Shri Agrasen Kanya P.G. College
Varanasi
(An Autonomous College)

Syllabus of the Subject

Biotechnology

For First Three Years of Under-Graduate (UG) Programme

As per guidelines of Common Minimum Syllabus prepared by Department of Higher Education, Uttar Pradesh Government according to the National Education Policy- 2020 (NEP-2020).

(w.e.f. the Session 2021-2022)

29.12.21 29.12.21 29/12/21 29/12/21

SEMESTER WISE PAPER TITLES WITH DETAILS					
Year	**Semester**	**Course Code**	**Paper Title**	**Theory/ Practical**	**Credits**
CERTIFICATE COURSE IN TOOLS AND TECHNIQUES OF CELL AND MOLECULAR BIOLOGY					
First Year	I	B100101T	Cell Biology and Genetics	Theory	4
		B100102P	Cell Biology and Genetics Lab	Practical	2
	II	B10 0201T	Molecular Biology and Genetic Engineering	Theory	4
		B100202P	Genetic Engineering Lab	Practical	2
DIPLOMA IN TOOLS AND TECHNIQUES OF BIOTECHNOLOGY					
Second Year	III	B100301T	Biochemistry and Biochemical tools	Theory	4
		B10 0302 P	Biochemistry Lab	Practical	2
	IV	B10 0401T	Microbiology and Immunology	Theory	4
		B10 0402 P	Microbiology and Immunology Lab	Practical	2
DEGREE IN BACHELOR OF SCIENCE					
Third Year	V	B10 0501 T	Biostatistics and Bioinformatics	Theory	4
		B100502T	Animal and Plant Biotechnology	Theory	4
		B10 0503P	Bioinformatics, Biostatistics and Tissue culture Lab	Practical	2
	VI	B100601T	Industrial and Environmental Biotechnology	Theory	4
		B100602T	Food Biotechnology	Theory	4
		B100603P	Industrial and Environmental Biotechnology Lab	Practical	2

Subject Prerequisite	
The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject.	
Programme Outcomes (POs)	
After completion of the B. Sc. Biotechnology programme, the candidate should be able to:	
PO1	Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology research, Biotechnology Industry, Pharma industry, Medical or hospital related organizations, and Academia.
PO2	Demonstrate skills to use modern analytical tools/ software/ equipment and analyse and solve problems in various courses of biotechnology.
PO3	Execute their professional roles in society as biotechnology professionals, employers and employees in various industries, researchers and educators.
PO4	Design, perform experiments, analyse and interpret data for investigating complex problems in biotechnology and related fields.
PO5	Demonstrate learning skills to work as a team in a multidisciplinary environment.
PO6	Design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools.
PO7	Develop skills, attitude and values required for self-directed, lifelong learning and professional development.
PO8	Acquire knowledge and understanding of norms and ethics in the field of biotechnology.

PROGRAMME SPECIFIC OUTCOMES (PSOS)	
CERTIFICATE IN TOOLS AND TECHNIQUES OF CELL AND MOLECULAR BIOLOGY	
First Year	This course introduces the knowledge of cell biology, genetics, molecular biology and genetic engineering. After completion of this certificate course, students will be able to – **PSO1:** demonstrate and apply their knowledge of cell biology, genetics, molecular biology and genetic engineering to solve the problems related to the field of biotechnology **PSO2:** gain knowledge about the application of various types of microscope, karyotyping, banding techniques, chromosome painting and FACS. **PSO3:** understand the basic concepts of genetics and molecular biology such as inheritance pattern, DNA replication, transcription and translation **PSO4:** understand and perform various recent molecular and recombinant DNA technology techniques in early diagnosis and prognosis of human diseases. **PSO5:** perform experiments of DNA isolation, agarose gel electrophoresis,gene cloning, transformations, protein expression and purification. This

	experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research. **PSO6**: apply at technical positions in different research laboratories, diagnostic centres and industries.
DIPLOMA IN TOOL AND TECHNIQUES IN BIOTECHNOLOGY	
Second Year	After completion of diploma course, students will be able to- **PSO1:** familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry. **PSO2**: understand the significance of Biochemistry and basics of enzymes. **PSO3:** learn the chemistry, structure and functions of major bio-molecules and metabolism of carbohydrate, protein etc. **PSO4:** understand different biochemical tools and techniques such as chromatography, electrophoresis, X-ray diffraction, NMR and mass spectrometry **PSO5:** perform different experiments based on the techniques such as chromatography, electrophoresis, centrifugation etc. **PSO6:** understand the different methods of sterilization **PSO7:** understand and also able to perform different immunological techniques like agglutination reaction, ABO typing and ELISA.
DEGREE IN BACHELOR OF SCIENCE	
Third Year	After completing the three years degree course in Biotechnology, the students will be able to – **PSO1:** demonstrate the concepts in computational Biology. Understand the interrelationship between Biology and Computer **PSO2:** acquire knowledge in different domains of biotechnology enabling their application in industry, research and academia. **PSO3:** perform and analyse the results of experiments using basic laboratory techniques of cell biology, molecular biology, genetic engineering, biochemistry, immunology, microbiology, bioinformatics, biostatistics, animal and plant biotechnology and Food biotechnology. **PSO4:** recognize the foundations of modern biotechnology and explain the principles that form the basis for recombinant technology. **PSO5:** develop an ability to properly understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind. **PSO6:** exhibit ability to do research independently as well as in collaboration. **PSO7:** recognize the importance of Bioethics, IPR, and entrepreneurship.

Programme/Class: Certificate	**Year:** First (1)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code: B100101T	**Course Title:** Cell Biology and Genetics	

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 how genetic information is transmitted in organism.
- 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 the regulation of cell cycle, programmed cell death and Cancer.
- learn different cell biology techniques like karyotyping, chromosome banding, FISH, FACS, centrifugation and 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	N0. of Lectures
I	• Introduction and history of Biotechnological science with special reference to contribution of Indian scholars in biological sciences	2
II	• Prototype structure of animal, plant and bacterial cells, Diversity of cell size and shape • Cell theory • C-value paradox • Cell Membrane: Chemical components of biological membranes, organization and Fluid Mosaic Model, and membrane transport. • Cytoskeleton and Extra cellular matrix	8
III	**Structure and Function of Cell organelles:** • Lysosomes: Vacuoles and micro bodies: Structure and functions • Ribosomes: Structures and function including role in protein synthesis. • Mitochondria: Structure and function, Genomes, biogenesis. • Chloroplasts: Structure and function, genomes, biogenesis • Nucleus: Structure and function, nuclear envelope	9
IV	**Chromosome structure:** • Chromosomes: chromatin and chromosomes organization, euchromatin and heterochromatin, nucleosome, metaphase chromosome, genes and	9

	chromosomes. • DNA as genetic material, Structure of DNA • Structural and numerical changes in human chromosomes and ploidy in plants. • Mutations: Types of mutations, spontaneous and induced mutations, Physical and chemical mutagens	
V	**Cell cycle, Cancer and Cell Signaling:** • Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast and higher organisms • Cell senescence and programmed cell death • Cancer – chromosomal disorders, oncogenes and tumor suppressor genes • Introduction to cell signalling and cell –cell interaction	7
VI	**Mendelian and nonmendelian genetics:** • Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance • Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment • Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy • Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory	8
VII	**Linkage, crossing over and population genetics:** • Linkage, crossing–over and chromosome and genetic mapping • Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. • Genetic Code: deciphering genetic code; degeneracy, unusual codons in mitochondria Mutations: types, mechanisms • Evolution and population genetics: Hardy Weinberglaw (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, evolutionary genetics, natural selection.	8
VIII	**Cytological techniques:** • Microscopy and staining techniques • Microtomy • Karyotyping • Chromosome banding,	9

