CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY
KANPUR

Four Year Undergraduate Programme (FYUP)

BIOTECHNOLOGY

Syllabus of

4 YEAR B.Sc. (HONOURS)

4 YEAR B.Sc. (HONOURS WITH RESEARCH)

AND

4+1 YEAR (B.Sc. HONOURS/ B.Sc. HONOURS WITH RESEARCH + M.Sc.) IN BIOTECHNOLOGY

SESSION 2025-2026 ONWARDS

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SESSION 2025-2026 ONWARDS

Prof. Neelam Pathak (Online)
Prof. Ram Narain (Online)
Prof. B.N. Mishra (Online)

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR
STRUCTURE OF SYLLABUS FOR THE
Program: Four Year Undergraduate Programme (FYUP) for Biotechnology

Syllabus Developed By			
Name of BoS convenor/BoS member	**Designation**	**Department**	**College/University**
Prof. S. K. Awasthi	Dean, Faculty of Life Sciences	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Prof. Varsha Gupta	Director, School of Life Sciences and Biotechnology	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Prof. Neelam Pathak	External Expert	Department of Biochemistry	R.M.L. Awadh University, Ayodhya
Prof. Ram Naraian	External Expert	Department of Biotechnology	V.B.S. Purvanchal University, Jaunpur
Prof. B. N. Mishra	External Expert	Department of Biotechnology	Instt. of Engineering and Technology, Lucknow
Prof. Rolee Sharma	Professor	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Dr.. Shilpa D. Kaistha	Associate Professor	Department of Biotechnology, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Dr. Alok Pandey	Head, Department of Biotechnology	Department of Biotechnology, School of Life Sciences and Biotechnology	CSJM University, Kanpur

CURRICULUM & CREDIT FRAMEWORK FOR FYUP

Year	Semester	Course Code	Paper Title	Theory / Practical	Credits
First Year	I	B100101T	Cell Biology and Genetics	Theory	4
		B100102P	Cell Biology and Genetics Lab	Practical	2
	II	B100201T	Molecular Biology and Genetic Engineering	Theory	4
		B100202P	Genetic Engineering Lab	Practical	2
Second Year	III	B100301T	Biochemistry and Biochemical tools	Theory	4
		B100302P	Biochemistry Lab	Practical	2
	IV	B100401T	Microbiology and Immunology	Theory	4
		B100402P	Microbiology and Immunology Lab	Practical	2
		B100403R	Research Project/ Internship	Project	3
Third Year	V	B100501T	Biostatistics and Bioinformatics	Theory	4
		B100502T	Animal and Plant Biotechnology	Theory	4
		B100503P	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
Bachelor of Science with Honours Degree in Biotechnology					
Fourth Year	VII	B100701T	Cell and Developmental Biology	Theory	4
		B100702T	General Biochemistry	Theory	4
		B100703T	Bioanalytical Techniques	Theory	4
		B100704T	General Microbiology	Theory	4
		B100705P	PRACTICAL	Practical	4

	VIII	B100801T	Molecular Biology and Genetics		Theory	4
		B100802T	Intermediary Metabolism		Theory	4
		B100803T	Plant Biotechnology and Tissue Culture		Theory	4
		B100804T	Enzymology		Theory	4
		B100805P	PRACTICAL		Practical	4
OR						
Bachelor of Science Degree Honours with Research (Only for students who secure 75% marks in the first 6 semesters)						
Fourth Year	VII	B10 0701T	Cell and Developmental Biology	***ELECTIVE (SELECT ANY 3)**	Theory	4
		B100702T	General Biochemistry		Theory	4
		B100703T	Bioanalytical Techniques		Theory	4
		B100704T	General Microbiology		Theory	4
		B100705P	PRACTICAL		Practical	4
		B100706R	Research Projects / Dissertation (Progressive)		Project	4
	VIII	B100801T	Molecular Biology and Genetics	***ELECTIVE (SELECT ANY 3)**	Theory	4
		B100802T	Intermediary Metabolism		Theory	4
		B100803T	Plant Biotechnology and Tissue Culture		Theory	4
		B100804T	Enzymology		Theory	4
		B100805P	PRACTICAL		Practical	4
		B100806R	Research Projects / Dissertation (Submitted)		Project	4
Master in Biotechnology (1 Year)						
Fifth Year	IX	B100901T	Cellular and Molecular Immunology		Theory	4
		B100902T	Principle and Application of Genetic Engineering		Theory	4
		B100903T	Genomics and Proteomics	***ELECTIVE (SELECT ANY 1)**	Theory	4
		B100904T	Fundamental of Biostatistics and Biomaths		Theory	4
		B100905T	Animal Cell Culture & Medical Biotechnology		Theory	4
		B100906T	Computational Biology and Bioinformatics		Theory	4
		B100907P	Practical		Practical	4
		B100907R	Research Projects /Dissertation (Progressive)		Project	4

	X	B101001T	Bioprocess Technology	* ELECTIVE (SELECT ANY 4)	Theory	4
		B101002T	Oncotechnology		Theory	4
		B101003T	Nanotechnology		Theory	4
		B101004T	Neurosciences and Technology		Theory	4
		B101005T	IPR, Bioethics and Entrepreneurships		Theory	4
		B101006T	Environmental Biotechnology		Theory	4
		B101007T	Microbial Biotechnology		Theory	4
		B101008T	Research Methodology		Theory	4
		B101009R	Dissertation (Submitted)		Project	4

Semester - Wise Syllabus of the Papers in FYUP of Biotechnology

Programme/Class: Certificate	Year: First (I)	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 Weinberg law (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 ह्ळ्ंबी डी (2017) बायोटे4ोलोजी Kalyani Publishers
20. पेकी गु ा,कोिशका िश ान िशम अनुशा्ाा्ाा्ाा्ाा्ा िशकी, 2015 2nd edition Rastogi Publications
21. स ह्ळ्ंबी डी, आनुशा्ाा्ाा्ा िशकी के आधार. (2017) Kalyani Publishers
22. ्ाा्ानेकी ्ाा्ी, 4र◆रंकार गायत्री. आधुननक कोिशका िश ान, 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 (I)	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. स हो०ो०ि०००ं 5 बी डी(2017) बायोटे4ोलोजी 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 (I)	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 Laboratory Press.
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

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

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,. Biologically important 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

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

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 their function 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 or parasitic 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.

Course 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=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)
Couse Code: B100402 P	Subject: Biotechnology 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-Ray Diffraction, 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 ह्यिंबी डी(2017) **बायोटे4ोलोजी** 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 and chlorinates 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
-

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.

