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The American College

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(An Autonomous Institution Affiliated to Madurai Kamaraj University)

Madurai – 625 002

Department of Biotechnology

B.Sc. Biotechnology Programme

Undergraduate Department of Biotechnology

(2022-2023 onwards)

SEM	Part	Course No.	Course Title	Hours	Credits	Marks
1	I	TAM/FRE/HIN/ 0000		3	2	30
1	II	ENG 1201	Conversational skills	3	2	30
1	IIIC	BTC 1603	Cell Biology (T+L)	4+2	6	90
1	IIIC	BTC 1505	Genetics	5	5	75
1	IIIC	BTC 1207	Lab in Genetics	2	2	30
1	IIIS	BCH 1469	Biochemistry for Biotechnologists - I (T+L)	3+2	4	60
1	IVE	BTC 1205	Biotechnology for society	3	2	30
1	IVLS	XXX 0000	Life Skill Course - 1	3	2	30
1	V	XXX 0000	PED/NCA/NCN/NSS/SLP	-	-	-
Total				30	25	375
2	I	TAM/FRE/HIN/0000		3	2	30
2	II	ENG 1202	Reading & Writing Skills	3	2	30
2	IIIC	BTC 1504	Microbiology	5	5	75
2	IIIC	BTC 1306	Lab in Microbiology	3	3	45
2	IIIC	BTC 1508	Bioinstrumentation	5	5	75
2	IIIS	BCH 1470	Biochemistry for Biotechnologists - II (T+L)	3+2	4	60
2	IVE	BTC 1206	Bioentrepreneurship	3	2	30
2	IVLS	XXX 0000	Life Skill Course - 2	3	2	30
2	V	XXX 0000	PED/NCA/NCN/NSS/SLP	-	1	15
Total				30	25+1	375/390
3	I	TAM/FRE/ HIN/0000		3	2	30
3	II	ENG 2201	Study Skills	3	2	30
3	III C	BTC 2601	Molecular Biology	6	6	90
3	III C	BTC 2303	Lab in Molecular Biology	3	3	45
3	III C	BTC 2405	Taxonomy	4	4	60
3	III C	BTC 2607	Animal and Plant Physiology (T+L)	4+2	6	90
3	III S	BTC 2409	Biodiversity and conservation	5	4	60
3	V	XXX 0000	PED/NCA/NCN/NSS/SLP	-	-	-
Total				30	27	405

SEM	Part	Course No.	Course Title	Hours	Credits	Marks
4	I	TAM/FRE/ HIN/0000		3	2	30
4	II	ENG 2202	Career Skills	3	2	30
4	III C	BTC 2604	Immunology (T+L)	4+2	6	90
4	III C	BTC 2606	Genetic Engineering	6	6	90
4	III C	BTC 2306	Lab in Genetic Engineering	3	3	45
4	III C	BTC 2408	Microbial Biotechnology	4	4	60
4	III S	BTC 2410	Environmental Biotechnology	5	4	60
4	V	XXX 0000	PED/NCA/NCN/NSS/SLP	-	1	15
Total				30	27+1	405/420
5	III C	BTC 3601	Industrial biotechnology	6	6	90
5	III C	BTC 3303	Lab in Industrial Biotechnology	3	3	45
5	III C	BTC 3805	Bioinformatics (T+L)	5+3	8	120
5	III C	BTC 3609	Genomics and proteomics	6	6	90
5	IV LS	XXX 0000	Life Skill Course - 3	3	2	30
5	IV	BTC 3200	Environmental Studies	4	2	30
Total				30	27	405
6	III C	BTC 3602	Animal Biotechnology	6	6	90
6	III C	BTC 3604	Plant Biotechnology	6	6	90
6	III C	BTC 3306	Lab in Animal & Plant Biotechnology	3	3	45
6	III C	BTC 3808	Project	8	8	120
6	IV LS	XXX 0000	Life Skill Course - 4	3	2	30
6	IV VE	HVS 3200	Human Values Development	4	2	30
Total				30	27	405
				180	158+2	2370/2400

C: CORE

S: SUPPORTIVE

E: NON-MAJOR ELECTIVE

LS: LIFESKILL

VE: VALUE EDUCATION

Part III Supportive

SEM	Course No.	Course Title	Hrs.	Cr	Marks
III	BTC 2409	Biodiversity and conservation	5	4	60
IV	BTC 2410	Environmental Biotechnology	4	4	60
Total			9	8	120