	• *in situ* hybridization and FISH • chromosome painting • Fluorescence Activated Cell Sorting	

Suggested Reading

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: a Molecular Approach** (6th Ed.). Washington: ASM ; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, New York
4. Iwasa J., Marshal W. **Karp's Cell Biology**(2018) (8th edition) Wiley & Sons, NY
5. Iwasa J., Marshal W. **Karp's Cell and Molecular Biology** . Concepts and experiments. (2015) (8th edition) Wiley & sons, New York
6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). **Molecular Biology of the Gene** (5th ed.). Pearson
7. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H. Freeman
8. Gupta P.K. **Cell and Molecular Biology** 2018. 5th edition Rastogi Publication India.
9. Hartl, D. L., & Jones, E. W. (1998). **Genetics: Principles and Analysis**. Sudbury, MA: Jones and Bartlett.
10. Pierce, B. A. (2005). **Genetics: a Conceptual Approach**. New York: W.H. Freeman.
11. Tamarin, R. H., & Leavitt, R. W. (1991). **Principles of Genetics**. Dubuque, IA: Wm. C. Brown.
12. Smith, J. M. (1998). **Evolutionary Genetics.** Oxford: Oxford University Press Genetics: Principles and Analysis – Hartl and Jones.
13. Gardner EJ, Simmons MJ, Sunstad DP. **Principles of Genetics**. 8th Edition. John Wiley and Sons.
14. Snustand DP, Simmons MJ. **Principles of Genetics**. (2016) 7th Edition. John Wiley and Sons.
15. Verma PS, Agarwal VK. **Cell Biology, Genetics, Molecular Biology, Evolution and Ecology**. (2004). S Chand and Company Ltd.
16. Satyanarayana U (2020). Biotechnology. Books and Allied (P) Ltd
17. Singh BD. (2015). Biotechnology: Expanding Horizons (4th edition). Kalyani Publishers
18. Dubey RC. (2014) A Textbook of Biotechnology(5th edition) S Chand and Company Ltd.
19. स हिं बी डी (2017) बायोटेक्नोलोजी Kalyani Publishers
20. पी के गुप्ता,**कोशिका विज्ञान एवम अनुवांशिकी**, 2015 2nd edition Rastogi Publications
21. स हिं बी डी, **आनुवांशिकी के आधार**. (2017) Kalyani Publishers
22. ोनी के ी, स्वरिंकार गायत्री. **आधुनिक कोशिका विज्ञान**, 2018 CBC

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/

Suggested Digital platform/Web link

Course prerequisite

The candidate should have passed (10+2) examination in science stream with PCB (Physics ,Chemistry, Biology and/or Biotechnology) or PCM (Physics , Chemistry and Maths) 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	**Year:** First (1)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code: B100102P	**Course Title:** Cell Biology and Genetics Lab	

Course Outcomes (COs)

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

- learn, understand and develop skill and hands on training in basics of cell biology and genetics.
- be able to differentiate between plant and animal cells
- be analysed different stages of mitosis and meiosis

Credits: 2	**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: 0-0-4

	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.	60

	10. Karyotype preparation. 11. Preparation of polytene chromosomes from salivary gland of Chironomous larvae. 12. Genetics problems based on : (i) Mendel's law (ii) Gene mapping and (iii) Transposable elements. 13. Ames test for mutagenesis. 14. Genetic experiment – Drosophila model	

Suggested Reading

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: a Molecular Approach** (6th Ed.). Washington: ASM ; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, New York
4. Iwasa J., Marshal W. **Karp's Cell Biology**(2018) (8th edition) Wiley & Sons, NY
5. Iwasa J., Marshal W. **Karp's Cell and Molecular Biology** . Concepts and experiments. (2015) (8th edition) Wiley & sons, New York
6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). **Molecular Biology of the Gene** (5th ed.). Pearson
7. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H. Freeman
8. Gupta P.K. **Cell and Molecular Biology** 2018. 5th edition Rastogi Publication India.
9. Hartl, D. L., & Jones, E. W. (1998). **Genetics: Principles and Analysis**. Sudbury, MA: Jones and Bartlett.
10. Roskam's J. Rodgers L.(2002). **Lab Ref: A Handbook of Recipes, Reagents, and other reference tools for use at the Bench.** Cold Spring Harbor Laboratory Press. USA.
11. Barker K (2004). **At the Bench: A laboratory Navigator**. Cold Spring Harbor Laboratory Press. USA

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Course prerequisite

The candidate should have passed (10+2) examination in science stream with PCB (Physics ,Chemistry, Biology and/or Biotechnology) or PCM (Physics , Chemistry and Maths) 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	**Year:** First (1)	**Semester:** Second (II)
Subject: Biotechnology		
Couse Code: B100201T	**Course Title:** Molecular Biology and Genetic Engineering	

Course Outcomes (COs)

Student will be able to-

- learn and understand the important discoveries that are made in the field of molecular biology.
- learn key molecular events that occur during the DNA replication, transcription, translation and regulation of gene concept.
- gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.
- understand gene concept, plasmids, and wide range of techniques, especially modern molecular tools in diagnosis.
- acquainted with various techniques of genetic engineering and their applications in biological research, diagnostics as well as in biotechnology industries.

Credits:	**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	Topic	No. of Lectures
I	**Gene organization and regulation of gene expression:** • Structure of DNA, Types of DNA • Gene organization in prokaryotes and eukaryotes, polycistronic genes, split genes promoters, enhancers. • Regulation of gene expression: Prokaryotes: lac and trp operons in *E. coli*.	7
II	**DNA Replication and DNA polymerases:** • Replication of genetic material in prokaryotes and eukaryotes • A brief description of initiation at replication origins and its cell cycle regulation. • Structure and function of prokaryotic and eukaryotic DNA polymerases	7
III	**Transcription and mRNA processing:** • RNA structure and types of RNA • Mechanism of transcription in prokaryotes and eukaryotes: transcription factors, structure of prokaryotic and eukaryotic RNA polymerases, initiation, elongation and termination. • RNA processing: processing of mRNA (Splicing, capping and polyadenylation)	8
IV	**Prokaryotic and eukaryotic translation:** • Ribosome structure and assembly, tRNA, aminoacyltRNA synthetases, • Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of	7

	translation. • Posttranslational modifications of proteins.	
V	**Vectors:** • Cloning vectors (plasmids, cosmids, bacterial artificial chromosomes and yeast artificial chromosomes), • shuttle vectors, • expression vectors	7
VI	**Enzymes used in DNA manipulating**: • Restriction endonuclease • Ligases • Polymerases • Kinases • Alkaline phosphatases • Reverse Transcriptase	8
VII	**Genomic Library, PCR, Sequencing etc:** • Preparation and comparison of Genomic and cDNA library. • PCR and its applications. • DNA Sequencing. • Site directed mutagenesis • Protein engineering concepts and examples (any two).	8
VIII	**Molecular Biology techniques:** • DNA isolation (Plasmid/ Genomic DNA isolation) • Blotting (Southern, Northern, Western) • Electrophoresis of nucleic acids and proteins • Gene cloning, Screening and characterization of cloned DNA • DNA Fingerprinting • RFLP, RAPD	8

