ALAGAPPA UNIVERSITY, KARAIKUDI
SYLLABUS UNDER CBCS PATTERN FOR AFFILIATED COLLEGES
WITH EFFECT FROM THE ACADEMIC YEAR 2022-23 ONWARDS

B.Sc., BIOTECHNOLOGY
Programme Structure

Sem.	Part	Course Code	Courses	Title of the Paper	T/P	Credits	Hours/ Week	Max. Marks		Total
								Int.	Ext.	
I	I	2211T	T/OL	Tamil/Other Languages-I	T	3	6	25	75	100
	II	712CE	E	Communicative English-I	T	3	6	25	75	100
	III	22BBT1C1	CC	Biochemistry	T	5	5	25	75	100
		22BBT1P1	CC	Practical–Biochemistry	P	4	4	40	60	100
		-	AL - IA	Computer Science/Any three Life Sciences	T	3	3	25	75	100
		-	AL - IA	Practical-Respective Allied Theory Course	P	2	2	40	60	100
	IV	22BVE1	SEC -I	Value Education	T	2	2	25	75	100
		-	-	Library	-	-	2	-	-	-
				Total		**22**	**30**	**205**	**495**	**700**
II	I	2221T	T/OL	Tamil/Other Languages-II	T	3	6	25	75	100
	II	722CE	E	Communicative English-II	T	3	6	25	75	100
	III	22BBT2C1	CC	Microbiology	T	5	5	25	75	100
		22BBT2P1	CC	Practical- Microbiology	P	4	4	40	60	100
		-	AL - IB	Computer Science/Any three Life Sciences	T	3	3	25	75	100
		-	AL - IB	Practical-Respective Allied Theory Course	P	2	2	40	60	100
	IV	22BES2	SEC -II	Environmental Studies	T	2	2	25	75	100
		Naan Mudhalvan Course		Language Proficiency for Employability(Effective English)	-	2	2	25	75	100
				Total		**24**	**30**	**230**	**570**	**800**
III	I	2231T	T/OL	Tamil/Other Languages-III	T	3	6	25	75	100
	II	2232E	E	English for Enrichment - I	T	3	6	25	75	100
	III	22BBT3C1	CC	Molecular Biology	T	3	3	25	75	100
		22BBT3C2	CC	Cell Biology	T	3	3	25	75	100
		22BBT3P1	CC	Practical–Cell and Molecular Biology	P	3	3	40	60	100
		-	AL - IIA	Computer Science/Any three Life Sciences	T	3	3	25	75	100
		-	AL - IIA	Practical-Respective Allied Theory Course	P	2	2	40	60	100
	IV	22BE3	SEC -III	Entrepreneurship	T	2	2	25	75	100
		-	NME-I	1. Adipadai Tamil (or) 2. Advance Tamil (or) 3. IT Skills for Employment (or) MOOC'S	T	2	2	25	75	100
				Total		**24**	**30**	**255**	**645**	**900**
	I	2241T	T/OL	Tamil/Other Languages-IV	T	3	6	25	75	100
	II	2242E	E	English for Enrichment - II	T	3	3	25	75	100
	III	22BBT4C1	CC	Genetics	T	4	4	25	75	100
		22BBT4C2	CC	Bioinformatics	T	4	4	25	75	100
		22BBT4P1	CC	Practical-Genetics &	P	3	3	40	60	100

IV				Bioinformatics						
		-	AL – II B	Computer Science/Any three Life Sciences	T	3	3	25	75	100
		-	AL - II B	Practical-Respective Allied Theory Course	P	2	2	40	60	100
	IV	-	NME-II	1.Adipadai Tamil (or) 2.AdvanceTamil (or) 3.SmallBusinessManagement (or) MOOC'S	T	2	2	25	75	100
		Naan Mudhalvan Course		Digital Skills for Employability – (Microsoft-Office Fundamentals)	-	2	3	25	75	100
				Total		**26**	**30**	**255**	**645**	**900**
V	III	22BBT5C1	CC	Immunology	T	4	4	25	75	100
		22BBT5C2	CC	Animal Biotechnology	T	4	4	25	75	100
		22BBT5C3	CC	Recombinant DNA technology	T	4	4	25	75	100
		22BBT5C4	CC	Plant Biotechnology	T	4	4	25	75	100
		22BBT5P1	CC	Practical- Immunology & Animal Biotechnology	P	4	6	40	60	100
		22BBT5P2	CC	Practical- Genetic engineering and Plant Biotechnology	P	4	6	40	60	100
	IV	-		Career development /employability skills	-	-	2	-	-	-
				Total		**24**	**30**	**180**	**420**	**600**
VI	III	22BBT6I	DSE	Internship		24	26	**150**	**250**	**400**
	IV	Naan Mudhalvan Course		Medical Coding for Employability (Medical coding*)	-	2	4	**25**	**75**	**100**
				Total		**26**	**30**	**175**	**325**	**500**
		(or)								
	III	22BBT6E1	DSE	Microbial Biotechnology	T	6	6	25	75	100
		22BBT6E2		Algal and Marine Biotechnology	T	6	6	25	75	100
		22BBT6E3		Environmental Biotechnology	T	6	6	25	75	100
		22BBT6E4		Medical Biotechnology	T	6	6	25	75	100
	IV	-	-	Library/Yoga etc	-	-	2	-	-	-
		Naan Mudhalvan Course		Medical Coding for Employability (Medical coding*)	-	2	4	**25**	**75**	**100**
				Total		**26**	**30**	**125**	**375**	**500**
		(or)								
	III	22BBT6PR	DSE	Project		6	8	25	75	100
		22BBT6E5		Biodiversity	T	6	6	25	75	100
		22BBT6E6		Biostatistics	T	6	6	25	75	100
		22BBT6E7		Molecular Diagnostics	T	6	6	25	75	100
	IV	Naan Mudhalvan Course		Medical Coding for Employability (Medical coding*)	-	2	4	**25**	**75**	**100**
				Total		**26**	**30**	**125**	**375**	**500**
				Grand Total		**146**	**-**	**--**	**-**	**4400**

* Medical Coding- Physical Training

Sem.	Part	Course Code	Title of the Paper	Credit	Hours/ Week	Marks		
						Int.	Ext.	Total
I	III	71BEPL - I	Professional English for Life Science -I	4	5	25	75	100
II		72BEPL – II	Professional English for Life Science -II	4	5	25	75	100
III		*	Professional English for Life Science – III	4	5	25	75	100
IV			Professional English for Life Science -IV	4	5	25	75	100

*The Syllabus of Professional English for III & IV Semester will be provided after Receiving the syllabus from TANSCHE.

As per TANSCHE, the Professional English book will be taught to all four streams a part from the existing hours of teaching/additional hours of teaching (1hour/day) as a 4 credit paper as an add on course on par with Major paper and completion of the paper is a must to continue his/her studies further

- T/OL-Tamil/Other Languages,
- E–English
- CC-Core course–Core competency, critical thinking, analytical reasoning, research skill & teamwork
- Allied –Exposure beyond the discipline
- AECC—Ability Enhancement Compulsory Course(Professional English & Environmental Studies) -Additional academic knowledge, psychology and problem solving etc.,
- SEC-Skill Enhancement Course-Exposure beyond the discipline (Value Education, Entrepreneurship Course, Computer application for Science etc.,
- NME -Non Major Elective–Exposure beyond the discipline
- DSE– Discipline specific elective –-Student choice– either or
    - Internship
    - If internship–Marks = Internal = 150 (75+75) two midterm evaluation through Viva voce and External = 250 marks (Report = 150+VivaVoce =100) = Total 400 marks
    - Theory papers or
    - Project +3 theory papers.
- MOOCs–Massive Open Online Courses

* T- Theory, P- practical

Semester-I				
Course code 22BBT1C1	**Core Course-I**	**T/P**	**C**	**H/W**
	BIOCHEMISTRY	**T**	**5**	**5**
Objectives	➢ Understand the basic concepts of cellular structure, its organization and the functions and importance of various biomolecules. ➢ Learn various energy production mechanisms in cells. ➢ Describe the laws of thermodynamics and their importance in biological phenomenon. ➢ Describe the various metabolic pathways involved in cells for its normal functioning.			
Unit-I	**Carbohydrates**: Classification. Monosaccharides – D and L designation, open chain and cyclic structures, epimers, anomers and mutarotation. Occurrence, structure and biological importance of disaccharides (sucrose, lactose, maltose) and polysaccharides (storage-starch, glycogen; structural – cellulose). Carbohydrate Metabolism: Glycolysis, TCA cycle.			
Unit-II	**Proteins:** Structure, Classification, Physical and Chemical properties of amino acids. Essential and non-essential aminoacids. Biological importance of proteins; Classification based on structure and functions, structural organization of proteins (primary, secondary, tertiary and quaternary structures). Shikimate pathway of amino acids biosynthesis.			
Unit- III	**Lipids:** Structure and properties of fatty acids. Structure and functions of phospholipids, sphingolipids, glycolipids and Lipoproteins. Lipid Metabolism: fatty acid oxidation and biosynthesis.			
Unit -IV	**Nucleic acids:** Structure and functions of DNA and RNA; Watson and Crick model of DNA and other forms for DNA (A and Z) composition, structure, types and Biological importance. Metabolites of nucleotides: de novo synthesis and salvage pathways.			
Unit-V	**Enzymes:** Nomenclature and classification of enzymes, enzyme units. Interaction between enzyme and substrate- lock and key, induced fit models. Enzyme kinetics (derivation of Michaelis - Menten Equation, Line - Weaver and Burk plot, Eadie- Hofstee plot).Clinical and industrial applications of enzymes. Abzymes, Ribozyme and Isozymes. Enzyme engineering and enzyme immobilization.			