Programme/Class: Honours Degree	Year: Fourth (4)	Semester: Seventh (VII)
Subject: Biotechnology		
Couse Code: B100701T	Course Title: CELL AND DEVELOPMENTAL BIOLOGY	

Course Outcomes:

This course aims to give the student an overview of basic cell biology and its application. This course will focus on identifying key components that constitute living cells. The focus will be orientated on cell and its application in developmental biology, with emphasise on key techniques currently used in the study of 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	Topic	No. of Lectures
I	**Cell Structure:** Cell as a unit of life, prokaryotic, and eukaryotic cell, differences between plant and animal cell, general idea about lipid bilayer membranes, membrane transport of small molecules, cell adhesion, cell junction and extra cellular matrix, chemical composition of cell wall, cross linkage, porosity, tensilestrength, turgor modifications in special types of cells, plasmodesmata and fluid transport between	7
II	**Cell Organelles** Structure and functions of -Endoplasmic Reticulum: types - rough & smooth, intracellular transport & lipid biosynthesis, ribosomes, Golgi apparatus, role of mitochondria in cellular energies & biogenesis, Chloroplasts, lysosomes: general organization, polymorphism, enzyme systems and their functions, vacuoles and ergastic substances, peroxisomes: formation, enzyme content, and role. •	8
III	**Cytoskeleton and Cell Signalling** Cytoskeleton: microtubules, microfilaments & associated proteins - actin, myosin and intermediate filaments, three-dimensional organization of cytoskeleton, chromatin and chromosomes, Roles of microfilaments and microtubules in cellular structure and function. **Cell Signalling:** General principles of signalling switches. Receptor characteristics. Identification and characteristics of receptor proteins, G-proteins and receptor tyrosine kinase mediated signalling Ca2+ flux and its interpretation in cytoplasm, role of Ca2+ binding proteins.	7

IV	**Cell division and cell cycle** Mitosis, meiosis and binary fission, cell cycle, cell cycle clock & check points, overview of cell cycle; Molecular mechanisms for regulating mitotic events; check points in cell cycle regulation; meiosis; cell birth, lineage and death. Apoptosis: The role of programmed cell death in maintaining the social order of cells and in tissue sculpting. Pathways and hallmarks of apoptosis. Role of caspases and Bcl2 family proteins.	7
V	**Cellular Development** Basics of Development: Potency, induction, commitment, specification, competence, determination and differentiation, morphogenetic gradient, cell fate and cell lineages, stem cell and their properties, transdifferentiation, genomic equivalence, and cytoplasmic determinants, imprinting, mutants their analysis. Gametogenesis: Fertilization and early development, differentiation of germ layers, cellular polarity, maternal gene effects, zygotic gene effects, homeotic gene effect in Drosophila, Embryogenesis.	7

Programme/Class: Honours Degree	Year: Fourth (4)	Semester: Seventh (VII)
Subject: Biotechnology		
Couse Code: B100702T	Course Title: GENERAL BIOCHEMISTRY	

Course Outcomes:

- The course aims is the understanding structure and function of major classes of biopolymers.
- Aims of the course are to understanding central metabolic process and role of enzymes in modulating pathways.
- The theoretical background of biochemical knowledge to interpret the results in biochemistry experiments.

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
UNIT I:	Properties of water and biological buffers Some Important Properties of Water: Dissociation of water and its ion product, pH, pka Bronsted Acids, ionization of weak acids and bases; Henderson-Hasselbalch equation, Titration curves and buffering action, physiological buffers; Principles of Thermodynamics	12
UNIT II:	Structure and Function of Carbohydrates Carbohydrates: Classification and properties of simple carbohyd rates, monosaccharides, disaccharides and polysaccharides. Structural polysaccharides: cellulose and chitin; storage polysaccharides: starCh and glycogen; glycosaminoglycans; glycoconjugates: proteoglycans, glycoproteins and glycolipids	12
UNIT III:	Structure and Function of Lipids Fatty Acids and Lipids: Structure, classification and properties of fatty acids, structure and functions of lipids: Triacyl glycerides, phosphoglycerates, sphingolipids, cholesterol, steroids, eicasanoids, Lipoproteins	12
UNIT IV:	Structure and Function cf Nucleic Acid Sturcture and functions of DNA: Base pairing: Watson-crick, Hoogsteen and Wobble base pairs, The salient features of the Watson-Crick model of B-DNA, The structure and helical parameters of B-DNA, A-DNA, and Z-DNA. Melting temperature (Tm), Forces stabilizing the B-DNA. Structure and functions of RNA: Physicochemical properties of RNA, classification, structure and functions of different types of RNAs (hnRNA, mRNA, rRNA, tRNA, snRNA, snoRNA, antisense RNA telomerase RNA, gRNA,etc.). The clover leaf and L-shaped structures of tRNA.	12
UNIT V:	Structure and Function of Amino Acid Amino acids and proteins: Classification, chemical structure and general properties of amino acids. Standard and nonstandard amino acids found in proteins. The peptide bond and its characteristics. Proteins: peptides, primary, secondary, tertiary	12

	and quaternary structure of proteins, Hydrolysis of proteins: Action of different proteases.	

Suggested Reading:

1. Biochemistry by Voet B and Voet JG, Wiley Publishers, USA
2. Biochemistry 5th Revised edition by Lubert Strver, Jeremy M. Berg, John L. Tymoczko, Macmillan Publishers, USA D.L.
3. Nelson and M.M. Cox Lehninger Principles of Biochemistry, Publisher: WH Freeman; 8th ed.NewYork

Programme/Class: Honours Degree	**Year:** Fourth (4)	**Semester:** Seventh (VII)
Subject: Biotechnology		
Couse Code: B100703T	**Course Title:** BIOANALYTICAL TECHNIQUES	
Course Outcomes:The purpose of this course is to provide an understanding of fundamental concepts and underlying principles in the instruments used in biotechnology. In addition, the course is expected to develop the analytical skill to enable them to interpret the data.		
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
UNIT I:	Microscopy Important concepts in microscopy: Resolution, contrast, magnification; principle and application of light microscopy: compound, phase contrast; dark field, fluorescence and confocal microscopy, principle and application of electron microscopy- scanning and transmission electron microscopy.	**12**
UNIT II:	Centrifugation Sedimentation: Centripetal force, centrifugal force and sedimentation coefficient. Principle of centrifugation: RCF and RPM, types of rotors: fixed angle, swinging bucket and vertical rotors, types of centrifuges and their uses, ultracentrifuge and its applications: preparative and analytical.	**12**
UNIT III:	Chromatography techniques Principle and application of paper chromatography; thin layer chromatography; gel filtration chromatography; column chromatography- ion-exchange chromatography; affinity chromatography; gas-liquid chromatography; high performance liquid chromatography. Electrophoresis and blotting techniques: Principle of electrophoresis; agarose gel electrophoresis; sodium dodecyl sulphate-polyacrylamide gel electrophoresis; first dimension and second dimension electrophoresis; isoelectric focusing; capillary electrophoresis;	**12**

	southern, northern and western blotting.	
UNIT IV:	Spectroscopic techniques Electromagnetic radiation; principle of absorption of light; principle and application of UV-Visible spectroscopy and IR spectroscopy; Fourier transform infrared spectroscopy; Fluorescence spectroscopy; NMR; Atomic absorption spectroscopy; Mass spectroscopy; Raman spectroscopy.	12
UNIT V:	Radioactivity Radioactivity Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counte r; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.	12

Suggested Reading:

1. Freifelder O., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2 nd Edition, W.H. Freeman & Company, San Fransisco, zg 2.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5 th Edition, Cambridge University Press, 2000.
3. O. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected Readings from Methods in Enzymology, Academic Press.

Programme/Class: Honours Degree	**Year:** Fourth	**Semester:** seventh (VII)
Subject: Biotechnology		
Couse Code: B100704T	**Course Title: GENERAL MICROBIOLOGY**	

Course Outcomes:

The course is designed to give an in-depth view of prokaryotes with special concentration on the structure, metabolism and genetics of bacteria. The students will gain a breath of understanding of microbiology from the cellular to molecular levels of organization in conjunction with bacterial physiology and metabolism.