Suggested Reading

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: a Molecular Approach** (6th Ed.). Washington: ASM ; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, New York
4. Iwasa J., Marshal W. **Karp's Cell Biology**(2018) (8th edition) Wiley & Sons, NY
5. Iwasa J., Marshal W. **Karp's Cell and Molecular Biology** . Concepts and experiments. (2015) (8th edition) Wiley & sons, New York
6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). **Molecular Biology of the Gene** (5th ed.). Pearson
7. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H. Freeman
8. Gupta P.K. **Cell and Molecular Biology** 2018. 5th edition Rastogi Publication India.
9. Brown TA. **Gene cloning and DNA analysis: An introduction**. (2016) 7th Edition. Wiley-Blackwell
10. Old, R. W., Primrose, S. B., & Twyman, R. M. (2006). **Principles of Gene Manipulation and Genomics**, 7th Edition: Blackwell Publishing.
11. Krebs JE, Goldstein ES and Kilpatrick ST (2014) **Lewin's Gene** XII, Jones and Barlett

Publisher
12. Brown, T. A. (2018). **Genomes** 4.(4th edition) New York: Garland Science Pub.
13. Green, M. R., & Sambrook, J. (2014) Fourth Edition. **Molecular Cloning: a Laboratory Manual.** Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
14. Micklos, DA & Freyer, CA. **DNA Science: A first course in Recombinant DNA Technology**(2nd Edition) –Cold Spring harbor laboratory press, NY
15. Satyanarayana U (2020). Biotechnology. Books and Allied (P) Ltd
16. Singh BD. (2015). Biotechnology: Expanding Horizons (4th edition). Kalyani Publishers
17. Dubey RC. (2014) A Textbook of Biotechnology(5th edition) S Chand and Company Ltd.
18. भ ह बी डी(2017) बायोटेक्नोलोजी Kalyani Publishers

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

Suggested link

- https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/
- https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/transcription-translation/
- https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/gene-regulation-and-the-lac-operon/
- https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/
- https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/agarose-gel-electrophoresis-dna-sequencing-pcr/
- https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/basic-mechanics-of-cloning/
- https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/labs/mod1_3/
- https://nptel.ac.in/courses/102/103/102103045/#

Suggested Digital platform/Web link

Course prerequisite

To study this course, student must have passed semester I.

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	**Year:** First (1)	**Semester:** Second (II)
Subject: Biotechnology		
Couse Code: B100202P	**Course Title:** Genetic Engineering Lab	

Course Outcomes (COs)

After completion of the course, the student shall be able to -

- prepare different bacterial growth media,
- understand principals and methods of competent cell preparation, restriction digestion, gene ligation, gene cloning, and transformation i. e gene manipulation.
- understand the method of agarose electrophoresis for plasmid and genomic DNA separation
- understand the method of blotting and PCR

Credits: 2	**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: 0-0-4

	Topic	**No. of Lectures**
	1. Preparation of solutions for Molecular Biology experiments. 2. Preparation of bacterial growth medium (L.B., 2XYT) 3. Competent cell preparation. 4. Transformation of *E.coli*. cells (color selection of transformants – with or without inserts) X – gal and IPTG. 5. Isolation of Plasmid DNA by alkaline lysis method 6. Isolation of genomic DNA from bacterial cells. 7. Agarose gel electrophoresis of genomic DNA & plasmid DNA 8. Concentration estimation by agarose gel electrophoresis 9. Preparation of restriction enzyme digests of DNA samples 10. Ligation 11. Southern blotting 12. PCR	60

Suggested Reading

1. Brown TA. **Gene cloning and DNA analysis: An introduction**. (2016) 7th Edition. Wiley-Blackwell
2. Old, R. W., Primrose, S. B., & Twyman, R. M. (2006). **Principles of Gene Manipulation and Genomics**, 7th Edition: Blackwell Publishing.
3. Krebs JE, Goldstein ES and Kilpatrick ST (2014) **Lewin's Gene XII**, Jones and Barlett Publisher
4. Brown, T. A. (2018). **Genomes** 4.(4th edition) New York: Garland Science Pub.
5. Green, M. R., & Sambrook, J. (2014) Fourth Edition. **Molecular Cloning: a Laboratory Manual.** Cold Spring Harbor, NY: Cold Spring Harbor LaboratoryPress.
6. Micklos, DA & Freyer, CA. **DNA Science: A first course in Recombinant DNA**

Technology (2nd Edition) –Cold Spring Harbor laboratory press, NY

7. Roskam's J. Rodgers L.(2002). **Lab Ref: A Handbook of Recipes, Reagents, and other reference tools for use at the Bench.** Cold Spring Harbor Laboratory Press. USA.
8. Barker K(2004). **At the Bench: A laboratory Navigator**. Cold Spring Harbor Laboratory Press. USA

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Course prerequisite

To study this course, student must have passed semester I.

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	**Year:** Second (2)	**Semester:** Third (III)
Subject: Biotechnology		
Couse Code: B100301T	**Course Title:** Biochemistry and Biochemical tools	

Course Outcomes

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	Topic	No. of Lectures
I	**Amino acids and Protein:** • Structure and properties of Amino acids • Types of proteins and their classification • Forces stabilizing protein structure. • Different Level of structural organization of proteins. • Denaturation and renaturation of proteins.	7
II	**Carbohydrates:** • Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. • Homo and Hetero Polysaccharides, Mucopolysaccharides, • Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.	7
III	**Nucleic acids:** • Structure and functions: • Physical & chemical properties of Nucleic acids, nucleosides & nucleotides, purines & pyrimidines,. Biologicallyimportant nucleotides, • Double helical model of DNA structure and forces stabilizing DNA double helical structure, A, B and Z – DNA, denaturation and renaturation of DNA.	7
IV	**Lipids:** • Structure and functions of Lipids • Classification, nomenclature and properties of fatty acids, essential fatty acids. • Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.	6
V	**Enzymes and Enzyme classification:** • Nomenclature and classification of Enzymes, brief introduction to active site. • Kinetics of enzyme actions • Cofactors, coenzyme, prosthetic groups, holoenzyme and	8

	apoenzyme • Enzyme inhibition – competitive, Non-competitive & uncompetitive type.	
VI	**Metabolism:** • Metabolism of carbohydrates- Gluconeogenesis, Glycolysis, TCA, and Glyoxylate cycle • Metabolism of fatty acids-oxidation of saturated, unsaturated fatty acids • Oxidation of amino acids and urea cycle.	9
VII	**Vitamins and Hormone:** • Introduction to Vitamins, hormones, Phytohormones and their role • Deficiency of vitamins and hormones and related human diseases.	8
VIII	**Techniques:** • Chromatography (Column chromatography, Ion- exchange chromatography, Gel- permeation (molecular sieve, chromatography, Affinity chromatography, Paper chromatography, Thin-layer chromatography, Gas chromatography and HPLC) • Spectroscopy (UV-Vis) • NMR • X-ray diffraction • Centrifugation • Mass spectrometry	8

