diarrhea, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc. Detection of food-borne pathogens.	12

Suggested Reading

1. Plant Biotechnology- Adrian Slater, Nigel W. Scott and Mark R. Fowler (Text Book).
2. Biotechnology- Expanding Horizons by B.D. Singh.

3. Food Microbiology: Fundamentals and frontiers - M.P. Doyle 4. Agricultural Biotechnology by Arie Altman. 5. Modern Food Micro-Biology - James M. Jay.
Course prerequisite The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.
Suggested Continuous Internal Evaluation (CIE) methods **Total marks:** 25 10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions
Further Suggestions: None

Programme/Class: B.Sc. (Hons)(III)	**Year: Third (III)**	**Semester: Sixth (VI)**
Subject: Biotechnology		
Couse Code: B100621P	**Course Title:** Food Biotechnology lab	
Credits:2	**Core Compulsory**	
Maximum Marks: 50	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		

Topics	No. of Lectures
1. Estimation of Total Plate Count in any food sample. 2. Detection of Salmonella, E. coli in food material. 3. MBRT test of milk samples. 4. Malt preparation for beer making. 5. Cheese making (Non-ripened cheese). 6. Sauerkraut production 7. Acetic acid/Vinegar Production and estimation of the product. 8. Toxin detection in the food materials. 9. Effect of internal factors on microbial growth in food i.e. pH, Temperature, Water Activity.	60

Programme/Class: B. Sc. (Hons.) (III)	**Year: Third (III)**	**Semester: Fifth (V)**
Subject: Biotechnology		
Couse Code: B100516R	**Course Title:** Industrial Training/Surveys/Research Project	
Credits: As per University norms	**Core Compulsory**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: B. Sc. (Hons.) (III)	Year: Third (III)	Semester: Sixth (VI)
Couse Code: B100622R	Subject: Biotechnology	
Credits: As per University norms	Course Title: Industrial Training/Surveys/Research Project	
Maximum Marks: As per University norms	Core Compulsory	
	Minimum Passing Marks: As per University norms	

Programme/Class: B.Sc. (Hons)(III)	Year: Third (III)	Semester: Sixth (VI)
Couse Code: B100623T	Subject: Biotechnology	
	Course Title: Genomics and proteomics	
	Course Outcomes (COs)	
After Completion of the course the students will be able to 1. Students will have a thorough understanding of various genomic technologies such as whole genome mapping & sequencing, comparative genomics, 2. The students will know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes. 3. Able to analyze the gene expression data sets to derive the biologically meaning information 4. Able to apply the knowledge of function genomics in public health		
Credits:4	Elective	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

Unit	Topics	No. of Lectures
I	Introduction to Genomics, DNA sequencing methods: manual & automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.	12
II	Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.	12
III	Introduction to protein structure, Chemical properties of proteins.Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions.	12
IV	Introduction to Proteomics, Analysis of proteomes.2D-PAGE. Sample	12

	preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE.	
V	Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.	12

Suggested Reading

1. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins
2. Molecular Biology of the Gene (1987) Watson J. D., Hopking N., Robast J. and Steiz, J.
3. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins (Third edition) Andreas D. Baxevanis& B. F. Francis Ouellette

Course prerequisite

The candidate should have passed 10+2 (class XII) Examination or its equivalent froma recognized Board/ University with any of the three subjects out of Physics, Chemistry, Biology and biotechnology or any other science subject.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: B.Sc. (Hons)(III)	**Year: Third** (III)	**Semester: Sixth (VI)**
	Subject: Biotechnology	
Couse Code: B100624T	**Course Title:** Enzymology	

Course Outcomes (COs)

After Completion of the course the students will be able to know

1. The general aspects of enzymes
2. Enzyme classification
3. Mechanism of enzyme action
4. Enzyme - Enzyme interaction
5. Application of Immobilized and soluble enzyme in industry

Credits:4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Brief description of general aspects of enzymes, enzyme techniques, kinetics, mechanism of enzyme action-enzyme specificity active sites,	12

	mechanism at active sites, covalent catalysis, acid base catalysis, proximity and orientation effects, zymogen, multi enzyme complexes, enzyme technology.	
II	Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. &pH. Collision and transition state theories, Significance of activation energy and free energy.	12
III	Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. chemical modification of active site groups, specific examples-: chymotrypsin, lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.	12
IV	Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes.	12
V	Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry.	12

Suggested Reading

1. Biochemistry, LubertStryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen
3. M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition,
4. McGrawHill, 2009.
4. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
5. Biochemistry by Mary K.Campbell& Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
6. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
7. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004