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
UNIT I:	**History and Scope of Microbiology** Major events leading to the establishment of science of microbiology; identification of microorganisms on the basis of morphological, physiological, biochemical, immunological, and molecular characteristics; bacterial classification according to Bergey's Manual of Systemic Bacteriology; relevance of microbiology to human life; microorganisms as model organisms	12

UNIT I:	**Structure of Prokaryotic cell** Overview of prokaryotic cell (size, shape and arrangement of the cell); structure of bacterial cell wall; structures external to cell wall (capsules, slime layer, pili and fimbriae, flagella, prosthecae); structures internal to cell wall (inclusion bodies, magnetosomes, nucleoid, mesosome); spores and cysts; differences between Gram +ve and Gram —ve bacteria,and archaebacteria and eubacteria	12
UNIT II:	**Growth and Nutrition In Bacteria** Nutritional types in microorganisms on the basis of sources of carbon, energy and electrons/hydrogen; Uptake of nutrients by bacterial cells: Passive diffusion, facilitated diffusion, group translocation; chemiosmotic theory and active transport; iron uptake; growth phases and mathematics of bacterial growth; physical and chemical agents to control bacterial growth.	12
UNIT III:	**Microbial Metabolism** Overview of microbial metabolism; types of photosynthesis in bacteria; photosynthetic machinery of bacteria (bacteriochlorophyll, carboxysomes, bacterial reaction centre, electron transport); photosynthetic fixation of CO2 in bacteria; bacterial fermentation; assimilation of inorganic phosphorus, sulfur, and nitrogen	12
UNIT IV:	**Microbial Genetics** Plasmids and epitomes; transformation (Griffith's experiment, competent cel|s); conjugation (U-tube experiment; F+ X Fmating; Hfr conjugation, F' conjugation); transduction (generalized and specialized transduction); transposable elements in bacteria (IS elements)	12

Suggested Reading:

1. Ananthanarayan, R and Kapil, A. 2013. A & P Textbook of Microbiology. 9th ed. Orient BlackSwan
2. Pelczar, MJ, Chan, ECS and Krieg, NR. 2001. Microbiology. Sth ed. Tata MCGraw Hill
3. Sharma, PD. 2010.Microbiology. Rastogi Publications.
4. Singh, RP. 2015.Microbiology. Kalyani Publishers S. Black, JG. 2012. Microbiology. 8th ed. John Wiley & Sons
6. Tortora, GJ. 2008. Microbiology. 9th ed. Pearson Education
7. Willey, J, Sherwood, L and Woalverton, C. 2011. Prescott's Microbiology. 8th ed. McGraw Hill edu.

Programme/Class: Honours Degree	**Year:** Fourth	**Semester:** VII
Subject: Biotechnology		
Couse Code: B100705P	**Course Title:** PRACTICAL	
Course Outcomes: The students will be able to perform experiments based on cell biology, Microbilogy and Biochemistry with the knowledge of analytical tools and techniques.		
Credits: 4	**Core Compulsory**	
Maximum Marks: 100 (75+25)	**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
UNIT I:	**Cell Biology** 1. Theory and application of buffers and pH. 2. Study and maintenance of simple and compound microscope	**60**

	3. Use of Micrometer and calibration, measurement of onion epidermal cells and yeast 4. Study of stages in mitosis from onion root tips 5. Study of stages in meiosis in grasshopper testes/onion or Rhoeo flower buds. Colorimetry and Spectrophotometry 6. Protein estimation by Lowry's method. 7. Estimation of protein by Bradford method. Analysis of Sugan, Amino acid and Fats/Oils 8. Estimation of sugars and amino acid by 8enedicts & Ninhydrin method 9. Determination of acid value of a fat. 10. Determination of saponification value of a 1at. Chromatographic Techniques 11. Identification of sugars In milk by paper chromatography. 12. Separation of amino acids by thin layer chromatography. 13. Separation of Biomolecules by gel permeation chromatography. Electrophoresis Techniques 14. Native-polyacrylamide Get Electrophoresis. 1S. SDS-polyacrylamide Gel Electrophoresis & staining using different methods (Coummassie blue, Silver staining and reverse staining) Microbiology Techniques 16. To perform the Gram staining, Negative Staining, Fast staining, Capsu|e Staining, MIC test. 17. Isolation and purification of microorganisms (bacteria) from soil/water/air by streak plate method and serial dilution	

Programme/Class: Honours Degree	**Year:** Fourth	**Semester:** VIII
Subject: Biotechnology		
Couse Code: B100801T	Course Title: **MOLECULAR BIOLOGY AND GENETICS**	

Course Outcomes:
This course is to expose the Students to the chromosome structure & gene expression in both prokaryotes and eukaryotes. It also familiarizes students with extra chromosomal elements, antisense technology.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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
UNIT I:	**DNA Replication and Repair** Central Dogma of molecular biology, DNA Replication- Prokaryotic DNA Polymerase I, II and III, Eukaryotic DNA Polymerases, Fidelity and Catalytic Efficiency of DNA Polymerases, Okazaki Fragments, Replication Origin, Primosomes, Concurrent Replication Mechanism Involving Leading and Lagging Strands of DNA DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair	12
UNIT II:	**RNA Transcription and Processing** Transcription: Prokaryotic and Eukaryotic Transcription- RNA	12

	polymerase sub units, different sigma factors, initiation, elongation and termination - rho dependent and independent; RNA processing enzymes, modification in RNA: 5'-Cap formation; Transcription termination; 3'-end processing and polyadenylation; Splicing: RNA Editing, Nuclear export of mRNA; mRNA stability. Different modes of mRNA, tRNA, and rRNA splicing, role of various snRNPs.	
UNIT III:	**Translation and Posttranslational Modification** Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis, inhibitors of protein synthesis, post-translational modifications and its importance.	12
UNIT IV:	**Regulation of Gene Expression** Regulation of gene expression .n prokar'yotes-The operon concept, lac & trp operons, Transcriptional control, Post translational control, .^.egulation in eukaryotes - Control by promoter, enhancer and silencers. Cis-trans elements, DNA methylation, Antisense technology, RNAi, siRNA, microRNA	12
UNIT V:	**Cytogenetics** Linkage and crossing over, Linkage mappi ng, Sex determination and sex-linked inheritance, Sex determination in plant and animal, Population and evolutionary genetics.	12

Suggested Reading:

1. Friefelder, David. "Molecular Biology." Narosn Publications, 1999.
2. Weaver, Robert F. "Molecular Biology" 2nd Edition, Tata McGraw-Hi II, 2003.
3. Karp, Gerald "Cell and Molecular Bioiogy: Concepts and Experiments" 4th EditiOFl, jOhLl Wiley, 2005.
4. Friefelder, David and George M. Malacinski "Essentials of Molecular Biology" 2nd Edition, Panima Publishing, 1993. 5. Lewin*s GENES XI, Published by Jones & 8artlett Learning; 11 edition (January 15, 2013

Programme/Class: Honours Degree	**Year:** Fourth	**Semester:** VIII
Subject: Biotechnology		
Couse Code: B100802T	Course Title: **INTERMEDIARY METABOLISM**	

Course Outcomes:

Students will be taught the metabolic pathways of carbohydrate, amino acid, lipid and coenzymes and their regulation. At the end of the they will be able to distinguish between different metabolic processes and their impact in metabolism of biomolecules.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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
UNIT I:	**Carbohydrate Metabolism and its Regulation** Glycolysis, TCA cycle, Gluconeogenesis, HMP pathway, Glycogen metabolism, Oxidative phosphorylation, Regulation of carbohydrate metabolism.	12
UNIT II:	**Lipid Metabolism and its Regulation** Beta-oxidation of fatty acids, Biosynthesis of triglycerides, glycerophospholipids, cerebrosides, ether lipids galactolipids and sulpho-lipids. Control of lipid metabolism.	12

UNIT III:	**Amino Acids Metabolism and its Regulation** Biosynthesis of a-ketoglutarate, oxaloacetate, pyruvate family amino acids and the control of their synthesis. biosynthesis of ribose-5 phosphate, 3-phospoglycerate and phosphoenolpyruvate plus erythrose-4-phosphate family amino acids and the control of their synthesis.	12
UNIT IV:	**Nucleic Acid Metabolism and It's Regulation** Biosynthesis of purines and pyrimidines, nucleosides and nucleotides; Degradation of purines and pyrimidines. Biosynthesis of coenzymes; Coenzyme A, NAD and NADP, FMN and CAD.	12
UNIT V:	**Inborn Error in Metabolism** Disorders of Carbohydrate metabolism, Inborn errors of amino acids Phenyl alanine & Tyrosine metabolism, Disorders of nucleic acid metabolism (Gout, Lesch Nyhan syndrome).	12

Suggested Reading:

1. Geoffrey L. Zubey, Biochemistry, Fourth Edition: Wm.C. Brown PuDIishers, 1998
2. Biochemistry by Robert Roskoski. W.B. Saunders, Philadelphia, ISBN 0-7216-5174-7
3. D.L. Nelson and M.M. Cox Lehninger Principles of Biochemistry, Publisher: WH Freeman; 8th ed.NewYork.
4. Biachem istry Sth Revised edition by LubertStryer, Jeremy M, Berg, John L. Tymoczko (ISBN: 8601300395166

Programme/Class: Honours Degree	**Year:** Fourth	**Semester:** VIII
Subject: Biotechnology		
Couse Code: B100803T	**Course Title:** PLANT BIOTECHNOLOGY AND TISSUE CULTURE	

Course Outcomes:

The course is designed to introduce students to the principles, practices and applications of plant biotechnology, plant tissue culture, genetic transformation, and transgenic to produce superior varieties. Students will learn the various applications of plant tis5ue culture and methods of gene transfer, and the production of hybrid varieties of plants in crop improvement.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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
UNIT I:	**Cloning in Plant Cells:** Biology of Agrobacterium tumefaciens. Structure of Ti-plasmid, T-DNAand gene transfer mechanisms, selection marker genes and reporter genes. Methods of direct gene transfer, Chloroplast transformation. Effect of gene copies and position in transgenic procluction.	**12**
UNIT II:	**Transgenic Plants:** Applications in phytoremediation, biopesticides, biodegradable plastics, pesticide and herbicide resistance plants, improving, horticultural and nutritional value of plants.	12

UNIT III:	**Plant tissue culture:** Historical perspective and general techniques for plant tissue culture. Tissue culture media, media preparation — nutrients and plant hormones; sterilization techniques.	12
UNIT IV:	Maintenance of callus, cell suspension culture, protoplast isolation and culture, somatic hybridization, haploid production.	12
UNIT V:	**Molecular Markers:** RFLP maps, RAPD markers, STD, micro satellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism) AFLP, QTL, map-based cloning, molecular marker assisted selection.	12

Suggested Reading:

- Plant tissue culture: Theory and Practice, a revised editi0n. Bhojwani SS, Razdan MK. An Imprint of Elseiver, First Indian reprint, 2004.
- Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & molecular biology of plants.Chichester, West Sussex: John Wiley & Sons.
- Glick, B. R., & pasternak, 1. J. (1994). Molecular biotechnology: Principles and applications of recombinant DNA. Washington, D.C.: ASM Press.
- Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford' Blackwell Pub. Primrose, 5. B., &Twyman, R. M. (2006). Principles of gene manipulation and genomics. Madden, MA: Blackwell Pub.

Programme/Class: Honours Degree	**Year:** Fourth	**Semester:** VIII
Subject: Biotechnology		
Couse Code: B100804T	**Course Title: Enzymology**	

Course Outcomes:

The course is designed to provide a basic understanding of the enzyme their properties and application in various industries.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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
UNIT I:	**General Introduction of Enzyme** Introduction and scope, Nomenclature, coenzyme and cofactors, Mechanisms of enzyme action, concept of active site and concept of ES complex, specificity of enzyme action, significance and evaluation of energy of activation, enzyme unit and turn over number.	12

UNIT II:	**Enzyme Kinetics** Order of reactions, kinetics of enzyme reaction—single and bi-substrate reaction, Michnelis-Menten equation, Different plots for the determination of Km & Vmax and their physiological significances, derivation of Michaelis-Menten equation, Allosteric enzyme, different type of enzyme inhibition,	12
UNIT III:	**Enzyme Immobilization** Physical and chemical techniques for enzyme immobilization, adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc, Examples advantages and disadvantages of different immobilization techniques	12
UNIT IV:	**Multi Enzyme System:** Mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes, Enzyme -enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase	12
UNIT V:	**Application of Enzymes** Commercial applications of enzymes in food, pharmaceutical and other industries, enzymes for analytical and diagnostic applications, purification and characterization of enzymes from natural sources, different methods of enzyme characterization	12

Suggested Reading:

1. Principles of Biochemistry BY A. Lehninger (1987)
2. Trevor Palmer and Philip Bonner; Enzymes: Biochemistry Biotechnology, Clinical chemistry.
3. Colin J. Suckling & Colin L. Gibson; Enzyme Chemistry: Impact & Application; BlaCkie Academic & ProfessionaI

Programme/Class: Honours Degree	**Year:** Fourth	**Semester:** VIII
Subject: Biotechnology		
Couse Code: B100805P	**Course Title: Practical**	

Course Outcomes: Students will be able to perform experiments related to Plant Tissue Culture, Molecular Biology And Enzymology.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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 60

1. Laboratory design setup for PTC unit.
2. Preparation, sterilization of media (Liquid & solid).
3. Surface sterili2ation, sealing of cultures, sources of contamination and their check measures.
4. Organ explant culture and micropropagation techniques.
5. Cal1us induction, propagation and differentiation.
6. Histological study of callus cells.

7. Suspension cultures.
8. Nurse culture techniques.
9. To observe practically various forms of undesirable characteristics in cultures such as:

i) Vitrification ii) Stunting of shoots iii) Abnormal embryoids. iv) Etiolated shoots.

10. Preparation of synthetic seeds and their shelf life studies.
11. MiCrografting Techniques.
12. Acclimatization of in vitro raised plantlets.
13. Comparison of ex vitro and in vitro rooting with respect to % survival.
14. To culture shoots on liquid media and derive a comparative account with reference to solid media grown cultures.
15. Preparation of plasmid DNA by alkaline lysis method
16. Genomic DNA isolation from bacteria
17. Isolation of DNA from plants by Hexadecyl trimethyl-ammonium bromide (CTAB) method
18. RNA isolation from plant tissues
19. Enzyme a5say; activity and specific activity determination of amylase.
20. Enzyme Kinetics: Effect of varying substrate concentration on enzyme activity, determination of Michaelis-Menten constant (Km) and Maximum Velocity (Vmax.) using Lineweaver-Burk plot.
21. Effect of temperature/pH and on enzyme activity. 22. Immobilization of enzyme.