Part IV Non-Major Electives

SEM	Course No.	Course Title	Hrs.	Cr	Marks
I	BTC 1205	Biotechnology for society	3	2	30
II	BTC 1206	Bioentrepreneurship	3	2	30
Total			6	4	60

Part IV: Life Skill Courses

SEM	Course No.	Course Title	Hrs.	Cr	Marks
I	BTC 1203	Nutraceuticals	3	2	30
II	BTC 1204	Evolution	3	2	30
V	BTC 3211	Research Methodology	3	2	30
VI	BTC 3212	Nanobiotechnology	3	2	30
Total			12	8	120

THE PROGRAM SPECIFIC OUTCOMES FOR THE B.Sc., BIOTECHNOLOGY PROGRAM

Upon completion of this programme the undergraduates will be able to

PSO1	Get adequate and sound knowledge to bring out all kind of biotechnological concepts
PSO2	Motivate to do innovative research useful for societal needs
PSO3	Train to get a hold successful career in a global society as a competent biotechnologist
PSO4	Understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution
PSO5	Obtain opportunities and infrastructure facilities to achieve their aspirations in the field of biotechnology through projects and internship programs
PSO6	Express ideas credibly in written and oral form to develop their leadership qualities
PSO7	Address important national and global needs and work in the direction of technology transfer by emphasizing on research merging bioscience and technology
PSO8	Identify various challenges in health care sector by combining biopharma industrial sector
PSO9	Disseminate and apply modern biotechnological techniques for fast and reliable monitoring any kind environmental issues
PSO10	Contribute the scientific skills in entrepreneurial ventures and management.

This course is designed to develop the students to acquire knowledge on cell theory, basic instrumentations in cell biology and their application structure and functions of cells and their organelles, cell division and practical skill on cell biology.

Upon successful completion of the course, students will be able to

- i. Understand stand the concept of cell theory, structural organization and differentiation between different cells
- ii. Gain fundamental knowledge on working principle and applications of various instruments required for cell biology
- iii. Get acquaintance of cytoplasm, plasma membrane and cytoskeleton of a cell and also gain cell signaling
- iv. Deliver the information about the ultrastructure and functions of cell and their cell organelles
- v. Replicate the concept of structure, function and division of chromosome

UNIT-I

Historical account of cell biology- cell as basic unit of life- cell theory and protoplasm theory- cell types-similarities and differences - prokaryotic cells (Bacteria and Archaea) and eukaryotic cells (Plant cell and animal cell) - cell cycle

UNIT-II

Principles of Light microscopy- Phase contrast microscopy-Electron microscopy (EM)- Scanning Electron microscopy (SEM) and Transmission Electron microscopy (TEM); Fluorescence microscopy- Flow cytometry- Sub-cellular fractionation

UNIT-III

Physio -chemical nature of cytoplasm- Structural organization and function of plasma membrane and cell wall (Eukaryotic only)- Cytoskeleton structure – microtubules, microfilaments, intermediate filament- Cell- to -Cell Signaling: Hormones and Receptors- Vesicles and their importance in transport

UNIT-IV

Structure and functions of cell organelles – endoplasmic reticulum (rough endoplasmic reticulum and smooth endoplasmic reticulum), golgi apparatus, lysosomes, microbodies (peroxysomes and glyoxysomes), Mitochondria, and ribosomes,

UNIT-V

Structural organization and function of chloroplasts, nucleus, nucleolus and nuclear membrane-
Molecular organization of chromosome-cell division-Mitosis and Meiosis

LAB EXPERIMENTS

1. Observation of specialized cells (nerve cell, muscle cell etc)
2. Measurement of cell- epidermal cell(Onion/Animal)
3. Study of divisional stages in Mitosis
4. Study of divisional stages in Meiosis
5. Buccal smear – Identification of Barr Body
6. Permanent slide preparation
7. Separation of chloroplast
8. Preparation of polytene chromosome from Chironomus larvae

TEXT BOOKS

1. Ajoy Paul., 2011. Text Book of Cell and Molecular Biology-. Books and Allied (P) Ltd, Kolkata. Third Edition.
2. Aminul Islam., 2011. A Text Book of Cell Biology-. Books and Allied (P) Ltd, Kolkatta. First edition.
3. C. B. Power, Cell biology.2010 Himalaya Publishing House
4. Veer BalaRastogi, Cell biology. 2019.New age International (P) Ltd