Reference and Textbooks:

Bender,D., Kathleen, M., Botham, K. M., Kannelly, P.J., & Weil, P.A. (2014). *Harpers Illustrated Biochemistry*. The McGraw-Hill companies, Inc.

David L. Nelson & Michael Cox. (2017). *Lehninger Principles of Biochemistry*. W.H Freeman Publishers.

David L. Nelson., & Michael. (2017). *Lehninger Principles of Biochemistry (7th ed.)*. International Edition, WH Freeman.

Donald Voet & Judith G. Voet. (2011). *Biochemistry (3rd ed).* John Wiley and Sons, Inc. New York

Heldt, H. W. (2004). *Plant Biochemistry (3 rd ed.)*. Academic Press.

Satyanarayanan, U. (2022). *Biochemistry*. Books and Allied Publications.

Outcomes	On successful completion of the course, ➢ Acquire knowledge on the building blocks of the macromolecules, their chemical properties and their modification and their importance in normal functioning of living organisms. ➢ Knowledge on metabolism of biomolecules ➢ General Information about nucleic acids and enzymes.

Semester-I				
Course code	**Core Practical-I**	**T/P**	**C**	**H/W**
22BBT1P1	**LAB IN BIOCHEMISTRY**	**P**	**4**	**4**

Objectives

- The course provides an opportunity to experimentally verify the theoretical concepts already studied.

1. Calculations for Molarity, normality, specific gravity, ionic strength, g % (w/w), mg, % (w/w, w/v). Preparation of molar, normal, ppm and ppb solutions. Basic principles of Colorimeter and Spectrophotometer (Verification of Beer's law, estimation of protein and to study relation between absorbance and % transmission).
2. Quantitative determination of Carbohydrates
3. Quantitative determination of Reducing sugar
4. Quantitative determination of Protein.
5. Separation of amino acids by paper chromatography
6. Determination of pK and pI values of amino acids
7. Determination of acid value of an edible oil
8. Determination of Saponification value of an edible oil
9. Determination of Iodine number of an edible oil
10. Separation of lipids by TLC
11. Enzyme assay of Alkaline phosphatase
12. Determination of Vmax and Km of Alkaline phosphatase.

Reference and Textbooks:

Beedu Sashidhar Rao., & Vijay Deshpande. (2005). *Experimental Biochemistry- A Student Companion*. I. K. International Pvt, Ltd.

David Harvey. (2000). *Modern Analytical Chemistry*. McGraw-Hill, New York, Vol.798.

David, T. Plummer. (1992). *An introduction to practical Biochemistry (3rd ed).*Tata McGraw Hill publishing Com. Ltd. New Delhi.

Palanivelu. (2000). *Laboratory Manual for Analytical Biochemistry and Separation techniques*. Madurai Kamaraj University.

Wilson, K., & Walker.J.(2010). *Principles and Techniques of Practical Biochemistry.* Cambridge Press.

Outcomes	On successful completion of the course, students ➢ Acquire basic knowledge on practical techniques and approaches commonly used in analytical biochemistry in the aspects of biochemical enzyme assays and separation techniques. ➢ Learn basic concepts and applications of the instruments used in biochemical analysis.

Semester-II				
Course code 22BBT2C1	**Core Course -II**	**T/P**	**C**	**H/W**
	MICROBIOLOGY	**T**	**5**	**5**

Objectives	The course provides ➢ Knowledge about history of microbiology, classification, microbial anatomy, physiology, the basic principle of growth and metabolism and microbial diversity. ➢ Basic descriptions of different prokaryotic, eukaryotic and other life-forms and how they exploit these principles; the natural ecology of microorganisms; the human use of microorganisms; and how microorganisms function in disease.
Unit - I	Historical perspectives of microbiology: Landmark discoveries relevant to the field of microbiology. Important criteria used for classification (morphological, ecological, biochemical, molecular and numerical criteria) of microorganisms. Domain and Kingdom concepts in classification of microorganisms, Classification of Bacteria according to Bergey's manual. Diversity of prokaryotic microorganisms.
Unit - II	The expanse of microbial diversity, estimates of total number of species, measures and indices of diversity. Microbial Anatomy – Bacterial Cell structure & Organization. Bacterial endospores. Archaeal cell structures. Viruses, General properties of Viruses, RNA & DNA Virus, Classification of virus – Baltimore, Virions & Prions. Microbial Physiology. Nutrition, Growth and Metabolism of microorganisms - Respiration, Fermentation, Photosynthesis.
Unit - III	Microbial Diseases and Host Pathogen Interaction: Normal microbiota; Reservoirs of infection; Nosocomial infection, Emerging microbial diseases. Mechanism of microbial pathogenicity, Toxins, Drug resistance, Sensitivity tests.
Unit - IV	Bacterial pathogens – *Staphylococcus, Streptococcus, Escherichia & Salmonella.* Viral pathogens – Rabies, Enterovirus, Corona viruses, Retrovirus, Oncogenic and HINI viruses. Fungal Diseases: Histoplasmosis, Aspergillosis, Cryptococcosis and Candidiasis.
Unit - V	Microscopy – Simple and Compound Microscopy – Dark field – Phase contrast – Fluorescence and Electron Microscopy. Specimen preparation of electron microscopy – Ocular and stage micrometers. Microorganisms in the environment - Air, Water & Soil. Microbes from extreme environment.

Reference and Textbooks:

Ananthanarayan, R. & Jayaram Paniker, C.K (2022). *Ananthanarayan and Paniker's Textbook of Microbiology.* 12th Edition, Universities Press.

Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Derek Weber & Warner Bair. (2019). *Microbiology: An Introduction*. 4th Edition. Pearson Benjamin Cummings Publication.

Gold man, E & Green, H. (2008). *Practical handbook of microbiology*. CRC press.

Gunasekaran, P. (1995). *Laboratory Manual in Microbiology*. New Delhi: New Age International (P) Ltd. Publishers.

Jayaraman, J. (1981). *Laboratory Manual in Biochemistry*. New Delhi: New Age International (Pvt.) Ltd. Publishers.

Joanne Willey, Linda Sherwood & Chris Woolverton (2013). *Prescott's Microbiology*. Tata McGraw – Hill Publication.

Outcomes	On successful completion of the course, Students can ➢ Know Historical perspectives of microbiology. ➢ Describe the use of Bergey's Manual of Systematic Bacteriology and its criteria for the taxonomy of prokaryotes. ➢ Understand and list the structural differences between eukaryotic and prokaryotic

	cells. Understand the role of beneficial microorganisms in the environment and the application to benefit mankind. ➢ Describe the mechanisms of action of major chemotherapeutic agents that control microorganisms. ➢ Explain about factors responsible for the virulence of different pathogenic microorganisms. Explain about molecular methods in assessing microbial diversity.

Semester-II				
Course code	**Core Practical-II**	**T/P**	**C**	**H/W**
22BBT2P1	**LAB IN MICROBIOLOGY**	**P**	**4**	**4**

Objectives

The course provides an opportunity to

- Learn the techniques relating to microscopy, culture handling and maintenance, microbial biochemistry and physiology and molecular biology.
- Understand the safety precautions required in microbiology laboratories.
- Employ the right staining methods and apply those methods to identify microorganisms
- Perform and evaluate the use of different biochemical tests in the laboratory for characterization of bacteria.
- Perform the serial dilution and the standard plate count techniques.

1. Handling and maintenance of Compound microscope, autoclave, hot air oven, incubator, laminar air flow, pH meter and other basic instruments. Cleaning glassware, sterilization, decontamination and disinfections.
2. Media preparation: Broth, Agar slant, Agar plate, enriched media (Blood agar), Differential media (Mac Conkey agar) and Selective medium – EMB.
3. Enumeration of bacteria and fungi from environmental samples such as air, water and soil.
4. Pure culture techniques: Streak, Pour and Spread plate technique.
5. Simple staining
6. Gram staining
7. Spore staining
8. Negative staining
9. Motility test – Hanging drop method
10. Antibiotic sensitivity test (MIC and MBC)
11. Determination of bacterial cell size by micrometry
12. Growth curve of bacteria

Reference and Textbooks:

Atlas, R.M., Brown, A.E., & Parks, L.C. (1995). *Laboratory Manual of Experimental Microbiology.* Mosby, St. Louis.