Programme/Class: Master of Science Degree	**Year:** Fifth	**Semester:** IX
Subject: Biotechnology		
Couse Code: B100901T	Course Title: **CELLULAR AND MOLECULAR IMMUNOLOGY**	

Course Outcomes:
To Prepare a foundation for students in Immunology and the Immunotechniques, able to define innate and adaptive immunity, detail information about Lymphoid organs, Structure of antibody, concept of vaccines and vaccination, autoimmunity and applied immunology.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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
UNIT - I:	**Cells and Organ of Immune System** Components of innate and acquired immunity; Haematopoiesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue. (MALT & CALT)	12

Unit-II:	**Antigen and Antibody** Antigens — immunogens; haptens; nature of antigens; Immunoglobulins-basic structure, classe5 & subclasses of immunoglobulins, antigenic determinants; antigen-antibody interactions.	**12**
Unit-III:	**MHC, B Cells and T Cells** Major Histacompatibility Complex — Immune responsiveness and disease susceptibility; B-cell receptor; Immunoglobulin superfamily; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell receptors and T-cell maturation, activation and differentiation; Functional T Cell Subsets; Complement system.	**12**
Unit - IV:	**Regulation of immune response** Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens, generation of humoral and cell mediated immune responses; Cytokines and their role in immune regulation; Immunological tolerance.	**12**
Unit-V:	**Cytotoxicity, Hypersensitivity and Autoimmunity** Cell mediated cytotoxicity: Mechanism of T cells and NK cetl mediated lysis; Antibody dependent cell mediated cytotoxicity; Macrophage mediated cytotoxicity; Immunity to Infection: Bacteria, viral, fungal and parasitic infections; Hypersensitivity — Type I-IV; Autaimmunity- MHC and TCR in autoimmunity.	**12**

Suggested Reading:

1. Abbas, A.K., Litchman, A.H. (2006-2007). Basic Immunology: Functions and Disorders of the Immune System, 2nd Ed. {updated edition), Philadelphia, Pennsylvania: W.B. Saunders Company Publishers.

2. Roit, I.M., Delves, P. Seamus M. and Burton D. (2006). Essential Immunology, 11th Ed., Willey-Blackwell.

4. Goldsby, R.A., Kindt, T.J., Osborne, B.A. (2005). Kuby Immanalogy, 5 th Ed., W.H. Freeman and Company, New York.

Programme/Class: Master of Science Degree	**Year:** Fifth	**Semester:** IX
Subject: Biotechnology		
Couse Code: B100902T	Course Title: **PRINCIPLE AND APPLICATION OF GENETIC ENGINEERING**	

Course Outcomes:

Students will learn to various approaches to conducting genetic engineering and their applications, utilise this application in human welfare and solving problems in society. This paper highlights the concept of genetic basis for modifying cellular functions, creating genetic modifications in a cell or organism

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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
UNIT-I:	**Restriction Enzymes:** DNA ligase, Klenow enzyme, T4 DNA polymerase, PolVFlucleotide kinase, Alkaline phosphatase; Cohesive and b|unt end ligation; Labelling of ONA: Nick translation, Random priming, Radioactive and	**12**

	non-radioactive probes.	
UNIT-II:	Plasmids, Phagemids and Expression Vectors M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Yeast vectors, Shuttle vectors, siRNA technology.	12
UNIT-III:	**Expression strategies for heterologous genes** vector engineering, codon optimization, host engineering, in vitro transcription & in vitro translation, expression in bacteria, expres5ion in yeast, Inclusion bodies; Methodologies to reduce formation of inclusion bodies,	12
UNIT-IV:	**Linkers and Adaptors** Homopolymerit tailing, strategies for cDNA libraries; Transformation, Northern, Southern and Colony hybridization, Southwestern and Far-western cloning; Phage display; cloning differentially expressed genes (mRNA differential display and subtractive cloning). DNA-Protein Interactions (Electromobility shift assay; DNasel footprinting)	12
UNIT-V:	**PCR and Its Applications:** Primer design; Fidelity of thermostable enzYmes (Taq & Pfu polymerases); DNA polymerases; Types of PCR — multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; PCR In gene recombination; SOEing; Site ‹pectfic mutagenesis, deletion; addition.	12

Suggested Reading:

1.S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.
2.J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3.Brown TO, Cenomes, 3rd ed. Garland Science 2006
5.TechntcaI Literature from Stratagene, Promega, Novagen, New England Biolab etc.

Programme/Class: Master of Science Degree	**Year:** Fifth	**Semester:** IX
Subject: Biotechnology		
Couse Code: B100903T	Course Title: **GENOMICS AND PROTEOMICS**	

Course Outcomes:

students will be trained in the analysis of genomics and proteomic s data. The course covers topics related to molecular biology, genome analysis, functional and structural genomics, recombinant DNA technology, and DNA & protein sequence data analysis. Students will learn several experiments in wet-tab and computational methodologies.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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

UNIT - I:	**Whole genome analysis** Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries, comparative genomes (Arabidopsis, rice and panda)	10
UNIT — II:	**DNA sequencing** Conventional sequencing (Sanger, Maxam and Gilbert), pyrosequencing, next generation sequencing, automated sequencing, translation to large scale projects, epigenomics, cancer genomes. FISH, Comparative Genomic Hybridization (CGH), SKS (Spectral Karyotyping).	15
UNIT — III:	**DNA Microarrays** Chemical DNA synthesis, Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Fluorescence based assay formats and signal amplification strategies, Analysis of single nucleotide polymorphism using DNA chips. Gene IdentifiCation and Expression Analysis: DNA microarrays, ESTs, SAGE, MPSS.	15
UNIT - IV:	**Proteome analysis** Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein miCroarrays, differential display proteomics, yeast 2- hybrid system, FRET, bimolecular fluorescence complementation assay. Advantages and disadvantages of DNA and protein microarrays. Total expression vs functional proteomics, oligosaccharide micraarrays for glycomics, pharmacogenomics, introduction to metabolomics.	20

Suggested Reading:

1. Peruski, L.F. Jr. and Peruski, A.H. (1997). The 1nternet and New Biology: Tools for Genom ic and Molecular Research ASM.
2. Schena, M.ed. (1999). DNA Microarrays: a practical approach. Oxford University Pre5s.