REFERENCE BOOKS

1. Alberts., 2002. Molecular Biology of the Cell –. Garland publication, Fourth Edition
2. Lodish, Berk, Zipursky, Matsudaria, Baltimore, Darnell, Molecular Cell Biology. W.H. Free man and company New York
3. De Roberties., Cell Biology, Blaze publishers & Distributors Pvt.Ltd., NewDelhi.
4. Debarati Das. Essential Practical Handbook of Cell Biology & Genetics, Biometry & Microbiology A Laboratory Manual (2017), 1st Edition

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2		2				
CO3				4		
CO4		2		4		
CO5				4		

Mean = 3.33

This course is designed to understand and gain the knowledge on concepts of classical genetics, inheritance of genes, sex determination, chromosomal variation population genetics and metabolic disorders in human

Upon successful completion of the course, students will be able to

- i. Analyze Mendelian genetics including different law and experiments carried out by him as well as allele interactions
- ii. Explain about the mechanism of sex linked inheritance, linkages and crossing over
- iii. Deliver knowledge about sex determination and different types of Non-Mendelian inheritance
- iv. Give explanation on mechanism involved in Chromosomal variation Chromosomal aberrations and Chromosomal disorders
- v. Clearly explain about Population Genetics, preparation and Analysis of Pedigree chart and causes of Inborn Errors

UNIT – I

Mendelian Genetics - Mendel's life - Principles of inheritance- Mendelian law and Experiment– Monohybrid and Dihybrid cross, Incomplete dominance and co-dominance, Non-allelic gene interaction- Epistasis, Multiple alleles- Blood Group Inheritance- Lethal alleles- Pleiotropy

UNIT – II

Sex-linked, sex influenced and sex-limited characters inheritance- Inheritance of X-linked gene (Colour blindness and haemophilia in man), Sex linkage in *Drosophila* - Polygenic Inheritance – Skin colour in Man – Linkage- kinds of linkage- linkage groups-Crossing over-types, mechanism and significance

UNIT – III

Chromosomal mechanisms of sex determination in *Drosophila* and Man; Non-Mendelian inheritance –cytoplasmic inheritance, extra nuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparental inheritance

UNIT – IV

Chromosomal variation in Number & Structure – Euploidy, Non-disjunction & Aneuploidy- Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosome in Diptera,- chromosomal rearrangements - Deletion, Duplication, Inversion, Translocation, Position Effect, Chromosomal aberrations- Chromosomal disorders – Turner syndrome, Down syndrome & Klinefelter syndrome

UNIT – V

Population Genetics – Gene Pool, Hardy – Weinberg Law, Gene Frequency Calculations, factors affecting Hardy – Weinberg Law- Human Genetics - Pedigree Analysis-Twins- Inborn Errors of Metabolism – Phenylketonuria

TEXT BOOKS

1. Ajoy Paul., 2011. Text Book of Genetics- from Genes to Genomes- Books and Allied (P) Ltd, Kolkata. Third Edition
2. P.S.Verma and V.K. Agrawal (2009) Genetics..S.Chand Publication

REFERENCE BOOKS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India.
2. Anthony Griffiths; John Doebley; Catherine Peichel; David A. Wassarman.(2020) Introduction to Genetic Analysis. XII Edition. Macmillan Learning.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3	4		
CO3				4		
CO4			3			
CO5				4		

Mean = 3.33

This course is framed to provide practical exposure on classical genetics, concepts of linkage and pedigree analysis and learn about role of chromosomes as spotters.

Upon successful completion of the course, students will be able to

1. Understand the genetics of heritable traits and get awareness on inherited genetic disorders.
2. Collect data on traits in population, analyse and interpret the data.

LAB EXPERIMENTS

- i. Study of Mendelian traits in man
- ii. Study on Mendelian laws and gene interactions using beads.
- iii. Linkage maps based on data from conjugation, transformation and transduction.
- iv. Linkage maps based on data from Drosophila crosses.
- v. Study of human karyotype (normal and abnormal).
- vi. Pedigree analysis (autosomal, X linked and Y linked traits only).

TEXT BOOKS

1. Laboratory Manual For Molecular Genetic Tests (2014), 1St Edition by Chowdhury, Jaypee Brothers Medical Publishers
2. Debarati Das. Essential Practical Handbook of Cell Biology & Genetics, Biometry & Microbiology A Laboratory Manual (2017), 1st Edition

REFERENCE BOOKS

1. Neeru Dhamija, Sunita Joshi Rediscovering Genetics - A Laboratory Manual (2020) FirstEdition
2. Chiyedza Small, Genetics Laboratory Manual 1st Edition (2019), Kendall Hunt Publishing

The objective of this course is to introduce the basic concepts to understand biochemistry. The students will be explored to concepts of biochemical bonding and forces involved in the structural moiety of various biomolecules and their functions. It will also emphasize the chemical structures and reactions of biological molecules.