Suggested Reading

1. Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). **Biochemistry.** (8th ed.) W H Freeman and Company New York.
2. Nelson DL. Cox MM. (2017) **Lehninger Principles of Biochemistry** (7th ed.). W H Freeman New York.
3. Voet, D., & Voet, J. G. (2016). **Biochemistry** (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). **Harper's Illustrated Biochemistry**.(31st edition) McGraw-Hill Education
5. Hofmann A. Clokie S. **Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology**. (2018) (8th edition)Cambridge University Press
6. Boyer RF. (2012) **Biochemistry laboratory : modern theory and techniques**(2nd Edition). Pearson Education, Inc
7. Jain JL. Jain S. Jain N. (2005). **Fundamentals of Biochemistry**. (6th edition). S Chand and Company Ltd.
8. Satyanarayana U. Chakrapani U. (2013). **Biochemistry**.(4th edition). Elsevier and Books and Allied (P) Ltd

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Suggested link

- https://ocw.mit.edu/courses/findbytopic/#cat=science&subcat=biology&spec=biochemis

try

- 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/

Suggested Digital platform/Web link

Course prerequisite

To study this course, student must have passed semester II.

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	**Year:** Second (2)	**Semester:** Third(III)
Subject: Biotechnology		
Couse Code: B100302P	**Course Title:** Biochemistry Lab	

Course Outcomes

Students will get practical exposure to commonly used biochemical techniques and also they become familiar to use instruments like calorimeter, pHmeter etc.
Introduce the primary steps in biomolecules (focus on proteins) purification which includes various methods in isolation and quantitation of proteins.
2. Learn how to separate proteins from a heterogenous mixture.
3. Learn to apply important chromatographic techniques to purify biomolecules
4. Familiarize the working principles of electrophoresis and UV/Vis and fluorescence spectroscopic techniques and application of the knowledge to get basic structural information of proteins

Credits: 2	**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: 0-0-4

	Topic	**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.	60

	5. Estimation of blood glucose by glucose oxidase method. 6. Spectrophotometer/colorimeter(Beer-Lambert's law) Estimation of Protein by UV-vis Spectrometer i. (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. 14. Determination of pK_a value of a weak acid by titrating with strong base.	

Suggested Reading

1. Berg, JM Tymoczko, JL. Gatto, GJ Jr. Stryer, L. (2015). **Biochemistry.** (8th ed.) W H Freeman and Company New York.
2. Nelson DL. Cox MM. (2017) **Lehninger Principles of Biochemistry** (7th ed.). W H Freeman New York.
3. Voet, D., & Voet, J. G. (2016). **Biochemistry** (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). **Harper's Illustrated Biochemistry**.(31st edition) McGraw-Hill Education
5. Hofmann A. Clokie S. **Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology**. (2018) (8th edition)Cambridge University Press
6. Boyer RF. (2012) **Biochemistry laboratory : modern theory and techniques**(2nd Edition). Pearson Education, Inc
7. Jain JL. Jain S. Jain N. (2005). **Fundamentals of Biochemistry**. (6th edition). S Chand and Company Ltd.
8. Satyanarayana U. Chakrapani U. (2013). **Biochemistry**.(4th edition). Elsevier and Books and Allied (P) Ltd
9. R.K. **Practical Biochemistry** – David Plummer. **Pub**: Tata McGraw Hill
10. Roskam's J. Rodgers L.(2002). **Lab Ref: A Handbook of Recipes, Reagents, and other reference tools for use at the Bench.** Cold Spring Harbor Laboratory Press. USA.
11. Barker K(2004). **At the Bench: A laboratory Navigator**. Cold Spring Harbor Laboratory Press. USA

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Course prerequisite

To study this course, student must have passed semester II.

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	**Year:** Second (2)	**Semester:** Fourth (IV)
Subject: Biotechnology		
Couse Code: B100401T	**Course Title:** Microbiology and Immunology	
Course Outcomes		
On the successful completion of the course, student will be able to: • the pioneers in microbiology and their contributions • understand the physical and chemical method of sterilization • analyze the media composition and grow the desired microbe. • understand the methods of cultivation of microorganisms • understand different staining methods • understand and differentiate the different types of microbes. • understand the principles of immunology • learn about structural features of components of immune system as well as theirfunction and development of immune system and mechanisms by which our body elicits immune response. • predict about nature of immune response that develops against bacterial, viral orparasitic infection, and prove it by designing new experiments. • understand different tools and techniques of immunology • understand the biology of different vaccines against infectious agents		
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	Topic	No. of Lectures
I	**Diversity and classification of microbes:** • Fundamentals, History and Evolution of Microbiology. • Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. • Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, • Morphology and cell structure of major groups of microorganisms - Viruses, Bacteria, Algae, Fungi, and Protozoa.	7
II	**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	8

	• Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.	
III	**Pathogen contamination and infectious diseases:** • Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition 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. Fermented Foods. • Bacterial diseases of human- Tuberculosis, Tetanus, Typhoid, Cholera • Viral diseases of human-Hepatitis B andC, AIDS	8
IV	**Sterilization, cultivation and staining:** • Principals and applications of different methods of sterilization • Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms • Methods of isolation, Purification and preservation. • Principals of staining and types of staining	7
V	**Introduction to immune system:** • Introduction to Immunology, Components of mammalian immune system (cell and organs), Innate and Adaptive immunity • Humoral and cell mediated immune response, Clonal selection theory • An overview of primary and secondary immune responses	8
VI	**Antigen and Antibody structure and diversity:** • Antigen, epitopes and Adjuvents • Structure and isotypes of Immunoglobulins allotypes and idiotypes • B- and T-cell receptors • B and T cell maturation • Antibody diversity generation, somatic gene rearrangements during B-lymphocyte differentiation, allelic exclusion, affinity maturation, class switching , somatic hypermutation	8
VII	**MHC, antigen processing and presentation:** • Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. • Antigen processing and presentation • Autoimmune diseases, Immunodeficiency-AIDS and SCID.	7
VIII	**Immunological Techniques and Vaccines:** • Introduction to immunodiagnostics – Precipitation, Agglutination, RIA, ELISA and Immunofluorescence.	7

	• Passive & active immunization. • Types of vaccines-DNA vaccines, recombinant vaccines, inactivated vaccine • Common indigenous vaccines	