Programme/Class: Master of Science Degree	Year: Fifth	Semester: IX
Subject: Biotechnology		
Couse Code: B100904T	Course Title: FUNDAMENTAL IN BIOSTATISTICS AND BIOMATHS	

Course Outcomes:

This paper is an introduction to statistical methods used in biological and medical research. Elementary probability theory, basic concepts of statistical inference, regression and correlation methods, and sample size estimation are covered. Emphasis on applications to medical problems.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75+25)	**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
UNIT-I	Binomial Theorem, Pascal rule and Pascal triangle.	
UNIT-II	Scientific notation, significant digits, rounding off. Scientific notation, Sampling, problem identification, design of experiment, factorial designs: full factorial design, fractional factorial design, concept of population and sample, random sampling, Data collection.	
UNIT-III	Measures of central tendency, mean, arithmetic mean, geometric mean & harmonic mean, medium, mode, quartile, decile, percentile, dispersion, mean deviation, standard deviation, geometric standard deviation, standard error, coefficient of variation, variance, coefficient of determinant and coefficient of non-determinant, moments, distribution of data, normal distribution, skewness and kurtosis	
UNIT-IV	Pearson's correlation coefficient, linear correlation and regression, correlation and regression analysis of exponential curve. Power function, log function, logarithmic regression, Dose response curve, coefficient of determination, Reciprocal regression analysis, double reciprocal regression analysis, logistic regression analysis, monomolecular regression, Gompert2 growth function and Gompertz decay function and its analysis.	
UNIT-V	Probability, Testing of hypothesis, Null and alternative hypothesis, Type-I and Type-II errors, level of significance, two tailed and one tailed tests, Z-score, chi-square (X2) test, student 't' test, 'F' test, Probability distribution function, standard normal oistribution, Poisson d\stributior function, binomial distribution, student 'I' distribution, chi square (X2) distribution, Analysis of variance, ANOVA-one way ANOVA and two way ANOVA. Non parametric statistics: Wilcoxon test: Wilcoson signed rank test, Wilcoxon rank sum test, Spearman rank coefficient, Kruskal-Wal|is test, Kendall's coefficient of Concordance (w).	
	Suggested Reading: 1. Kothari, C.R. (2004) Research Methodology Methods and Techniques, New Age International Publications, New Delhi 2. P,S.S. Sundar Rao, P.H. Richard, An Introduction to Biostatistics, Prentice Hall of India (P.) Ltd. New Delhi 2003. 3. Jerrold H. Zar, Biostatistical Analysis, Tan Prints (I) Pvt. Ltd., New Delhi, 2003.	

Programme/Class: Master of Science Degree	Year: Fifth	Semester: IX
Subject: Biotechnology		
Couse Code: B100905T	Course Title: ANIMAL CELL CULTURE AND MEDICAL BIOTECHNOLOGY	
Course Outcomes: Students will learn about Identification and characterization of animal breeds, developing DNA - based diagnostics and genetically engineered vaccines for animals, studying animal genomics and its varied applications, Developing embryo-transfer technology, cloning, and transgenic animals		
Credits: 4	Core Compulsory	
Maximum Marks: 100 (75+25)	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
UNIT I:	**History of animal cell culture, Different types of cell cultures:** Development of cell lines, Primary and Continuous cell cultures, Cell culture media: media composition, serum, antibiotics, supplements, physicochemical properties, Cell culture laboratory setup and instrumentation.	
UNIT II:	Cell culture techniques Cell separation methods, characterization and maintenance of cell lines. Trypsinization, cryopreservation. Common cell culture contaminants. Good Laboratory Practices	
UNIT III:	Stem cell research Different types of stem cells. Stem cell culture, stem cell differentiation, current status and application in medicine. Embryo culture, somatic cell nuclear transfer (SCNT), IVF. Artificial blood.	
UNIT IV:	**Gene transfer technology in animals** Viral and non-viral method5, PrOduction and status of transgenic animals, molecular pharming, Animal & Human cloning: Techniques, relevance and ethical issues.	
UNIT V:	**Application of cell culture technology** Production of human and animal vaccines and pharmaceutical proteins. Molecular diagnostics: techniques and relevance, detection of animal pathogen in environmental systems, animal imaging, molecular medicine, isotopes and their usage in diagnosis and therapy.	

Suggested Reading:

1. Freshney, I. R. (2010). Culture of Animal Cells, Sth Edition, Wiley-Liss.
2. Masters, J.R.W.(2000). Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press,
3. Clynes, M. (2008) Animal Cell Culture Techniques., Springer.
4. Hafez, B., Hafez, E.S.Z. (2010) Reproduction in *Farm* Animals, 7th Edition, Wiley- Blackwell. Turksen, K. Z004. Adult Stem Cells. Humana Press, Inc.
5. Thomson, J et al. 2004. Handbook of Stem Cells: Embryonic/ Adult and Fetal Stem cells (Vol. 1 & 2). Academic Press

Programme/Class: Master of Science Degree	Year: Fifth	Semester: IX
Subject: Biotechnology		
Couse Code: B100906T	Course Title: COMPUTATIONAL BIOLOGY AND BIOINFORMATICS	

Course Outcomes: Students will be able to

Differentiate the output of different diseases with their correlation in a particular population.

Survey to identify correlation with a particular disease in a defined population.

Credits: 4	Core Compulsory
Maximum Marks: 100 (75+25)	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
UNIT-I	Aim scope and elementary idea of statistics in Biology, Tabulatian and diagrammatic representation of statistical data. Concepts of statistical population and sample, elementary account of sampling methods, frequency distributions. Measures of central location and dispersion, measures of skewness and Kurtosis.	12
UNIT-II	Probability — definition simple theorems on probability, conditional probability Discrete and continuous variables, Standard distributions-Binominal, Poisson normal.	12
UNIT-III	Correlation and regression — Least square method of fitting linear and quadratic regression, standard errors of estimate, correlation coefficient.	12
UNIT-IV	Basic ideas of sampling distribution Statistical estimation and Test of significance, confidence limit. home commonly used tests of significance. Normal tests student's 't' test, x° and F tests. Analysis of variance.	12
UNIT-V	History and development of computer, computer peripherals and hardware description, operating system, office application, logic development, basic knowledge of computer software and scientific application packages.	12

Suggested Reading:

1. Research Methodology and Biostatistics: A comprehensive Guide for Health Care Professionals. By Sharma Suresh.
2. Biostatistics and Computer Applications hy G.N. Rao, N. K. Tiwari
3. Biostatistics: Basic Concepts and Methodology for the Health Sciences. By Wayne W. Oaniel

Programme/Class: Master of Science Degree	Year: Fifth	Semester: VII
Subject: Biotechnology		
Couse Code: B100907P	Course Title: **PRACTICAL**	
Course Outcomes: Students will be able to perform experiments related to immunology and genetic engeenering.		
Credits: 4	**Core Compulsory**	
Maximum Marks: 100 (75+25)	**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

1. Differential leukocyte count
2. Haemagglutination assay
3. Isolation of mononuclear cells from peripheral blood and viability test by dye exclusion method
4. Separation of serum from blood
5. Double immunodiffusion test using specific antibody and antigen Dot Immuno blot assay (DIBA)
6. ELISA
7. Polyacrylamide gel electrophoresis

Isolation of genomic DNA from plant tissues.

10. Isolation of genomic ONA from E. coli cells.
11. Spectrophotometric analysts of DNA.
12. Restriction digestion of DNA.
13. Separation of digested fragments by agarose gel electrophoresis.
14. Transfer of resolved DNA fragments from agarose gel to nylon/nitrocellulose membrane.
15. Hybridization of nylon/nitrocellulose blots.
16. Isolation of plasmid. Making competent cells of E. coli.
17. Transformation of competent E, coli cells.
18. Cloning of foreign DNA insert in plasmid (PET Vector).
19. Isolation of total RNA.
20. Expression of fusion protein (His-tagged/MBD-tagged)
21. PCR.

Programme/Class: Master of Science Degree	Year: Fifth	Semester: X
Subject: Biotechnology		
Couse Code: B101001T	Course Title: Bioprocess Engineering	

Course Outcomes: Students will be able to understand

Basic idea of microbial kinetics, upstream processing, bioreactar design and operation, and downstream processing. At the end of the course, the students would have learnt about fermentation processes, kinetics of microbial growth and all the steps involved upstream and downstream processing for any production process. The course also helps to understand the industrial applications of bioprocess engineering.