Cappuccino, J.G. & Sherman, N. (2002). *Microbiology: A Laboratory Manual*. Addison-Wesley.

Holt, J.G., Krieg, N.R.(2000). *Bergey's Manual of Determinative Bacteriology*- 9th edition. Lippincott Williams & Wilkin Publishers.

James Cappuccino & Natalia Sherman. (2014). *Microbiology: A Laboratory Manual*. 10th edition. Pearson Benjamin Cummings Publication.

Rajan. S. (2018). *Experimental Procedures in Life Sciences*. CBS Publication.

Outcomes

On successful completion of the course, the students can

- Familiarize with laboratory equipment's used for working with microorganisms.
- Develop expertise to use microscopes in the laboratory
- Describe how microorganisms are collected, inoculated, cultured, incubated, and autoclaved
- Understand the methods to characterize the unknown bacteria
- Be proficient in writing scientific texts by accumulating information and results of each laboratory experiment in form of reports

Semester-III				
Course code 22BBT3C1	**Core Course -III**	**T/P**	**C**	**H/W**
	MOLECULAR BIOLOGY	**T**	**3**	**3**

Objectives	The course makes the students ➢ Understand the essentials of molecular biology: replication, transcription and translation; enzymes involved in the central dogma of life, proofreading, inhibitors and post modifications. ➢ Thorough in prokaryotic and eukaryotic genome organization; lac & trp operon; regulation of transcription and translation in eukaryotes.
Unit-I	DNA as the genetic material, Structure and Types. Replication - Mechanism of DNA replication in Prokaryotic and eukaryotic systems, Enzymes involved, replication origin and replication fork, fidelity of replication, extra-chromosomal replicons, Inhibitors of DNA replication. Structure and functions of different types of RNA.
Unit-II	Transcription - Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, elongation and termination, RNA processing (capping, polyadenylation, RNA editing, and splicing), RNA transport and Transcription inhibitors.
Unit- III	Genetic code. Translation - Prokaryotic and eukaryotic translation machinery, Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.
Unit -IV	Gene concept - regulation of bacterial gene expression. Lactose system - coordinate regulation, Lac components, positive and negative regulation, catabolite repression. Tryptophan operon – regulation and attenuation. Arabinose operon and its regulation.
Unit-V	Genome Organization in eukaryotes, repetitive DNA and renaturation kinetics, Eukaryotic DNA Packaging, Regulation of transcription and translation in eukaryotes, role of chromatin in gene expression and gene silencing.

Reference and Textbooks:

Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, & Peter Walter. (2008). *Molecular Biology of the Cell (5th ed)*. Garland Science.

Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, John Wilson, & Tim Hunt (2015). *Molecular Biology of the Cell*. 6th Edition. W.W. Norton & Company.

Burton E. Tropp**.** (2012). *Molecular Biology: Genes to Proteins*. Jones and Bartlett Publishers.

George M Malacinski. (2015). *Freifelder's Essentials of Molecular Biology.* 4th edition. Jones and Bartlett Publishers.

Benjamin Lewin. (2007). *Genes XI*. New York: Oxford University Press.

David Freifelder. D. (2008). *Microbial Genetics (18th ed*). New Delhi: Narosa Publishing House.

Freifelder, D. (2000). *Molecular Biology (2nd ed).* New Delhi: Narosa Publishing house.

Jeyanthi, G.P. (2009). *Molecular Biology*. MJP Publishers, Chennai.

Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. & Weiner, A. M. (2013). *Molecular Biology*

<table>
<tr><td colspan="2">of the Gene (17th ed). Tokyo: The Benjamin Cummings Publishing Company Inc.
Veer Bala Rastogi. (2016). Principles of molecular biology. Medtech Publishers.
Russel, P. (2009). Genetics: A Molecular Approach. India: Pearson Education.
Stanley R. Maloy, John E.C. & Freifelder, D. (2008). Microbial Genetics. New Delhi: Narosa Publishing House.
Stryer, L. (2019). Biochemistry (9th ed). New York: W.H. Freeman and Company.</td></tr>
<tr><td>Outcomes</td><td>On successful completion of the course,
➢ Students get knowledge on Nucleic acids and their characteristics, transcription, translation, protein sorting and regulation of gene expression.
➢ Understand the occurrence of central dogma of life in the cell and the machineries involved to initiate and inhibit.
➢ Fathom the genome organization and control of gene expressions in prokaryotes and eukaryotes.</td></tr>
</table>

Semester-III				
Course code 22BBT3C2	**Core Course -IV**	**T/P**	**C**	**H/W**
	CELL BIOLOGY	**T**	**3**	**3**

Objectives	The course is aimed to make students ➢ Understand the basic concepts of prokaryotic and eukaryotic cell ➢ Get comprehensive and concise overview of basic cell biology aspects ➢ Understand the individual and coordinated functions of various cell organelles ➢ Apply cell biology concepts in plant and animal biotechnology ➢ Apply various assays in plant and animal biotechnology experiments
Unit - I	An overview of plant and Animal Cells. Structure and Organization of prokaryotic and eukaryotic cells. Structural organization and function of intracellular organelles (Nucleus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast, Lysosomes, Peroxisomes and vacuoles).
Unit - II	Chromatin organization and packaging. Three dimensional organization and functions of Cytoskeletons (Microfilaments, Intermediate filaments, Microtubules and associated proteins).
Unit - III	Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, and ion pumps. Intracellular protein sorting- Mechanism and regulation of intracellular transport in mitochondria, chloroplast, endoplasmic reticulum and nucleus. Electrical properties of membranes.
Unit - IV	Protein insertion and processing in Endoplasmic reticulum and protein trafficking from Endoplasmic reticulum to Golgi bodies. Cell cycle and its regulation. Molecular events during cell cycle, Check points, Cyclins and protein kinases.
Unit - V	Cellular differentiation in plants – Basic process and mechanism. Specific role of hormones and regulation of cellular differentiation. Plant cell wall- Nature, composition and organization. Organization of shoot and root apical meristem; shoot, root and flower development.

Reference and Textbooks:

Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. (2014). *Molecular Biology of the Cell-6th Edition*.Garland Publishing (Taylor & Francis Group)

Geoffrey Cooper. (2018). *The Cell: A Molecular Approach*, 8th Edition. Oxford University press.

Gerald Karp, Janet Iwasa & Wallace Marshall. (2019). *Karp's Cell and Molecular Biology-9th Edition*. John Wiley & Sons. Inc.

Harvey Lodish. (2014). *Molecular Cell Biology*, *7th Edition*, W.H.Freeman and Company.

Jeff Hardin, Greg Bertoni & Lewis. J. Kleinsmith. (2016). *Becker's World of the Cell*, *9th Edition*. Pearson Benjamin Cummings Publication.

Outcomes	On successful completion of the course, the students can ➢ Equip themselves with a basic knowledge of the structural and functional properties of cells ➢ Learn the basic concepts and theories of cell and become aware of the complexity (endomembrane system in eukaryotes) and harmony of the cell. ➢ Describe important functions of the cell, its microscopic structure and the structure of the key cellular components including membranes, various membrane bound organelles, the cytoskeleton network, and the genetic material. ➢ Get basic knowledge on practical techniques and approaches commonly used in molecular cell biology aspects such as protein sorting and aging studies ➢ Understand cellular components and their functions at a particular stage of development and differentiation ➢ Describe the mechanisms for cell growth, cell division, cell expansion and cell differentiation.

Semester-III				
Course code 22BBT3P1	**Core Practical-III**	**T/P**	**C**	**H/W**
	LAB IN CELL AND MOLECULAR BIOLOGY	**P**	**3**	**3**

Objectives

The course provides

- Understanding about the basic techniques involved in the isolation of DNA, RNA and proteins from various sources
- In-depth analysis of DNA, protein and RNA by electrophoretic techniques
- Understanding about mitosis and meiosis in cells

1. Isolation of genomic DNA from plant cell
2. Isolation of plasmid DNA from bacteria
3. Isolation of genomic DNA from bacteria
4. Isolation of DNA from Animal tissue
5. Isolation of casein in Milk
6. Isolation of protein from bacteria
7. RNA extraction from any source
8. Analysis of isolated DNA by Agarose gel electrophoresis
9. Analysis of isolated protein by SDS-PAGE
10. Analysis of Plasmid DNA by Agarose gel electrophoresis
11. Estimation of isolated RNA.
12. Mitosis in Onion root tip
13. Meiosis in flower bud.

Reference and Textbooks:

Ashok Kumar. (2011). *Molecular Biology and Recombinant DNA Technology: A Practical Book* Narendra Publication House.