Suggested Reading

1. Pelczar M J, Reid R D, and Chan EC. (2001). **Microbiology** (5th ed.). New York: McGraw-Hill.
2. Willey J M, Sherwood L, Woolverton C J, Prescott L M, and Willey J M. (2011). **Prescott's Microbiology**. New York: McGraw-Hill.
3. Mattha, W, Berg C Y, and Black JG. (2005). **Microbiology, Principles and Explorations**. Boston, MA: John Wiley & Sons.
4. Cappuccino J G, and Welsh,C. (2016). **Microbiology: a Laboratory Manual**. Benjamin-Cummings Publishing Company.
5. Collins C H, Lyne PM, Grange J M, and Falkinham III J. (2004). **Collins and Lyne's Microbiological Methods** (8th ed.). Arnolds.
6. Levinson WE. (2020). **Review of Medical Microbiology and Immunology** (16th edition). McGraw Hill Education.
7. Ananthanarayana R, Panicker CKJ(2020). **Ananthanarayana and Panicker's Textbook of Microbiology**(11th edition) Universities Press (India) Pvt. Ltd
8. Punt J, Stranford S, Jones P., Owen JA, (2018). **Kuby Immunology**.(8th edition) New York: W.H. Freeman.
9. Delves P J, Martin SJ, Burton DR, and Roitt IM. (2017). **Roitt's Essential Immunology**.(13th edition). Wiley- Blackwell.
10. Murphy K, and Weaver C, (2016). **Janeway's Immunobiology**. (9th edition) New York: Garland Science.
11. Abbas AK, Lichtman AHH, Pillai S.(2017) **Cellular and Molecular Immunology** (9th edition)
12. Paul W E. (2012). **Fundamental Immunology**. New York: Raven Press.
13. Parham, P. (2005). **The Immune System**. New York: Garland Science.
14. Mohanty SK, Leela KS.(2014) **Textbook of Immunology**. (2nd Edition). Jaypee Brothers Medical Publishers Pvt Ltd.
15. Hay FC, Westwood OMR.(2008). **Practical Immunology**.(4th Edition). Wiley Blackwell.

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Suggested link

- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=microbiology
- https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=immunology
- https://nptel.ac.in/courses/102/103/102103038/
- https://nptel.ac.in/courses/102/105/102105083/
- https://nptel.ac.in/courses/102/103/102103015/
- https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf
- https://nptel.ac.in/content/storage2/courses/102103015/module1/lec1/1.html

Suggested Digital platform/Web link

Course prerequisite

To study this course, student must have passed semester III.

Suggested Continuous Internal Evaluation (CIE) methods

10 marks for Test

10 marks for presentation along with assignment 05 marks for Class interactions
Further Suggestions: None

Programme/Class: Diploma	**Year:** Second (2)	**Semester:** Fourth (IV)
Subject: Biotechnology		
Couse Code: B100402 P	**Course Title:** Microbiology and Immunology Lab	
Course Outcomes		
After completion of this course , students will be able to: • Understand methods of cleaning and sterilization of plasticwares and glasswares. • understand and perform pure culture techniques which includes, pour plate and • spread plate . • understand the preparation and use of differential, selective and special media. • understand and identify the morphology of cells of the immune system. • understand the basic concepts of blood grouping. • understand antigen antibody interactions and thus quantitate the presence of antigen and or antibodies in biological samples.		
Credits:2	**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: 0-0-4		

	Topic	**No. of Lectures**
	1. Safety measures in microbiology laboratory 2. Study of instruments: Compound microscope, Autoclave, Hot air oven, PH meter, and Laminar airflow 3. Introduction to different sterilization techniques 4. Isolation of bacteria & their biochemical characterization. 5. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop. 6. Preparation of media and sterilization, 7. Methods of isolation of bacteria from different sources. 8. Determination of bacterial cell size by micrometry. 9. Enumeration of microorganism - total & viable count. 10. Differential leucocytes count 11. Total leucocytes count 12. Total RBC count 13. Haemagglutination assay 14. Separation of serum from blood 15. Double immunodiffusion test using specific antibody and antigen. 16. ELISA demostration	60
Suggested Reading		

1. Pelczar M J, Reid R D, and Chan EC. (2001). **Microbiology** (5th ed.). New York: McGraw-Hill.
2. Willey J M, Sherwood L, Woolverton C J, Prescott L M, and Willey J M. (2011). **Prescott's Microbiology**. New York: McGraw-Hill.
3. Mattha, W, Berg C Y, and Black JG. (2005). **Microbiology, Principles and Explorations**. Boston, MA: John Wiley & Sons.
4. Cappuccino J G, and Welsh,C. (2016). **Microbiology: a Laboratory Manual**. Benjamin-Cummings Publishing Company.
5. Collins C H, Lyne PM, Grange J M, and Falkinham III J. (2004). **Collins and Lyne's Microbiological Methods** (8th ed.). Arnolds.
6. Levinson WE. (2020). **Review of Medical Microbiology and Immunology** (16th edition). McGraw Hill Education.
7. Ananthanarayana R, Panicker CKJ(2020). **Ananthanarayana and Panicker's Textbook of Microbiology**(11th edition) Universities Press (India) Pvt. Ltd
8. Punt J, Stranford S, Jones P., Owen JA, (2018). **Kuby Immunology**.(8th edition) New York: W.H. Freeman.
9. Delves P J, Martin SJ, Burton DR, and Roitt IM. (2017). **Roitt's Essential Immunology**.(13th edition). Wiley- Blackwell.
10. Murphy K, and Weaver C, (2016). **Janeway's Immunobiology**. (9th edition) New York: Garland Science

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Course prerequisite

To study this course, student must have passed semester III.

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: Degree	**Year:** Third (3)	**Semester:** Fifth (V)
Subject: Biotechnology		
Couse Code: B100501T	**Course Title:** Biostatistics and Bioinformatics	

Course Outcomes

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 usinf 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 bioinfomatical 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	Topic	No. of Lectures
I	**History and introduction to Bioinformatics:** • Introduction and applications of bioinformatics • Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-RayDiffraction, and microarray). Applications of Bioinformatics.	7
II	**Databases, Data generation, Data storage and retrieval:** • 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). • Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search.	8
III	**Sequence and Phylogeny analysis:** • 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). • Introduction to BLAST, using it on the web, Interpreting results, Phylogenetic Analysis. • PCR primer designing etc.	8
IV	**Searching Databases:** • SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. • Genome Annotation: Pattern and repeat finding, Gene identification tools.	7

V	**Types and Collection of data**: • Primary and Secondary data, Classification and Graphical representation of Statistical data. • Measures of central tendency and Dispersion. • Measures of Skewness and Kurtosis.	7
VI	**Probability:** • Definition of probability, Theorems on total and compound probability • Elementary ideas of Binomial, Poisson and Normal distributions.	8
VII	**Sampling:** • Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. • Problems on test of significance, t-test, chi-square test • for goodness of fit and analysis of variance (ANOVA)	8
VIII	**Correlation and Regression:** • Types, Karl-Pearson's correlation, Spearman's Rank correlation, Regression equation and fitting • Main features of regression analysis-simple and multiple regression analysis • Differences between correlation and regression analysis	7