At the end of the course, students will be able to:

- i. Explain the different bonds involved in the biological compounds, the importance of pH and the role of buffer system in the body.
- ii. Identify the structure and functions of carbohydrates.
- iii. Explain the importance of lipids, PUFA & Omega fatty acids in humans.
- iv. Recognize the importance of the structure of proteins in the maintenance of the shape and the role of non-covalent bonds.
- v. Discuss the types, structure and importance of nucleic acids.

UNIT I - Atoms, chemical bonds & pH

8 Hrs

Definition - structure of atoms & molecules, chemical bonds — ionic bond - covalent bond - hydrogen bond— inter & intra molecular bonds – hydrophobic interaction – Van der Waals forces - Electrophiles – Nucleophiles – importance of pH & buffer solution.

UNIT II - Carbohydrates

10 Hrs

Introduction – classification - structure and importance - monosaccharides — glucose, fructose - disaccharides – sucrose, lactose– trisaccharides – rhamnose, raffinose – polysaccharides – homopolysaccharides – starch, glycogen, cellulose – heteropolysaccharides – mucopolysaccharides – heparin, chondroitin sulfate.

UNIT III - Lipids

9 Hrs

Introduction – classification – physical properties and chemical properties of lipids and fatty acids – saturated and unsaturated fatty acids - structure and importance of phospholipids and sterols.

UNIT IV - Amino acids and Proteins

9 Hrs

Introduction – amino acids – classification and structure – peptide bond - protein – classification - primary, secondary, tertiary and quaternary structure - biological importance.

UNIT V - Nucleic acids

9 Hrs

Introduction, chemistry of nucleic acids – nucleosides, nucleotides – Chargaff's base pairing rule – DNA, RNA – types, structure – Watson and Crick model – biological importance of nucleic acids.

LAB EXPERIMENTS

1. Preparation of different types of buffer solutions.
2. Qualitative analysis of carbohydrates – glucose, fructose, lactose, sucrose, starch
3. Qualitative analysis of amino acids – phenylalanine, tyrosine, tryptophan, cysteine
4. Test for proteins – albumin
5. Test for lipids – cholesterol
6. Reducing Sugar – Benedict's quantitative method
7. Verify Beer-Lambert's law - colorimetric method.
8. Starch from potato and Casein from milk.

REFERENCES:

1. Vasudevan DM, Sreekumari S, KannanVaidyanathan, (2013), Textbook of Biochemistry for Medical Students, 7th edition, Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.ISBN: 9789350905302.
2. Jain J.L (2009), Fundamentals of Biochemistry, Rajendra Ravindra Printers Pvt. 7361, New Delhi, ISBN:81-219-2453-7.
3. Satyanarayana U (2007), Biochemistry 3rd edition. Book and Allied (P) Ltd. Kolkata. ISBN: 81-87134-80-1.
4. LubertStryer (1997), Biochemistry. 4th edition, W. H. Freeman and Company, New York.
5. Lehninger A.L, David L. Nelson and Michael M. Cox (2008), Principles of Biochemistry5th edition, W.H. Freeman Publishers, New York, ISBN: 0-716-7710-8.
6. Jayaraman J. (2011), Laboratory Manual in Biochemistry, 5th edition, New Age International Publishers (P) Ltd., New Delhi.ISBN: 978-8122430493
7. David T Plummer (1988), An introduction to Practical Biochemistry, 3rd edition. Tata McGraw Hill Publishing Company Limited, ISBN: 978-0-07-099487-4.
8. Keith Wilson and John Walker, (2010), Principles and Techniques of Biochemistry and Molecular Biology.7th edition. Cambridge University Press, UK, ISBN: 978-0-521 51635-8.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3				4		
CO4				4		
CO5			3			

Mean: 3.2

(Non Major Elective)

This course is intended to provide basic concepts, scope, applications and contribution to the society of biotechnology in various fields such as Agriculture, Medical and Environment for the non-biology students

Upon successful completion of the course, students will be able to

- i. Understand the scope, success stories and bioethics in the field of biotechnology
- ii. Clarify various applications of biotechnology in Agriculture like the production of transgenic plant , Biofertilizer and Genetically modified food
- iii. Comprehend about the principle, steps involved and applications of ART and Transgenic animals
- iv. Deliver the way to produce and applications of microbial based products for the benefit of society
- v. Provide technical knowledge on the productions of biofuels and waste water treatment procedures