Ausubel, F.M., Roger, B., Robert E. Kingston, David A. Moore, Seidman, J.G., John A. Smith. & Kelvin, S. (1992). *Short Protocols in Molecular Biology (3rd ed).* New York: Jolm Wiley &Sons Inc.

Berger, S.L. & Kimmel, R. (1987). *Guide to Molecular Cloning Techniques*. New York: Academic Press, Inc.

Brown, T.A. (1998). *Molecular Biology Lab Fax 11 Gene Analysis*. London: Academic Press.

Chaitanya, K. V. (2013). *Cell and Molecular Biology: A Lab Manual*. PHI publications

Outcomes

On successful completion of the course, students will become

- Familiar with the central dogma of molecular biology, and will learn about the techniques in extraction and separation of DNA and proteins.
- Well-equipped in carrying out experiments in Cell division.

Semester-IV				
Course code	**Core Course- V**	**T/P**	**C**	**H/W**
22BBT4C1	**GENETICS**	**T**	**4**	**4**

Objectives	The course introduces the ➢ Basic concepts of Mendelian principles of inheritance and concept of genes. ➢ Comprehend the genome mapping methods and recombination. ➢ Comprehend the extra chromosomal inheritance and microbial methods of genetic transfers. ➢ Demonstrate the mutation, its types and detection and its genetic implications. ➢ Fathom the human genetics and quantitative genetics.
Unit - I	Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests. Extensions of Mendelian principles:Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenotype, linkage, linkage mapping and crossing over, sex linkage, sex limited and sex influenced characters.
Unit - II	Plasmids: Types of plasmids - F, R and Col plasmids. Properties of plasmids – sex factors, drug resistant, colicinogenic, Agrobacterium Ti and broad host range plasmid. Detection and purification of plasmid DNA. Transfer of plasmid DNA. Replication of plasmid. Control of copy number, plasmid amplification, curing and incompatability.
Unit - III	Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.
Unit - IV	Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
Unit - V	Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping

Reference and Textbooks:

Benjamin Pierce. (2020). *Genetics: A Conceptual Approach*. 7th Edition. WH Freeman Publication.

Sambamurty, A. V. S. S. (2007). Molecular Genetics. Narosa Publication.

Sanders, M.F. and Bowman, J.L. (2018). Genetic Analysis: An Integrated Approach. Pearson Publisher.

Snustad, D. P., & Simmons, M. J. (2015). *Principles of genetics*. John Wiley & Sons.

Stanley R. Maloy, John, E.C. & Freifelder, D. (2008). *Microbial Genetics*. New Delhi: Narosa Publishing House.

William Klug, Michael Cummings, Charlotte Spencer, Michael Palladino & Darrell Killian.(2019). *Concepts of Genetics*. Pearson Benjamin Cummings Publication.

Outcomes	On successful completion of the course, students can ➢ Acquire knowledge on the fundamentals of Mendelian genetics that includes how the inherited characters are transferred from one generation to other generation. ➢ Understand to analyze and locate the locus of the gene through gene mapping and recombination. ➢ Comprehend the extrachromosomal inheritance and the importance of maternal inheritance and the microbial methods of gene transfer. ➢ Fathom how the mutations take place, its causative agents, types &detection and the genetic implication due to mutation and chromosomal number alteration.

Semester- I V				
Course code 22BBT4C2	**Core Course-VI**	**T/P**	**C**	**H/W**
	BIOINFORMATICS	**T**	**4**	**4**

Objectives	The course facilitates to ➢ Understand basics of bioinformatics which includes recent advancements in computer application ➢ Analyze the biological data using bioinformatics tools and software's ➢ Know about specific application of software's and algorithms used for the clear understanding of biological data. ➢ Knowledge about software's used in biomolecules structure, prediction and interaction, tools used to analyze the genomics and proteomics data and drug designing concepts.
Unit - I	Biological databases – Retrieving information and sequences from databases. Open Access databases, Proprietary and Open Source software: Bioinformatics analysis packages available – EMBOSS.
Unit - II	Sequence Alignment - BLAST-Basic and Specialized. Sequence alignment - Global Vs local alignment, Pair wise alignment, Principles of sequence similarity search algorithms. Multiple sequence alignment, Alignment viewers, Formatting and editing multiple sequence alignments. Phylogenetic analysis.
Unit - III	DNA Sequencing and gene prediction - Analysis of electropherogram; Contig assembly; Checking for vector contamination and chimeras; Sequence annotation and submission in public databases. Restriction mapping and Primer design using programs from public domain. Prediction of Genes and Regulatory sequences in DNA. q-PCR data analysis. RNA structure analysis, Protein secondary and tertiary structure prediction - and motifs.
Unit - IV	Protein sequence analysis: Composition, molecular weight, PI, extinction coefficient and peptide mapping
Unit - V	Molecular docking and Drug designing - Virtual screening, Molecular modeling and docking. Molecular dynamics and simulation. Drug designing concepts – Pharmacogenomics, Pharmacokinetics- Drug absorption, bioavailability, distribution, and excretion. Software tools (ADMET).

Reference and Textbooks:

Baxevanis, A. D., Bader, G. D., & Wishart, D. S. (Eds.). (2020). *Bioinformatics*. John Wiley & Sons.

Gautham, N. (2006). *Bioinformatics: databases and algorithms*. Alpha Science Int'l Ltd..

Ham, B. M. (2011). *Proteomics of biological systems: protein phosphorylation using mass spectrometry techniques*. John Wiley & Sons.

Lesk, A. (2019). *Introduction to bioinformatics-5th edition*. Oxford university press.

Liberles, D. A., Kolesov, G., & Dittmar, K. (2010). Understanding gene duplication through biochemistry and population genetics. *Evolution after gene duplication*, 1-21.

Ramsden, J. (2015). *Bioinformatics: an introduction* (Vol. 21). Springer Publication.

Outcomes	On successful completion of the course, Students can ➢ Understand biological databases and how to retrieve the information from the databases ➢ Differentiate open and proprietary source software ➢ Learn about algorithms and matrices in global and local alignment ➢ Construct phylogentic tree using multiple sequence alignment

	➢ Analyze DNA sequencing data using electropherogram viewer, contig assembly software. ➢ Find vector contamination in DNA sequences and how to annotate and submit DNA sequences in public domain

Semester-IV				
Course code 22BBT4P1	**Core Practical-IV**	**T/P**	**C**	**H/W**
	LAB IN GENETICS AND BIOINFORMATICS	**P**	**3**	**3**

Objectives

The course provides an opportunity to experimentally verify the

- Mendelian inheritance through mono and dihybrid crosses and Drosophila
- Laws of Mendel through probability methods.
- Effects of mutation on survival of bacteria and its growth
- Methods to isolate antibiotic resistance mutants
- Basic Bioinformatics analysis

1. Problem sets in Mendelian inheritance a) single point crosses & b) two point crosses.
2. Life cycle of Drosophila melanogaster
3. Culture techniques and handling of flies
4. Polygenic inheritance with reference to Finger Print
5. Determination of Phenomenon of segregation – Artificial – Probability
6. Determination of independent assortment – Artificial – Probability
7. Barr body identification in cells of buccal smear
8. Determination percentage of killing of bacterial cells by UV rays.
9. Plotting of UV survival curve of bacteria.
10. Isolation of antibiotic resistant mutants.
11. BLAST analysis and interpretation of results
12. Protein sequence analysis

Reference and Textbooks:

Gregore Koliantz, & Daniel B. Szymanski. (2015). *Genetics: A Laboratory Manual.* Wiley Publications

David Peyton**.** (2012). *Genetics Laboratory Lab Manual.* Kendall/Hunt Publishing Company.

Andreas D. Baxevanis, Gary D. Bader & David S. Wishart**.** (2020). *Bioinformatics -4th edition*. Wiley publication.

Jean-Michel Claverie, & Cedric Notredame. (2006). *Bioinformatics for Dummies*. Wiley publication.

Malov, S.R. (1990). *Experimental Techniques in Bacterial Genetics*. Boston: Jones and Bartlett Publishers.

Miller, J.H. (1992). *A Short Course in Bacterial Genetics: A Lab Manual &Hand Book for E. coli and related Bacteria.* Cold Spring Harbour: Cold spring Harbor Lab press.