Suggested Reading

1. Lesk, A. M. (2002). **Introduction to Bioinformatics**. Oxford: Oxford University Press.
2. Mount, D. W. (2001). **Bioinformatics: Sequence and Genome Analysis**. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). **Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins**. New York: Wiley-Interscience.
4. Pevsner, J. (2015). **Bioinformatics and Functional Genomics**. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). **Structural Bioinformatics**. Hoboken, NJ: Wiley-Liss.
6. Sharma V. Munjal A. Shanker A.(2018). **A Textbook of Bioinformatics**.(2nd Edition). Rastogi Publication.
7. Choudhuri S. (2014**) Bioinformatics for beginners**. (1st edition) Elsevier.
8. Harisha S. (2019) **Fundamentals of Bioinformatics**. Dreamtech Press
9. Rastogi SC. Mendiratta N. Rastogi P. (2013). **Bioinformatics Methods and Applications Genomics Proteomics and Drug Discovery.** (4th edition). Prentice Hall India Learning Private Limited
10. Ghosh Z. Mallick B. (2008). **Bioinformatics: Principles and Applications**. OUP India
11. Rosner, B. (2000). **Fundamentals of Biostatistics**. Boston, MA: Duxbury Press.
12. Daniel, W. W. (1987). **Biostatistics, a Foundation for Analysis in the Health Sciences**. New York: Wiley
13. Mariappan P. (2013) **Biostatistics**. Pearson
14. Rastogi VB.(2015). **Biostatistics** (3rd Edition). MedTec

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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/
- https://ocw.mit.edu/courses/mathematics/18-650-statistics-for-applications-fall-2016/
- https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/
- https://ocw.mit.edu/courses/mathematics/18-443-statistics-for-applications-fall-2003/lecture-notes/

Suggested Digital platform/Web link

Course prerequisite

To study this course, student must have passed semester IV.

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: Degree	**Year:** Third (3)	**Semester:** Fifth (V)
Subject: Biotechnology		
Couse Code: B100502T	**Course Title:** Animal and Plant 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 the principles, practices and applications of plant biotechnology, transgenic plant generation, plant tissue culture, plant genomics, and genetic transformation.
- 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, plants and microbes.

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	Topic	No. of Lectures
I	**Transgenesis:** • Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. • Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis,	7

	Trypanosomiasis, Theileriosis.	
II	**Gene delivery methods for animals :** • Viral vectors • Vector less or direct DNA transfer, particle bombardment, electroporation, microinjection & chemical methods, creation of animal models of human diseases.	8
III	**Animal propagation:** • Artificial insemination, animal Clones. • Conservation Biology – embryo transfer techniques.	6
IV	**Genetic modification in Medicine:** • Gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, • Human genetic engineering, problems & ethics • Introduction to Stem Cell Technology and its applications	8
V	**Introduction, Cryo and organogenic differentiation:** • Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. • Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation. • Protoplast isolation and fusion, methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. • Somaclonal variation nomenclature, methods, applications basis and disadvantages	7
VI	**In vitro haploid production Androgenic methods:** • Anther culture, Microspore culture androgenesis • 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.	8
VII	**Plant Growth Promoting bacteria:** • Nitrogen fixation, • Nitrogenase, Hydrogenase, Nodulation • Biocontrol of pathogens • Growth promotion by free-living bacteria.	8
VIII	**Transgenesis:** • Plant transformation technologies • *Agrobacterium tumifaciens* infection, basis of tumor formation, features of Ti & Ri plasmids,	8

	mechanisms of DNA transfer, role of virulence genes, use of Ti plasmid as vector, binary vectors • Application of plant transformation for productivity and performance: Herbicides resistance, insect resistance, Bt genes, non-Bt like protease inhibitors, virus resistance, long shelf life of fruits and flowers	

Suggested Reading

1. Razdan, M. K. (2003). **Introduction to Plant Tissue Culture**. Enfield, NH: Science
2. Chawla, H. S. (2000). **Introduction to Plant Biotechnology**. Enfield, NH: Science.
3. Smith R(2012). **Plant Tissue Culture** (3rd Edition) Academic Press.
4. Slater, A., Scott, N. W., & Fowler, M. R. (2008). **Plant Biotechnology: an Introduction to Genetic Engineering**. Oxford: Oxford University Press.
5. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). **Biochemistry & Molecular Biology of Plants.** Chichester, West Sussex: John Wiley & Sons.
6. Umesha, S. (2013). **Plant Biotechnology**. The Energy and Resources.
7. Glick, B. R., & Pasternak, J. J. (2010). **Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington**, D.C.: ASM Press.
8. Brown, T. A. (2006). **Gene Cloning and DNA Analysis: an Introduction.** Oxford: Blackwell Pub.
9. Primrose, S. B., & Twyman, R. M. (2006). **Principles of Gene Manipulation and Genomics.** Malden, MA: Blackwell Pub.
10. Slater, A., Scott, N. W., & Fowler, M. R. (2003). **Plant Biotechnology: The Genetic Manipulation of Plants**. Oxford: Oxford University Press.
11. Levine, M. M. (2004). **New Generation Vaccines**. New York: M. Dekker.
12. Pörtner, R. (2007). **Animal Cell Biotechnology: Methods and Protocols**. Totowa, NJ: Humana Press
13. Singh B. Gautam SK (2013). **Textbook of animal biotechnology**. The Energy and Resources Institute, TERI
14. Gupta PK.(2018) **Animal Biotechnology**. Rastogi Publications
15. Singh BD. (2015). **Plant Biotechnology** (3rd edition). Kalyani Publishers
16. Chawla HS. (2020) **Introduction to Plant Biotechnology**(3rd edition) OXFORD & IBH Publishing
17. Satyanarayana U (2020). **Biotechnology**. Books and Allied (P) Ltd
18. Singh BD. (2015). **Biotechnology: Expanding Horizons** (4th edition). Kalyani Publishers
19. Dubey RC. (2014) **A Textbook of Biotechnology** (5th edition) S Chand and Company Ltd.
20. स हिं बी डी(2017) **बायोटेक्नोलोजी** Kalyani Publishers

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Suggested link

- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=stemcells
- https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/lecture-notes/lecture13.pdf
- https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/lecture-notes/
- https://ocw.mit.edu/courses/health-sciences-and-technology/hst-535-principles-and-practice-of-tissue-engineering-fall-2004/
- https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-

biological-engineering-fall-2007/labs/mod1_3/
Suggested Digital platform/Web link
Course prerequisite To study this course, student must have passed semester V.
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: Degree	**Year:** Third (3)	**Semester: Fifth (V)**
Subject: Biotechnology		
Couse Code: B100503P	**Course Title:** Bioinformatics, Biostatistics Tissue culture Lab	
Course Outcomes (COs)		
Students should be able to - • apply basic bioinformatics tools for the studies and research in other areas of their biotechnology and microbiology programs, such as finding • gene/protein homologs, designing primers, identifying mutations, etc. • do cleaning, sterilization of laboratory, plastic and glasswares. • prepare different types of culture media for animal and plant cell culture • understand and solve the problems in the area of animal and plant Biotechnology.		
Credits: 2	**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: 0-0-4		