Credits: 4	Core Compulsory
Maximum Marks: 100 (75+25)	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
UNIT I:	**Introduction to Bioprocess technology and basic mode of fermentation** Isolation, screening and maintenance of industrially important microbes; Outline of an integrated bioproces5: Up5tream add downstream, unit operations involved in bioprocesses, generalized process flow sheets; Concepts of basic modes of fermentation - batch, fed bat¢h and continuous; Microbial growth and death kinetics.	12
UNIT II:	**Principles of upstream processing** Medium formulation: Carbon sources, Nitrogen sources, Minerals, Chelators, Growth factors, Antifoams, Introduction to media optimization; Inoculum development: criteria for the transfer of inoculum, development of inocula for bacterial processes; Sterilization: batch and continuous heat sterilization of liquid media, filter sterilization of liquid media.	12
UNIT III:	**Design of novel bioreactors** Introduction to ideal and non-ideal bioreactors; Design and components of various bioreactors: Stirred tank (CSTR), packed bed bioreactors, Bubble-column photo bioreactors. IViethods of measuring process variables, online and offline analytical methods.bioreactors, fluidized bed bioreactors, trickle bed bioreactors, airlift loop bioreactors,	12
UNIT IV:	**Introduction to downstrearri processing** Bio separation processes — filtration (conventional and microfiltration), centrifugation (settling of solids and centrifugal filtration), cell disruption (Chemical and mechanical); Isolation Processes: batch extraction and adsorption; Product purification: precipitation with salt and nonsolvent, ultrafiltration and chromatographic techniques; Polishing: crystallization, drying, storage and packaging.	12
UNIT V:	Application of bioprocess engineering in industries Fermented foods and beverages (Baker yeast production), Environmental industry (Biological waste water treatment), medical app|iCations of biaprocess engineering (Tissue engineering, Gene therapy).	12

Suggested Reading:

1. Stanbury, P.F., Hall S. J. and Whitaker A. 2003. Principles of Fermentation Technology. 2nd ed. Science & Technology Books.
2. Doran P. 2012. Bioprocess Engineering Principles, 2nd ed. Academic Press
3. Nielsen, J. and Villadsen, J. 2007. Bioreaction Engineering Principles. 2nd ed. Springer science and business media

Programme/Class: Master of Science Degree	Year: Fifth	Semester: X
Couse Code: B101002T	Subject: Biotechnology	
Course Outcomes: Students will be able to • explore foundational concepts in cancer biology, provide a survey of the hallmarks of cancer, learn the molecular and genetic basis of cancer, and understand the challenges of translating basic science discoveries into effective therapeutic agents.	Course Title: ONCOTECHNOLOGY	
Credits: 4		
Maximum Marks: 100 (75+25)	Core Compulsory	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0	Minimum Passing Marks: As per University norms	

Unit	Topic	No. of Lectures
UNIT I:	**Basics of Cancer** Type of cancers, Cancer genomics, Causes of cancer, Risk factors, Cancer cell properties, In vitro and in vivo models of cancer research, Current methodology in Cancer research.	15
UNIT II:	**Signalling Mechanisms in Cancer** Oncogenes such as Ras, Src, etc., Tumor suppressor genes such as APC, p53 and Rb-E2F interaction, CDK-CycIin-CDKl and CDC regUlation in cancer progression, EGFR and IGFR signalling, Epigenetic mechanisms: DNA and histone modification, and micro RNA in Cancer, Mechanism of chemical, viral and radiation induced cancer.	15
UNIT III:	**Mitochondria and Cancer** Warburg Hypothesis, Mitochondrial dysfunctions in cancer, mitochondrial genetics, metaboTtc alterations in cancer, oxidative stress, Apoptosis, Autophagy	15
UNIT IV:	**Cancer Diagnosis and therapeutic approaches** Cancer statistics, Cancer Screening Overview, Molecular diagnostics for detection of tumor, cancer specific markers, Types of Treatment, Side Effects, Clinical Trials, Cancer Drugs, Alternative Medicine.	15

Suggested Reading:

1. Molecular Biology of Human Cancers by Wolfgang Arthur Schulz Springer. (2007).2nd edition
2. Biology of Cancer by Robert Weinberg (2013). 2nd edition
3. Chemoprevention of Cancer and DNA Damage by Dietary Factors by S. Knasmuller, David M. DeMarini, Ion Johnson, and Clarissa Gerhauser Willey- Blackwell Publisher. (2009). 1st edition
4. Mitochondria Practical Protocols Editors: Leister, Dario, Herrmann, Johannes M. (Eds.) 2007 Publisher: Springer ISBN 978-1- 59745-365- 3
5. Mitochondrial DNA: Methods and Protocols Editors: Stuart, Jeffrey A (Ed.) zoog springer Protocols Publisher: Springer ISBN 978-1- 59745-521- 3

Programme/Class: Master of Science Degree	Year: Fifth	Semester: X
Couse Code: B101003T	Subject: Biotechnology	
	Course Title: NANOTECHNOLOGY	

Course Outcomes: students will understand basic knowledge in the interface between chemistry, physics and biology on the nanostructure level with a focus on biotechnological usage.

Credits: 4	
Maximum Marks: 100 (75+25)	**Core ELECTIVE**
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0	**Minimum Passing Marks:** As per University norms

Unit	Topic	No. of Lectures
UNIT I:	Introduction to Nanobiotechnology Nanotechnology definition and concepts; Cellular Nanostructures; Nanopores; Bimolecular motors; Criteria for suitability of nanostructures for biological applicatiOn5	60
UNIT II:	Basic characterization techniques Electron microscopy; Atomic force microscopy; Photon correlation spectroscopy.	
UNIT III:	Nano structures Thin films; Colloidal nanostructures Nano vesicles; Nano spheres; Nano capsules.	
UNIT IV:	Nanostructures for drug delivery Nanostructures for drug delivery, concepts, targeting, routes of delivery and advantages.	
UNIT V:	Applications of nano structures Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging; Nano devices for sensor development.	

Suggested Reading:

1. Multilayer Thin Films, Editor(s): Gero Decher, Joseph B. Schlenoff Publisher: Wiley-VCH Verlag GmbH & Co. KGaA ISBN: 3527304401
2. Bionanotechnology: Lessons from Nature Author: David S. Gaodsell Publisher: Wiley-Liss ISBN: 047141719X
3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press ISBN: 0-B247-2579- 4