Outcomes

On successful completion of the course, the students can

- Comprehend role of hypothesis testing/ experimental design in genetics research
- Analyzing monohybrid, dihybrid, and trihybrid crosses using Drosophila model systems
- Evaluating human pedigrees to determine whether different human genetic disorders are dominant or recessive

Semester-V				
Course code 22BBT5C1	**Core Course-VII**	**T/P**	**C**	**H/W**
	IMMUNOLOGY	**T**	**4**	**4**

Objectives	The course facilitates to ➢ Learn the basic principles of defense mechanism against infections. ➢ Understand the structure and function of the molecules, cells, and organs involved in Immunity. ➢ Learn the mechanism of how the immune system recognizes foreign antigen and the significance of self/non-self-discrimination. ➢ analyze how cell mediated and antibody-mediated immunity works to protect a host from pathogenic organisms and harmful substances.
Unit-I	Basic Concepts in Immunology. Hematopoiesis. Immune system: lymphoid organs - primary and secondary; structure and functions; cells of the immune system. CD markers. Innate and Acquired/adaptive immune system: cells and molecules involved, Clonal selection theory, Activation, Maturation and Differentiation of B-Cell and T-Cell, T and B-cell receptors, Cell mediated and humoral immune response. Role of Toll like receptors in innate immunity.
Unit-II	Characteristics and functions of Cytokines. Immunoglobulins (class, subclass, structure and function) and immunoglobulin genes (Organization and expression, Generation of antibody diversity). Immunogenicity- Immunogens, adjuvants, epitopes, haptens and carriers. T dependent and T independent antigens. Strength of antigen-antibody interactions: affinity, avidity, valency.
Unit- III	The complement systems: mode of activation, classical and alternate pathway. Immunization- active and passive. Mechanisms of antigen processing and presentation-cytosolic and endocytic pathways Antibody engineering.
Unit -IV	Major histocompatibility complex (MHC): structure and its interaction with peptide. Immune response to infectious diseases – tuberculosis), SARS-CoV-2 and helminths. Autoimmune disorders (Rheumatoid arthritis).
Unit-V	Transplantation immunity - Organ transplantation and HLA tissue typing. Hypersensitivity reactions- Type I, II, III and IV. Oncogenes and antioncogenes. Congenital and Acquired Immunodeficiency. Inflammation. Hybridoma and monoclonals. Vaccine – Introduction- types- Edible vaccines. Stem Cells and its clinical application.

Reference and Textbooks:

Coico, R., & Sunshine, G. (2015). *Immunology: a short course*. John Wiley & Sons.

Day, M. J., & Schultz, R. D. (2014). *Veterinary immunology: principles and practice*. CRC Press.

Geha, R., & Notarangelo, L. (2012). *Case studies in immunology: a clinical companion*. Garland Science.

Rao, C. V. (2013). *Immunology (2nd ed).* New Delhi: Narosa Publishing House.

Jeffrey Actor.(2014). *Introductory Immunology: Basic Concepts for Interdisciplinary Applications*. Academic Press.

Joseph, A. Bellanti. (2016). *Immunology IV: Clinical Applications in Health and Disease*. Washington, DC: Georgetown University School of Medicine.

Judy Owen, Jenni Punt, & Sharon Stanford. (2018). *Kuby Immunology -8th Edition*. WH Freeman publication.

Seamus J. Martin , Dennis R. Burton, Ivan M. Roitt, & Peter J. Delves .(2017). *Roitt's Essential Immunology- 13th Edition*. Wiley-Blackwell Publication.

Outcomes	On successful completion of the course, Students ➢ Obtain knowledge on the basic concepts of immune system, mechanisms of immunity and the development and maturation process of immune competent cells ➢ Recognize the structures and functions of immunoglobulin molecules ➢ Understand the mechanism of immunodeficiency diseases and autoimmunity against infection. ➢ Realize the methods for the treatment of immune related diseases

Semester-V				
Course code	**Core Course-VIII**	**T/P**	**C**	**H/W**
22BBT5C2	**ANIMAL BIOTECHNOLOGY**	**T**	**4**	**4**

Objectives	The course aims to ➢ Realize the basic concepts of animal cell culture. ➢ Understand the basic properties of cancer cells. ➢ Describe the principle and application of gene manipulation. ➢ Illustrate how transgenic animals can be produced with a specific gene of interest and their clinical advantages
Unit - I	Scope of animal biotechnology, Methods of transferring genes- physical, chemical and biological methods. Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds, fish and Insects). Transgenic animals as models for neurodegenerative disorders, carcinogenesis and hypertension. Assisted reproduction biotechnology: Artificial insemination and embryo transfer.
Unit - II	Methods for the construction of recombinant animal viral vectors for gene transfer into cell lines. Biology of Animal viral vectors - SV40, adeno virus, retro virus, vaccinia virus, herpes virus, adeno associated virus and baculovirus. Baculovirus in biocontrol.
Unit - III	Animal biotechnology for production of regulatory proteins, blood products, vaccines and hormones. Cell signaling (Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways).
Unit - IV	Gene therapy - Ex vivo and in vivo, viral and non- viral, Biotechnological applications for HIV diagnostics and therapy. DNA based diagnosis of genetic diseases.
Unit - V	History of stem cells. Preparation and applications of embryonic, adult and umbilical cord blood stem cells. Stem cell differentiation and transplantation. 3D tissue culture and their application. Bioethics and stem cell research.

Reference and Textbooks:

Holland, A. J., & Johnson, A. (Eds.). (2012). *Animal biotechnology and ethics*. Springer Science & Business Media.

Primrose, S. B., Twyman, R. M., & Old, R. W. (2001). *Principles of gene manipulation* (Vol. 6). Oxford: Blackwell Science.

Purohit, S.S. (2004). *Biotechnology: Fundamentals and Applications*. Students Edition.

Satyanarayana, U. (2020). *Biotechnology*. Books & Allied Ltd.

Singh, B. (2005). *Textbook of animal biotechnology*. The Energy and Resources Institute (TERI).

Verma, A., & Singh, A. (Eds.). (2013). *Animal biotechnology: Models in discovery and translation*. Academic Press.

Outcomes	On successful completion of the course, students can ➢ Realize the basic concepts of animal cell culture. ➢ Understand the basic properties of cancer cells. ➢ Describe the principle and application of gene manipulation. ➢ Illustrate how transgenic animals can be produced with a specific gene of interest and their clinical advantages.

Semester-V				
Course code 22BBT5C3	**Core Course-IX**	**T/P**	**C**	**H/W**
	RECOMBINANT DNA TECHNOLOGY	**T**	**4**	**4**

Objectives	The course makes students ➢ Understand the concepts, introduction of genetic engineering, introduction about restriction enzymes, ligases, polymerases, vectors, their types, sources and their roles in genetic engineering. ➢ Knowledgeable in basic techniques of molecular biology and their applications in various aspects. ➢ Versed in all application aspects of recombinant DNA technology like production of protein and enzyme from cloned genes, production of therapeutic products as well as use of this subject in diagnosis and treatment of inherited disorder and infectious disease.
Unit - I	**Enzymes in Genetic Engineering:** Restriction enzymes, Ligase, Alkaline phosphatase, Phosphonucleotide kinase, Terminal Deoxynucleotidyl transferase, S1 nuclease, DNA Polymerases I (Holoenzyme, Klenow fragment, T4 DNA Pol, Tag Pol), Ribonuclease (RNase H) and Reverse transcriptase.
Unit - II	**Cloning vectors and types:** important feature of a cloning vector, vectors for prokaryotes –both gram negative (specially emphasizing on *E. coli*) and gram positive bacteria, Plasmid, plasmid based cloning vectors (pBR322 and pUC 19), capabilities of different kind of vectors in relation to carry foreign DNA, cloning vectors based on viral DNA (λ and M13 vector), hybrid vectors (Cosmid, Fosmid and Phagemid vector), high capacity vectors (YACs, BACs, PACs), shuttle vectors, introduction and use of expression vectors.
Unit - III	**Gene libraries:** Basic principles of construction of genomic and cDNA libraries. PCR based cloning approach (TA cloning). Use of linkers, adapters and homopolymer tailing.
Unit - IV	**Transfer of recombinant DNA into bacterial cells**: Transformation, transfection. Manipulation of gene expression in host cells (*Saccharomyces cerevisiae* in expression system, insect cell expression system (Baculovirus expression vector), mammalian cell expression vectors (SV40).
Unit - V	**Analysis of cloned genes:** Radioactive labelling of probes, probes developed by PCR, Non-radioactive labelling- horse radish peroxidase method, dioxygen labelling system, biotin-streptavidin labelling system, somatotropin. Southern hybridization and autoradiography.

Reference and Textbooks:

Brown, T.A (2016). *Gene Cloning and DNA Analysis: An Introduction*. 8th Edition. Wiley Publication.

Dubey, R.C. (2014). *A Textbook of Biotechnology*. Fifth edition. S Chand publication.

Green, M. R., & Sambrook, J. (2012). Molecular cloning. *A Laboratory Manual 4th*.

Michael Janitz. (2008). *Next generation sequencing.* Wiley-Blackwell publication.

Primrose, S. B., & Twyman, R. (2013). *Principles of gene manipulation and genomics*. John Wiley & Sons.

Sambrook, J. & Russel, D.W. (2012). *Molecular cloning: A Laboratory Manual 4th Edition*. Cold Spring Laboratory Press.