	Topic	No. of Lectures
	1. An introduction to Computers, MS-Word, MS Excel, MS Power Point. 2. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt. 3. Similarity searches using tools like BLAST and interpretation of results. 4. Multiple sequence alignment using ClustalW and interpretation of results. 5. Use of gene prediction methods (GRAIL, Genscan, Glimmer). 6. Use of various primer designing and restriction site prediction tools. 7. Use of different protein structure prediction databases (PDB, SCOP, CATH etc.). 8. Exercise to data entry, edit, copy , move etc. using MS EXCEL spreadsheet	60

	9. Computations analysis of biological data by Mean, Median, Mode, S.D., Correlation, regression Analysis, Chi square test, Student test, ANOVA 10. Designing of bar diagram, pi chart, histogram, scatter plots, in EXCEL for presentation of data. 11. Measure of skewness and kurtosis 12. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization 13. Sources of contamination and decontamination measures. 14. Preparation of Hanks Balanced salt solution 15. Preparation of Minimal Essential Growth medium 16. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid. 17. Preparation of complex nutrient medium (Murashige & Skoog's medium) 18. To selection, Prune, sterilize and prepare an explant for culture. 19. Significance of growth hormones in culture medium. 20. To demonstrate various steps of Micropropagation.	

Suggested Reading

1. Lesk, A. M. (2002). **Introduction to Bioinformatics**. Oxford: Oxford University Press.
2. Mount, D. W. (2001). **Bioinformatics: Sequence and Genome Analysis**. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). **Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins**. New York: Wiley-Interscience.
4. Pevsner, J. (2015). **Bioinformatics and Functional Genomics**. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). **Structural Bioinformatics**. Hoboken, NJ: Wiley-Liss.
6. Sharma V. Munjal A. Shanker A.(2018). **A Textbook of Bioinformatics**.(2nd Edition). Rastogi Publication.
7. Choudhuri S. (2014**) Bioinformatics for beginners**. (1st edition) Elsevier.
8. Harisha S. (2019) **Fundamentals of Bioinformatics**. Dreamtech Press
9. Rastogi SC. Mendiratta N. Rastogi P. (2013). **Bioinformatics Methods and Applications Genomics Proteomics and Drug Discovery.** (4th edition). Prentice Hall India Learning Private Limited
10. Ghosh Z. Mallick B. (2008). **Bioinformatics: Principles and Applications**. OUP India
11. Rosner, B. (2000). **Fundamentals of Biostatistics**. Boston, MA: Duxbury Press.
12. Daniel, W. W. (1987). **Biostatistics, a Foundation for Analysis in the Health Sciences**. New York: Wiley
13. Mariappan P. (2013) **Biostatistics**. Pearson
14. Rastogi VB.(2015). **Biostatistics** (3rd Edition). MedTec

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

Course prerequisite

To study this course, student must have passed semester IV.

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: Degree	**Year:** Third (3)	**Semester:** Sixth (VI)
Subject: Biotechnology		
Couse Code: B100601T	**Course Title:** Industrial and Environmental Biotechnology	
Course Outcomes		
After successful completion of the course, student will be able to: • understand the problems in isolation, strain improvement and growth of microorganisms in industrial processes. • isolate and improve the industrially important microorganisms. • understand design and types of fermenters and operation of fermenters. • learn fundamentals of Environmental Biotechnology • understand the importance of clean (pollution free) environment • understand biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling. • understand the regulation of bioethics and policies of IPR and entrepreneurship.		
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	Topic	No. of Lectures
I	**Introduction of Industrial microbiology and Bioprocess technology:** • History-Introduction, scope and relation with other sciences. • Screening for new metabolites: primary and secondary products. • Strain development through selection, mutations and recombination, and other recent methods	7
II	**Bioprocess technology:** • Introduction to bioprocess technology. • Design and working of a typical bioreactor • Range of bioprocess technology and its chronological development. • Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.	9
III	**Production of alcohols, antibiotic and enzymes:** • Production of alcohols (Ethanol) and organic acids (citric and acetic). • Production of biologically active compounds:	9

	antibiotics (penicillin) and enzymes (amylase, protease). • Production of microbial food and single cell proteins • Bioreactor for immobilized cells/enzyme system • Biosensors and their applications	
IV	**Environment and pollution:** • Physico-chemical and biological characteristics of environment. • Water, soil and air as a component of environment. • Pollutants: Nature, origin, source, monitoring and their impacts. • Air, Water and Noise pollution • Conventional fuels and their environmental impact	8
V	**Bioremediation:** • 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 andchlorinates hydrocarbons and petroleum products.	8
VI	**Sewage treatment and biofertilizers:** • Treatment of municipal waste and Industrial effluents. • Bio-fertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. • Algal and fungal biofertilizers (VAM)	7
VIII	**Bioleaching and genetically modified organisms:** • Enrichment of ores by microorganisms (Gold, Copper and Uranium). • Environmental significance of genetically modified microbes, plants and animals.	6
VIII	**Bioethics, IPR, Entrepreneurship:** • Importance of Bioethics, IPR and entrepreneurship • Introduction to Intellectual Property Rights (IPR)- World Intellectual properties, Indian Intellectual properties • Entrepreneurship in India	6

Suggested Reading

1. Glazier AN and Nikaido H (2007).Microbial Biotechnology – Fundamental & Applied Microbiology – Second Edition. Cambridge University Press.
2. Casida LE (2019) **Industrial Microbiology**. Second Edition,New Age International Publisher.
3. Stanbury P F and Whitaker, A. (2010). **Principles of Fermentation Technology**. Oxford: Pergamon Press
4. Shuler M L and Kargi F. (2002). **Bioprocess Engineering: Basic Concepts**. Upper Saddle River, NJ: Prentice Hall.
5. Crueger W and Crueger A (2002) Cruegers Biotechnology: **A Textbook of Industrial Microbiology.** Third Edition, Panima Publishing Corp., New Delhi.
6. Blanch H W and Clark D S. (1997). **Biochemical Engineering**. New York: M.

Dekker.
7. Bailey J E and Ollis D F. (1986). **Biochemical Engineering Fundamentals.** New York: McGraw-Hill.
8. Richard HB, Julian ED, Arnold LD. (2010) **Manual of Industrial Microbiology and Biotechnology**, 3rd Edition
9. Thakur IS. (2011)**Environmental Biotechnology basic concepts and applications.** I. K. International Publishing House Pvt. Limited
10. Evans GM and J. C. Furlong (2003). **Environmental Biotechnology: Theory and Applications**. Wiley Publishers.
11. Ritmann R and McCarty P L (2000**). Environmental Biotechnology: Principle & Applications.** 2nd Ed., McGraw Hill Science.
12. Scragg A., (2005) **Environmental Biotechnology**. Pearson Education Limited.
13. Srinivas TR (2008). **Environmental Biotechnology**.New Age International Pvt. Ltd.
14. Chapman JL .**Ecology: Principal & Application.**Cambridge Univ. Press.
15. Odum E and Barret G. (2004) **Fundamentals of Ecology**. Nataraj Publication.