Programme/Class: Master of Science Degree	Year: Fifth	Semester: X
Subject: Biotechnology		
Couse Code: B101004T	Course Title: NEUROSCIENCES AND TECHNOLOGY	
Course Outcomes: students will understand basic basic understanding of how our nervous system is organized and how it functions. To acquaint the students with different sense organs and their functions. To promote students for integrative thinking about the brain, behaviour, learning & memory and how disorders of the brain impact us at different levels. To help students understand about different neurological disorders at different levels.		
Credits: 4	Core ELECTIVE	
Maximum Marks: 100 (75+25)	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
	Unit I: Organization of the nervous system Basics about the nervous system, Different types of the nervous system, Anatomy and functions of the Central Nervous System and Peripheral Nervous System, Different parts of the brain and their functions, Structure, functions and types of Neurons, Non- neuronal cells in the nervous system, Blood Brain Barrier. Unit II: Neural signalling Ion transport, Resting potential, Action potential, Synaptic transmission at excitatory *and* inhibitory synapses, Neurotransmitters. Unit III: Sensory systems Anatomy, biochemistry and functioning of Vision, Olfaction, Auditory and Motor system. Unit IV: Brain and Behaviour Chemical control of brain, Mental disorders like anxiety, mood disorders, depress'ion, bipolar disorder, PTSD, Schizophrenia, Neurodegenerative diseases like Alzheimer's, Parkinson's, Huntington's, Multiple sclerosis, Amyotrophic lateral sclerosis, Neurotechnology. Unit Unit V: Learning and Memory Basics of learning and memory, Types of learning and memory, Long-term poter depression, Different behavioural training paradigms, Associative and non- associati reward and punishment learning, fear conditioning, Stages of memory, Sensory memory and long-term memory, Forgetting, Brain systems in memories	60
	Suggested Reading: 1) Kandel E. R. (2012) PrlnEiples of Neural Sc ence, Fifth EditioLt. 2) Purves D., Augustine G. J. and Hall W. C. (2011) Neuroscience, Fifth Edition. 3) Nicho\\s J. G. and Martin A. R (2011) From Neuron to Brain	

Programme/Class: Master of Science Degree	Year: Fifth	Semester: X
Subject: Biotechnology		
Couse Code: B101005T	Course Title: IPR, Bioethics and Entrepreneurship	
Course Outcomes: Students will understand basic basic understanding of IPR Bioethics and Enterpreneurship		
Credits: 4	Core ELECTIVE	
Maximum Marks: 100 (75+25)	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
		60

UNIT I: Intellectual Property Rights Introduction to intellectual property rights; requirements and utility of IPRs; different types of IPRs; features of World Intellectual Property Organization (WIPO); TRIPS agreement; International treaties and conventions on intellectual property.

UNIT II: Patents

Fundamentals of patent; conditions for the grant of patents; what can be and what cannot be patented; types of patents; patenting agencies; filing patents in India; procedure for grant of patents; patenting of biological material; patenting of transgenic, isolated genes and DNA sequences.

UNIT III: Copyright, trademark and geographic indication

Introduction to copyright and its applicability; copyright registration in India; laws and policies regarding copyright (Berne convention and Copyright (Amendment) Act, 2012); fundamental concepts and importance of trademark; relevance of geographical indication.

UNIT IV: Bioethics

Need of bioethics; definitions of bioethics; applications of bioethics and its relations with other branches of studies; ethical issues in genetically modified organisms; bioethical implications of human genome project; ethical issues in stem cell research and use; ethical issues in biodiversity management; case study on ethical issues surrounding vaccines in food.

UNIT V: 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.

Programme/Class: Master of Science Degree	Year: Fifth	Semester: X
Subject: Biotechnology		
Couse Code: B101006T	Course Title: Environmental Biotechnology	
Course Outcomes: Students will understand basic basic understanding of		
Credits: 4	Core ELECTIVE	
Maximum Marks: 100 (75+25)	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
	UNIT-I Introduction of ecology, Environmental factors. Biosphere, food web, trophic level and their pyramids. Ecosystem – types, development and evolution, habitat and niche. Concept of productivity and standing crops. Biome ecological indicators, ecology efficiency, edge effect, Biogeochemical cycles. **UNIT-II** Population ecology – definition and characters. Regulation of population size by density dependent and independent factors. Quantative analysis of plant community. Biotic community – characteristics of community. Ecological succession- causes sera climax community. Primary and secondary succession, Evolutionary ecology.	60
	UNIT-III Pollution – air, water, lignin, detergent, dyes, heavy metal, drugs, Industrial waste effluents (pulp, sugar, and paper mills), and pollution control device impact analysis of some common pollutants. Harmful effects of rays – UV, gamma, ozone layer, ozone holes, greenhouse effect. Degradation: environmental biodegradable pollutants, non-degradable pollutants Treatment of waste water and industrial effluent. **UNIT-IV** Metabolism and Toxicity of agro and industrial chemical to plants and animals. Toxicology of free radicals and its scavengers. Xenobiotics, Bioremediation, Vermiculture Biochemical aspects environmental Monitoring and ecosystem analysis. **UNIT-V** Detection of Toxic exposure: acute Toxicity, chronic and sub-acute exposure and their tests. Testing agents for carcinogenic, mutagenic and teratogenic action. The basis of antidotal procedures.	

1. Environmental Biochemistry. Neelima Rajvaidya, Dilip Kumar Markandey. APH Publishing, 2005.
2. Biochemical Ecotoxicology: Principles and Methods. Francois Gagne. Elsevier, 2014.
3. Environmental Biochemistry. Erik Hamilton (Editor). Larsen and Keller Education (21 June 2017)

Programme/Class: Master of Science Degree	Year: Fifth	Semester: X
Subject: Biotechnology		
Couse Code: B101007T	Course Title: Microbial Biotechnology	

Course Outcomes: Students will understand basic basic understanding of basics of microbial technology, Product development and Production.

Credits: 4	Core ELECTIVE
Maximum Marks: 100 (75+25)	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
		60

UNIT–I

Introduction to microbial technology, Microbial metabolites: Primary & Secondary, microbial applications in food and health care industries. Introduction to microbial genomes, phylogenetic relationships between various genera of microbes- 16S*rRNA* sequencing and Ribosomal Database project

UNIT-II

Prokaryotic genome organization, chromids, Bacterial and viral metagenomics, synthetic genomics, microbial sequencing projects, comparative genomics of relevant organisms such as pathogens and non-pathogens, human microbiome project.

UNIT-III

Microbial biofilms, polyketide synthase, antibiotic resistance, extremophiles and extremophilic biocatalysts, fantibiotics, biosynthesis of nanomaterials, probiotics, microbial degradation of xenobiotics, viral enzymes in modern biotechnology and clinical applications.

UNIT-IV

Microbial bio-products: penicillin G, Microbial Enzymes: amylases, cellulases, cellobiohydrolase, endoglucanase, cellobiose, β-glucosidase, proteases. Microbial cultures, microbial product recovery.

UNIT – V

Alcohol biotechnology: Beer, Whisky, and Wine. Microbial culture, fermentation media, microbial bio-processes and product recovery for beer, whisky and wine.

Programme/Class: Master of Science Degree	Year: Fifth	Semester: X
Subject: Biotechnology		
Couse Code: B101008T	Course Title: Research Methodology	
Course Outcomes: Students will understand basic basic understanding of Research methodology.		
Credits: 4	Core ELECTIVE	
Maximum Marks: 100 (75+25)	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
		60

UNIT-I

Introduction to Research Methodology: Objectives and motivation in research.

UNIT-II

Defining the Research Problem: Selecting and defining a research problem, Reviewing and conducting literature search, Developing a research plan.

UNIT-III

Types and Methods of Research: Classification of Research, Pure and applied Research, Exploring or Formulative Research, Descriptive Research, Diagnostic Research/Study, Evaluation of Research/Studies, Action Research, Experimental Research.

UNIT-IV

Designing of Experiment: Different experimental designs – single and multifactorial design, Making measurements and sources of error in measurements, Methods of data collection and record keeping.

UNIT-V

Data Processing and Statistical Analysis: Processing operations, tabulation, and graphical representation, Statistics in research: Concepts of sample and population, Report writing, Writing a research paper - abstract, introduction, methodology, results and discussion.

Suggested Reading:

1. Research Methodology: Methods & Techniques by C.R. Kothari, New Age International Publishers.