Outcomes	On successful completion of the course, Students will ➢ Understand the role, use and types of different DNA modifying enzymes viz. Polymerases, Nucleases, restriction endonuclease, ligases etc. ➢ Acquire basic knowledge of DNA sequencing methods from conventional (Sanger sequencing) to High throughput Next generation sequencing technology, their principle, chemistry, theory and types. ➢ Understand the strategies and steps involved in construction of genomic and cDNA library, essential tools and role of each and every constituents.

Semester-V				
Course code 22BBT5C4	**Core Course- X**	**T/P**	**C**	**H/W**
	PLANT BIOTECHNOLOGY	**T**	**4**	**4**

Objectives	The course aims to impart ➢ Familiarization with theoretical knowledge about the basic principles and application of plant tissue culture and recombinant DNA technology. ➢ understanding of the use of molecular markers in assessing the genetic similarity and diversity of plants ➢ deeper understanding of the specialized topics such as transplastomic plants, cryopreservation, phytoremediation terminator seeds, and various recent advances in the field of plant molecular biology.
Unit - I	Plant tissue culture: Types of cultures – Callus, Cell suspension, Micropropagation, and Anther culture. Plant regeneration: Somatic embryogenesis and organogenesis. Different types of culture media (MS & LS). Microsporangium & Megasporangium development in plants.
Unit - II	*Agrobacterium tumefaciens* and crown gall tumours. Basis of tumour formation. Mechanisms of TDNA transfer to plants. Co-integrate, binary and super binary Ti-plasmid based vectors for plant transformation. Agroinfection. Agrobacterium - mediated transformation of food crops.
Unit - III	Molecular markers - RAPD, ISSR, SCAR, STS, Microsatellites, AFLP and DNA Bar coding for analyzing genetic diversity and improvement. Biodiversity Conservation – Importance and types, Artificial seeds – Introduction, Principle and Methods .Applications of synseeds in commercial seed industry.
Unit - IV	Direct and Indirect methods of gene transfer into plant cells and development of transgenic plants. Direct transformation of plants by physical methods (Biolistic, Microlaser, Ultrasonication and Silicon carbide WHISKER^{TM} method). Transposon Tagging. Molecular Farming - Polyhydroxybutyrate (PHB), Polyfructons and Cyclodextrans. Transgenic crops – Flavr Savr^{TM}, Bt Cotton, and Golden rice
Unit - V	Genetic engineering in plants - selectable markers and reporter genes used in plant gene expression vectors. Genetic engineering of plants for virus resistance, pest resistance, herbicide tolerance, abiotic stress tolerance, and delays of fruit ripening.

Reference and Textbooks:

Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). (2015). *Biochemistry and molecular biology of plants*. John wiley & sons.

Chawla, H.S. (2020). *Introduction to Plant Biotechnology*. 3rd Edition. OXFORD & IBH Publication.

Chrispeels, M. J., & Sadava, D. E. (2003). *Plants, genes, and crop biotechnology*. Jones & Bartlett Learning.

Singh, B.D, (2015). *Plant Biotechnology*. 3rd Edition. Kalyani Publishers.

Slater, (2008). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford Publication.

Outcomes	On successful completion of the course, Students can ➢ Narrate the gene function and regulation is used in modern plant biotechnology for plant improvement. ➢ Gain knowledge to Identify the basic methods and approaches used in molecular biology to utilize molecular markers ➢ Differentiate the pros and cons of transgenic plants

Semester-V				
Course code	**Core Practical-V**	**T/P**	**C**	**H/W**
22BBT5P1	**LAB IN IMMUNOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY**	**P**	**4**	**6**

Objectives

The course enables students to

- Understand the basic concepts in immunology by practical approach
- Learn the various human hematological techniques
- Understand human and animal cell culture methods
- Study about the recent advancement in immunology and know about the diagnostic methods for human infectious diseases

1. Separation of serum and plasma from blood samples.
2. Determination of human blood groups – A, B, AB, O and Rh factor.
3. Enumeration of White Blood Cells.
4. Detection of differential leukocyte count in blood sample
5. Single Radial immunodiffusion
6. Double immunodiffusion (Ag-Ab Titration and Ag-Ab pattern)
7. Rocket immunoelectrophoresis and Counter current immunoelectrophoresis.
8. Widal test
9. Dot enzyme-linked immunosorbent assay (Dot-ELISA) for antibody or antigen detection
10. Preparation of Hanks Balanced salt solution
11. Demonstration of cell lines as experimental models for reliable research.
12. DNA isolation from animal tissue and Quantification of isolated DNA.

Reference and Textbooks:

Annadurai, B. (2010). *A Textbook of Immunology & Immuno Technology*. S. Chand Publishing

Jennie P. Mather, & David Barnes. (2006). *Animal cell culture methods*. Elsiever.

Nigam, A. & Archana Ayyagari (2008). *Lab Manual in Biochemistry, Immunology and Biotechnology*. McGraw-Hill Publication.

Sudha Gangal. (2007). *Principles and Practice of Animal Tissue*. Culture Universities Press (India) Private Ltd.

Wilmore Webley. (2017). *Immunology Lab Manual*. LAD Custom Publication.

Outcomes	On successful completion of the course, the students can ➢ Independently perform the experiments involved in human immunology research ➢ Understand about the human immune system and infectious diseases.

Semester-V				
Course code:	**Core Practical-VI**	**T/P**	**C**	**H/W**
22BBT5P2	**LAB IN GENETIC ENGINEERING AND PLANT BIOTECHNOLOGY**	**P**	**4**	**6**

Objectives

The course provides

- Focus on cloning, construction of genomic DNA libraries followed by the library screening which would be the next stage of gene manipulation.
- In-depth understanding of various techniques involved in gene amplification, DNA fingerprinting, labelling and detection of nucleic acid sequences.

1. Isolation of bacterial chromosomal DNA and Plasmid DNA.
2. Restriction digestion of DNA and its electrophoretic separation
3. Ligation of DNA molecules and their testing using electrophoresis.
4. Preparation of competent cells
5. Transformation in *E.coli* using plasmid.
6. Isolation of recombinants. (Blue-White selection)
7. GFP cloning
8. Southern Blotting
9. PCR (Demo)
10. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid for plant tissue culture.
11. Preparation of complex nutrient medium (Murashige & Skoog's medium) for plant cell culture
12. Demonstration of various steps of Micropropagation (in plants).

Reference and Textbooks:

Sambrook, J., Fritsch, E. F., & Maniatis, T. (2015). *Molecular cloning: a laboratory manual* (No. Ed. 2). Cold spring harbor laboratory press.

John venison, S. (2009). *Laboratory manual for Genetic Engineering*. PHI Learning publication.

Pal Maliga. (1995). *Methods in Plant Molecular Biology. A Laboratory Course Manual*. Cold Spring Harbor Laboratory Press.

Chawla, H.S.(2008). *Plant Biotechnology-Laboratory manual for Plant Biotechnology*. Oxford & IBH Publishing Co. Pvt. Ltd.

Bhojwani, S.S., & Razdan, M.K.(2004). *Plant Tissue Culture: Theory and Practice*. Revised Edition - Elsevier Science Publications.

Outcomes	➢ On successful completion of the course, Student will get acquainted with the tools and techniques in molecular cloning and basics in plant tissue culture.

Semester–VI				
Course code 22BBT6E1	**DSE-I**	**T/P**	**C**	**H/W**
	MICROBIAL BIOTECHNOLOGY	**T**	**6**	**6**

Objectives	The course provides knowledge about ➢ Strain improvement methods ➢ Upstream fermentation process ➢ Downstream fermentation process
Unit - I	An introduction to fermentation process: Screening of industrial microbes – Detection and assay of fermentation products. Classification of fermentation types. Genetic control of fermentation. Strain selection and improvement, mutation - protoplast fusion, parasexual reproduction and recombinant DNA technique for strain development. Preservation methods of cultures.
Unit - II	Types and design of bioreactors: Packed / fluidized, fed, transport phenomena – mass transfer, newtonian and non – Newtonian behaviour of fluid – mass transfer coefficient, oxygen, viscosity, heat transfer and scale up. Mode of operation. Instrumentation and computer application in fermentation
Unit - III	Fermentation kinetics: Yield factors - growth rate parameters- kinetics of growth and product formation in batch, chemostat and fed batch culture. Inoculum development, media formulation, optimization methods, media sterilization, statistical design for media formulation, optimization, contour Plot. Immobilization of cells and enzymes - methods and applications
Unit - IV	Fermentation of microbial products: Single Cell Protein (SCP).Anaerobic fermentation (beer and wine). Aerobic fermentation (vinegar and citric acid. Antibiotic fermentation (penicillin and streptomycin). Vitamins (B12, riboflavin), Hormone (gibberellic acid, IAA). Enzyme (amylase, protease). Biogas production.
Unit - V	Downstream processing: Cell disruption – physical and chemical methods. Precipitation. filtration- batch and continuous filters. Centrifugation - types, liquidliquid extraction, chromatography, membrane process, drying, crystallization. Quality control and evaluation of industrial products, packaging.