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

Suggested link

- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-34-waste-containment-and-remediation-technology-spring-2004/lecture-notes/
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-018j-ecology-i-the-earth-system-fall-2009/
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-018j-ecology-i-the-earth-system-fall-2009/lecture-notes/MIT1_018JF09_Lec07.pdf
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-89-environmental-microbiology-fall-2004/
- https://ocw.mit.edu/high-school/biology/exam-prep/cellular-energetics/fermentation-cellular-respiration/fermentation/

Suggested Digital platform/Web link

Course prerequisite

To study this course, a student must have passed semester V.

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: Degree	**Year:** Third (3)	**Semester:** Sixth (VI)
Subject: Biotechnology		
Couse Code: B100602T	**Course Title:** Food Biotechnology	

Course Outcomes

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

- understand the history and evolution of food technology and processing.
- understand the importance microorganisms in food preservation
- learn various food processing and preservation technologies.

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	**Topic**	**No. of Lectures**
I	**Introduction to Food Biotechnology** • Historical Background of Food technology • Traditional fermented foods (meat, fish, bread, sauerkraut, soy bean, coffee, cocoa, tea) • Importance, global trends, codex guidelines, nutritional labelling in India, FSSAI guidelines • Improvements through Biotechnology (e.g. Golden Rice, Potato, Flavr Savr Tomato etc.)	7
II	**Enzymes in Food Industry:** • Carbohydrases • Proteasase • Lipases • Modification of food using enzymes: • Role of endogenous enzymes in food quality, • Enzymes use as processing aid and ingredients	8
III	**Food Fermentations:** • Common fermented foods - Cheese, Butter, Yoghurt, fermented/condensed milk and kefir. • Alcoholic beverages (Beer, Wine, Whisky), • Sauerkraut, Pickles, Soy products, Tea, coffee etc.	7
IV	**Food preservation:** • Food adulteration and prevailing food standards in India. • Source of microorganisms in milk and their types. • Microbiological examination of milk (standard plate count, direct microscopic count, reductase and phosphatase test). • Dehydration and pasteurization of milk.	7
V	**Value addition products:** • Value addition products like High Fructose Syrup, Invert Sugars etc. SCPs (e.g. Spirulina, Yeast etc.) as food supplements, • Edible fungus: Mushrooms. Potential of Probiotics. • Flavour enhancers: Nucleosides, nucleotides and related compounds. Organic acids (Citric acid, Acetic acid) and their uses in foods/food products.	7
VI	**Vitamins and Minerals:** • Importance of Vitamins and their supplementation in foods and feedstock. • Food preservation and storage. Food Processing • Important minerals and their function in body and deficiency conditions	7

	• Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals;	
VII	**Growth of microorganisms in food:** • Intrinsic and extrinsic factors. • Food Spoilage (microbial and non-microbial) Control mechanisms of food spoilage: Physical and Chemical. • Microbial spoilage of food and factors affecting them: Spoilage of various kinds of foods: fish. meat, poultry, sea foods, bread and dairy products). • Food adulteration and prevailing food standards in India. • Indicator Microorganisms: As an indicator of good quality	8
VIII	**Food and water borne diseases:** • Gastroenteritis, Diarrhoea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Dental Infections, etc. • Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc. • Detection of food-borne pathogens.	9

Suggested Reading

1. Ray B and Bhunia A. 2008. **Fundamental Food Microbiology**, 4th Ed., CRC press, Taylor and Francis Group, USA.
2. Martin RA and Maurice OM. 2008. **Food Microbiology**, 3rd Ed., The Royal Society of Chemistry, Cambridge, UK.
3. James M J.. 2000. **Modern Food Microbiology**, 6th Ed. Aspen Publishers, Inc., Gaithersburg,Maryland, USA.
4. Frazier WC, and Westhoff DC. **Food Microbiology**. Fourth edition, MacGraw Hills publication
5. Lopez GFG, Canaas G, Nathan EV. **Food Sciences and Food biotechnology**.
6. Adams AR, and Moss MO. *Food Microbiology*. Third edition, Royal Society of Chemistry publishing .
7. Hohn T and Leisinger KM. **Biotechnology of Food Crops in Developing Countries**.
8. Doyle MP, Beuchat LR and Montville TJ. **Food Microbiology Fundamentals and Frontiers**. ASM Press.
9. Schwartzberg HG, RaoMA. (Eds.) **Biotechnology and Food Process Engineering** .

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

Suggested link

Suggested link

- https://ocw.mit.edu/courses/linguistics-and-philosophy/24-03-good-food-ethics-and-politics-of-food-spring-2017/lecture-notes/MIT24_03S17_lec24.pdf
- https://ocw.mit.edu/courses/linguistics-and-philosophy/24-03-good-food-ethics-and-politics-of-food-spring-2017/lecture-notes/MIT24_03S17_lec20.pdf
- https://www.rug.nl/research/irees/research/edulink-fsba/fsba-course-modules/fsba-module-2-unit-3-notes-english.pdf
- https://foodinsight.org/wp-content/uploads/2003/03/Biotech-Guide.pdf
-

Suggested Digital platform/Web link
Course prerequisite To study this course, student must have passed semester V.
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: Degree	**Year:** Third (3)	**Semester:** Sixth (VI)
Subject: Biotechnology		
Couse Code: B100603P	**Course Title:** Industrial and Environmental Biotechnology Lab	
Course Outcomes		
After completion of this course , students will be able to- • understand various methods of screening of industrially important microorganisms from different sources. • understand the working of small scale fermenter and also determine the aeration efficiency of the fermenter • understand the technique of immobilization of cells like yeast and E.coli.		
Credits: 2	**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: 0-0-4		

	Topic	**No. of Lectures**
	1. Calculation of bacterial growth curve. 2. Calculation thermal death point (TDP) of a microbial sample. 3. Production and analysis of ethanol. 4. Production and analysis of amylase.. 5. Production and analysis of lactic acid. 6. Isolation of industrially important microorganism from natural resource. 7. Calculation of Total Dissolved Solids (TDS) of water sample. 8. Calculation of BOD of water sample. 9. Calculation of COD of water sample. 10. Bacterial Examination of Water by MPN Method.	60

Suggested Reading

1. Glazier AN and Nikaido H (2007).Microbial Biotechnology – Fundamental & Applied Microbiology – Second Edition. Cambridge University Press.

2. Casida LE (2019) **Industrial Microbiology**. Second Edition,New Age International Publisher.
3. Stanbury P F and Whitaker, A. (2010). **Principles of Fermentation Technology**. Oxford: Pergamon Press
4. Crueger W and Crueger A (2002) Crueger's Biotechnology: **A Textbook of Industrial Microbiology.** Third Edition, Panima Publishing Corp., New Delhi.
5. Blanch H W and Clark D S. (1997). **Biochemical Engineering**. New York: M. Dekker.
6. Bailey J E and Ollis D F. (1986). **Biochemical Engineering Fundamentals.** New York: McGraw-Hill.
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9. Evans GM and J. C. Furlong (2003). **Environmental Biotechnology: Theory and Applications**. Wiley Publishers.
10. Scragg A., (2005) **Environmental Biotechnology**. Pearson Education Limited.
11. Srinivas TR (2008). **Environmental Biotechnology**.New Age International Pvt. Ltd.

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Course prerequisite

To study this course, student must have passed semester V.

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