Reference and Textbooks:

Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). *Principles of fermentation technology*. Elsevier.

Thatoi,N.H. & Mishra, B.B.(2012). *Microbial Biotechnology:Methods and Applications*. Narosa Publication house India Ltd.

Brahmachari, G., Demain, A. L., & Adrio, J. L. (Eds.). (2016). *Biotechnology of microbial enzymes: production, biocatalysis and Industrial applications*. Academic Press.

Casida, L.E.J.R. (2019). *Industrial Microbiology (2nd ed).* New Delhi: New Age International (P) Ltd., Publishers.

Crueger,W.(2017).*Biotechnology: A Test Book of Industrial Microbiology (3rd ed).* MEDTECH Publishers.

El-Mansi, E.M.T., Bryce, C.F.A., Arnold L. Demain & Allman, A.R. (2012). *Fermentation Microbiology and Biotechnology*. CRC Press.

Outcomes	On successful completion of the course, Students ➢ get knowledge on strain improvement ➢ can work in fermentation industry ➢ get idea on upstream and downstream fermentation process.

Semester–VI				
Course code 22BBT6E2	**DSE-II**	**T/P**	**C**	**H/W**
	ALGAL AND MARINE BIOTECHNOLOGY	**T**	**6**	**6**

Objectives	The course enables students to ➢ To understand marine environment and knowing the diversity of micro and macro-organisms and its products is essential for research in bio-pharmaceutical fields. ➢ Know the importance of algal biotechnology
Unit-I	Occurrence and distribution of algae: Fundamentals of algal cultivation. Culture methods - batch cultures, continuous cultures semi-continuous cultures, commercial-scale cultures, outdoor ponds, photobioreactors and culture of sessile microalgae.
Unit-II	Quantitative determinations of algal density and growth, Growth rate and generation time determinations. Cultivation of economically important freshwater and marine algae. Algae as a source of food.
Unit- III	Application of cell fusion, tissue culture and hybridization techniques in algae. Algaegenomics. Genetic engineering of algae: construction of transformation and expression vectors, methods of gene introduction. Metabolic engineering in lipid metabolism. Phycoremediation.
Unit -IV	Microalgal biotechnological applications in nutrition, health and environment. Biofuels and Biofertilizer: Biogas, Ethanol, Diesel and Hydrogen production by algae. Seaweed fertilizer and algae as Biofertilizer.
Unit-V	Chromosomal manipulation of commercially important marine organisms. Transgenic fish technology. Transgenic fishes with growth hormone (GH) and antifreeze genes. Transposon in fishes.

Reference and Textbooks:

Bux, F., & Chisti, Y. (Eds.). (2016). *Algae biotechnology: products and processes*. Springer International Publishing.

Bux, F., & Chisti, Y. (Eds.). (2018). *Algae biotechnology: products and processes*. Springer International Publishing.

Kim, S. K. (Ed.). (2015). *Handbook of marine microalgae: Biotechnology advances*. Academic Press.

Madigan, M. T., Martinko, J. M., & Parker, J. (2006). *Brock biology of microorganisms* (Vol. 11, p. 136). Upper Saddle River, NJ: Pearson Prentice Hall.

Vashishta, B.R., Sinha, A.K., & Singh V.P. (2010). *Algae (Revised).* New Delhi: S.Chand & Company Ltd.

Outcomes	On successful completion of the course, students ➢ Understand the role of seaweeds and their major applications ➢ Acquire basic information on practical techniques and approaches commonly used in algal culture ➢ Become aware of Algal diversity and bio-resources that enable them to prosper in their natural habitats

Semester-VI				
Course code 22BBT6E3	**DSE-III**	**T/P**	**C**	**H/W**
	ENVIRONMENTAL BIOTECHNOLOGY	**T**	**6**	**6**

Objectives	The course empowers students to ➢ Acquire skills in bioremediation of environmental pollutants, ➢ Apply the skills in developing innovative biotechnological processes for waste conversion, resource recovery, and production of bioproducts bioresources. ➢ Knowledge in environmental biotechnology for gene cloning
Unit-I	Diversity and distribution of microorganisms in soil; Soil Microflora- Bacteria, Fungi and Actinomycetes. Classification, physical, chemical properties and structure of soil. Microbial interactions - mutualism, synergism, commensalism, amensalism, parasitism, predation and competition.
Unit-II	Microbial interactions with plants– phyllosphere, mycorrhizae, rhizosphere and symbiotic association in root nodules. Biofertilizer – VAM, Rhizobium, Frankia, Azospirillum, Azotobacter, Cyanobacteria, Phospho bacteria and Azolla. Bioinsecticides – viral, bacterial and fungal- a brief note
Unit- III	Use of microbes in environmental decontamination - Biodegradation - Biosorption - Biotransformation - Bioaugmentation - Biostimulation - Rhyzoremediation, Mycoremediation - Phycoremediation - Bioleaching and Biomining - MEOR - Bioremediation pollutants: Heavy metals, PAHs, VOCs - Bioindicators and biosensors for detection of pollution. (K1, K2, K3).
Unit -IV	Biotechnology for Waste Management - Sewage treatment - Activated Sludge Process - Anaerobic Treatment - Sludge stabilization - Aerobic Composting, Anaerobic Digestion, Biogas Production, Algal Cultivation: Nutrient Removal. Solid Waste Treatment - Biocomposting - Vermicomposting - Air Pollution Control - Bioscrubber, Biofilters. (K3, K4, K5, K6)
Unit-V	Microbial bioproducts for environmental cleanup - Microbial biomass - Biosorbents - Biosurfactants - Microbial enzymes: lignocellulases, lipases, dioxygenases - Bioflocculants - Bioplastics - Biofertilizers - Biopesticides - Microbial fuels: Bioethanol, Biobutanol, and Biohydrogen. (K4, K5, K6)

Reference and Textbooks:

Bernaral R. Glick & Jack J. Pastemak. (1994). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. ASM Press. Washington, DC USA.

Brown, T.A. (1995). *Gene cloning - A introduction*. Chapman & Hall, London.

Buckley, R. G. (2019). *Environmental Microbiology*. CBS Publication.

Glazer, A. N., & Nikaido, H. (2007). *Microbial biotechnology: fundamentals of applied microbiology*. Cambridge University Press.

Glazer, A. N., & Nikaido, H. (2007). *Microbial biotechnology: fundamentals of applied microbiology*. Cambridge University Press.

Kreuzer & Massey. (2001). *rDNA & Biotechnology. A guide for Teachers, 2nd Edition*. ASM Press, Washington DC, USA.

Neetu Sharma, Abhinashi Singh Sodhi, & Navneet Batra. (2021). *Basic Concepts in Environmental Biotechnology.* CRC Press.

Rittmann, E.B., & Perry, L. (2020). *Environmental Biotechnology: Principles and Applications*. 2nd Edition. McGraw Hill Publication.

Outcomes	On successful completion of the course, Students can acquire skills in ➢ principles of bioremediation of environmental pollutants. ➢ role of microbes in degradation of environmental pollutants ➢ manipulating the microbes for biodegradation of pollutants ➢ processes for waste bioconversion to value-added products ➢ process for recovery of resources from different wastes.

Semester-VI				
Course code 22BBT6E4	**DSE-IV**	**T/P**	**C**	**H/W**
	MEDICAL BIOTECHNOLOGY	**T**	**6**	**6**

Objectives	The course offers an opportunity the students to ➢ Understanding the basics concepts in gene therapy, gene delivery methods and gene therapy models. ➢ Inculcate the role of vaccines and Tissue engineering in overcoming human diseases and disorder.
Unit - I	Gene therapy – Ex vivo versus in vivo gene therapy - Potential target diseases for gene therapy - Gene transfer methods - Non-viral gene transfer - Gene transfer using recombinant viruses - Clinical studies - Pharmaceutical Production and regulation.
Unit - II	Gene delivery methods – Viral delivery (through Retroviral vectors, Adenoviral vectors), Non-viral delivery, Antibody engineering. Gene therapy Models- Liver diseases, lung diseases, hematopoietic diseases, Circulated gene products, cancer and Autoimmune diseases.
Unit - III	Classification of antibiotics based on mode of action: antibacterial (Penicillin), antiviral (Amantidine), antifungal (Amphotericin) antiparasitic drugs (Quinine and Metraindazole). Infectious diseases- Definition of emerging & re-emerging diseases. Factors contributing to emergence. Examples (Chickungunya, Zika virus, H1N1 and Ebola). National programmes in prevention of infectious diseases.
Unit - IV	Vaccines: Types – inactivated, subunit, synthetic, DNA and live attenuated vaccines-Immunoinformation.Immune-enhancing technology, synthetic therapy – synthetic DNAs, therapeutic Ribozymes. Nanomedicine.
Unit - V	Tissue engineering – Skin, Liver, Pancreas. Xenotransplantation – terminology, technology, organ donors, social and ethical issue. Cell Adhesion-based therapy – integrins, inflammation, cancer and metastasis.

Reference and Textbooks:

Bernard R. Glick, Cheryl L. Patten, & Terry L. Delovitch. (2013). *Medical Biotechnology: Principles and Applications of Recombinant DNA*. ASM Press.

Jesse Russell, & Ronald Cohn. (2012). *Medical Microbiology*. Book on Demand Ltd.

Khan, F. A. (2014). *Biotechnology in medical sciences*. CRC Press.

Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. (2020). *Medical microbiology E-book*. Elsevier Health Sciences.

Pongracz.J. (2008). *Medical Biotechnology*. Elsevier Publication.

Wilkinson, M. (2011). *Medical microbiology*. Scion Publishing Ltd.

Outcomes	On successful completion of the course, Students can ➢ Acquire skills in gene therapy, gene delivery methods, gene therapy models ➢ Understand concepts of vaccines and Tissue engineering. ➢ Understand the principles in tissue engineering and xenotransplantation

Semester-VI				
Course code 22BBT6E5	**DSE-V**	**T/P**	**C**	**H/W**
	BIODIVERSITY	**T**	**6**	**6**

Objectives	The course deals with the ➢ ways to protect the environment ➢ highlights of important environmental issues and protection methods ➢ value of biodiversity and drivers of its loss ➢ current efforts to conserve biodiversity on global, national and local scales
Unit - I	Types of Biodiversity: Species, Genetic and Ecosystem diversity – Alpha, beta, and gamma diversity (K1 & K2) – Biodiversity and ecosystem function (K4 & K5) – Megadiversity zones and Biodiversity Hot Spots in India (K2 & K3) – Endangered and endemic species of flora and fauna in India (K1 & K2) - Ecologically Sensitive Areas (ESA) in India (K4 & K5) - Values of Biodiversity (K4 & K5).
Unit - II	Biodiversity threats under Anthropocene era: Habitat loss, fragmentation and degradation – Pollution - Overexploitation (K2, K4 & K5) – IUCN Threat Categories – Red Data Book (K2 & K4) – Climate change on species extinction - Causes and Impacts of Invasive species to biodiversity (K2, K3, K4 & K5) - Human-Animal conflict with special reference to elephants (K3, K4 , K5 & K6)
Unit - III	In situ conservation: Afforestation, Social Forestry, Agro-forestry, Zoos, Biosphere Reserves, National Parks, Sanctuaries, Protected Area Network, Sacred Groves and Sthalavrikshas (K1, K2 & K3). Ex situ conservation: Botanical gardens, Cryopreservation, Gene Bank, Seed Bank, Pollen Bank, Sperm Bank, cDNA Bank (K1, K2 & K3) - Status and protection of species in National and International levels (K3 & K4).
Unit - IV	Biodiversity Prospecting - Examples of biopiracy and bioprospecting (K2 & K5) - National Biodiversity Authority (NBA) – Functions of State Biodiversity Board (SBB) and Biodiversity Management Committee's (BMC) – People's Biodiversity Register (PBR) (K3, K4, K5 & K6).
Unit - V	International Organizations and biodiversity conservation: Role of CITES, IUCN and Convention on Biological Diversity (CBD) in biodiversity conservation (K2, K3 & K4) – WWF-India for priority and threatened species conservation (K3, K4 & K5).

Reference and Textbooks:

Comizzoli, P., Brown, J. L., & Holt, W. V. (Eds.). (2019). *Reproductive sciences in animal conservation*. Cham: Springer, New York.

Krishnamurthy, K.V. (2018). *An Advanced Textbook on Biodiversity: Principles and Practice*. Oxford and IBH Publication.

Lovejoy, T. E., & Hannah, L. J. (Eds.). (2019). *Biodiversity and climate change*. Yale University Press.

Odum, E. P., & Barrett, G. W. (2004). *Fundamentals of ecology* (Vol. 3, p. 5). Philadelphia: Saunders.

Preetha, N., Laladhas, K. P., & Oommen, V. O. (2015). Biodiversity Conservation-Challenges for Future and Way Forward. *Biodiversity Conservation-Challenges for the Future*, 249.

Outcomes	On successful completion of the course, Student can ➢ Understand the various in situ and ex situ conservation measures and make critical judgments on the conflict between conservation and development. ➢ Outline the main reasons for decline and threats to biodiversity worldwide and understand the need for local action to address the global loss of biodiversity ➢ Understand the relationship between biodiversity and ecosystem functions

Semester–VI				
Course code 22BBT6E6	**DSE-VI**	**T/P**	**C**	**H/W**
	BIOSTATISTICS	**T**	**6**	**6**
Objectives	➢ The course introduces basic statistical concepts, methods and principles in the field of biotechnology.			
Unit - I	Brief description and tabulation of data and its graphical representation.			
Unit - II	Measures of central tendency: Mean, median, mode and their applications.			
Unit - III	Measures of dispersion: Mean deviation, variance, standard deviation and coefficient			
Unit - IV	Ideas of two types of errors and level of significance, test of significance Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA).			
Unit - V	Simple linear regression and correlation. Emphasis on examples from Biological Sciences. Statistical softwares- SPSS.			

Reference and Textbooks:

Agarwal**,** B.L. (2013). *Basic Statistics.* New Age International Private Limited.

Gupta**,** S.C. (2018). *Fundamentals of Statistics*. Himalaya Publishing House.

Holmes, S. H., & Huber, W. (2018). *Modern statistics for modern biology*. Cambridge University Press.

Lander, P. (2017). *R for Everyone: Advanced Analytics and Graphics (2 nd ed.).* Pearson.

Norman, M. (2001). *The Art of R Programming – A Tour of Statistical Software Design*. Cengage Learning.

Segal, L. (1980). *Mathematical Models in Molecular and Cellular Biology*, Cambridge: Cambridge University Press.

Zar, J.H. (1984). *Bio Statistical Methods.* USA: Prentice Hall International Edition

Outcomes	➢ On successful completion of the course, Students study about central tendency, Measures of dispersion, variance, Correlation and Regression.

Semester-VI				
Course code 22BBT6E7	**DSE-VII**	**T/P**	**C**	**H/W**
	MOLECULAR DIAGNOSTICS	**T**	**6**	**6**

Objectives	The course imparts ➢ Understanding of molecular DNA isolation and quantification, Probe and primer designing and in determining the Paternity and diagnosis of fungal pathogens. ➢ Study about the recent advancement in immunology and know about the diagnostic methods for human infectious diseases. ➢ Recognize the importance of utilizing the modern techniques to provide optimal patient care.
Unit - I	Cytogenetics - Karyotype analysis, blood, bone marrow, amniotic fluid, chorionic villus samples, products of conception Fluorescent in situ hybridization, Cytogenetic studies using microarrays. Molecular diagnosis of syndromes (Klinefelter syndrome)
Unit - II	Molecular DNA isolation and quantification, Probe and primer designing, PCR -standard and various modifications, Real time PCR, Multiplex Ligation-dependent Probe Amplification (MLPA) analysis, SNP, Single strand conformation polymorphism (SSCP).
Unit - III	Applications of PCR- PCR based microbial typing: Bacterial identification based on 16S rRNA sequences - Amplified Ribosomal DNA Restriction analysis (ARDRA)- Culture independent analysis of bacteria - Denaturing gradient gel electrophoresis (DGGE), TGGE.
Unit - IV	Molecular diagnosis of fungal pathogens - based on 18SrRNA sequences - Detection of viral pathogens through PCR. RAPD for animal. PCR in forensic science- RFLP, AFLP, STR, Multiplex PCR- Determination of Paternity- Human identification and sex determination
Unit - V	Blotting techniques - Southern, Northern & Western, isotopic and non-isotopic methods, DNA Sequencing, including massively parallel sequencing. Use of microarrays, Bioinformatics as applied to sequencing and microarrays.

Reference and Textbooks:

Buckingham, L. (2019). *Molecular diagnostics: fundamentals, methods and clinical applications*. FA Davis.

Persing, D.H.(2004). *Molecular Microbiology – Diagnostic Principles and Practice*. ASM Press, Washington, USA.

Preethi Kartan. (2017). *Advances in Molecular Diagnostics*. Arcler Education Inc.

Rifai, N., Horvath, A. R., Wittwer, C. T., & Park, J. (Eds.). (2018). *Principles and applications of molecular diagnostics*. Elsevier.

Outcomes	On successful completion of the course, Students ➢ Demonstrate competency in investigating, evaluating, and interpreting molecular diagnostics cases. ➢ Recommending the appropriate molecular test for a specific indication ➢ Demonstrate commitments to review and improve Molecular Diagnostics practice patterns and to life-long learning.