UNIT-I

History and Scope of Biotechnology- Traditional and Modern Biotechnology- Branches of Biotechnology- (Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare, Industrial Biotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology) Biotechnology Institutions in India (Public and Private Sector)-Biotech Success Stories- Bioethics in Biotechnology

UNIT-II

Biotechnology in Agriculture: Biofertilizers- Transgenic plants- Fungal and Insect Resistant Plants-BT Cotton- Transgenic rice- Golden Rice. Plant Based Vaccines- Genetically Modified Food-Bioplastics

UNIT-III

Animal Biotechnology: Assisted reproductive Technology (ART)- Artificial insemination; Transgenic animals and their applications- Mice and Sheep- Animal bioreactor

UNIT-IV

Microbial Biotechnology: Microbial Production of organic acids (Acetic acid and Citric Acid)
Antibiotic- Penicillin, polysaccharide and Beverage-Wine

UNIT-V

Biofuels: Bioethanol and Biogas production- Biodyes- Biological waste treatment- Liquid and solid wastes

TEXT BOOKS

1. U.Satyanarayana and U.Chakrapani Biotechnology (2019) 12th Edition Books & Allied Ltd
2. Plant Biotechnology: An introduction to genetic engineering (2008) Adrian Slater, Nigel W.Scott, Mark R. Fowler. Oxford University, Press
3. Patel A.H. 1997. Industrial Microbiology, Macmillan India limited.

REFERENCE BOOKS

1. Glazer A.N. and Nikaido, H. 2007. Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press
2. Babink L.A. and Philips J.P. Animal Biotechnology, Comprehensive Biotechnology First Supplement (1989), Pregamon press, Oxford
3. Ian Gordon (2004) Reproductive Technologies in Farm Animals 1st Edition, CABI Inter.,

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2		4		
CO2				4		
CO3		2		4		
CO4			3			
CO5				4		

Mean = 3.28

This course is intended to impart knowledge on fundamental concepts on nutraceuticals, classification and biochemical constituents of food, nutraceutical products derived from animal, plants and microbes and gain acquaintance of role of nutraceutical industries for human development

Upon successful completion of the course, students will be able to

- i. Deliver information about Historical and future perspectives and classification of nutraceuticals and dietary supplements
- ii. Well familiar with biochemistry of nutrition, Classification of food components, nutritional assessment and Basics of energy balance
- iii. Develop skill on nutraceutical compounds from plant and animal origin and their application in human health
- iv. Clarify the information about microbial derived nutraceutical products and their function in health sector
- v. Understand about the role of medicinal and aromatic plants in nutraceutical industry and Nutrition related diseases

UNIT- I

Historical perspective- scope & future prospects of nutraceuticals- classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals.

UNIT- II

Biochemistry of nutrition and dietetics - Classification of food components based on nutritional value, nutritional assessment of carbohydrates, proteins and fats, recommended dietary intake, acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilisation. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.

UNIT- III

Nutraceuticals of plant and animal origin- Plant secondary metabolites- Alkaloids, phenols, Terpenoids. Animal metabolites - chitin, chitosan, glucosamine, chondroitin sulphate-applications in preventive medicine and treatment-Concept of cosmoceuticals and aquaceuticals. Properties and functions of various Nutraceuticals- Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha ketoglutarate.

UNIT- IV

Microbial and algal nutraceuticals-Concept of prebiotics and probiotics - principle, mechanism and applications – Synbiotics- Algae as source of omega - 3 fatty acids, antioxidants and minerals - antioxidants -in prevention and treatment of cancer, obesity and stress

UNIT -V

Role of medicinal and aromatic plants in nutraceutical industry- Biofortification and nutritional enhancement.GM foods with enhanced nutraceutical properties-Golden rice, Nutrition related diseases- symptoms, prevention and management (diabetes mellitus and hypercholesterolemia)

TEXT BOOKS

1. Raphael Ikan.(1991) Natural products: A laboratory Guide, Academic press,
2. Sujatha V. Bhat, Bhimsen A. Nagasampagi, Meenakshi Sivakumar..(2006)Chemistry of Natural Products. Narosa Publishing House.
3. Bod Buchananm Wilhelm Gruissem, Russell Jones. (2002) Biochemistry and Molecular Biology of Plants. John Wiley & Sons

REFERENCE BOOKS

1. James Ralph Hanson (2003) Natural Products: The Secondary Metabolites. Royal Society of Chemistry,
2. Alan Crozier, Michael N. Clifford and Hiroshi Ashihara (2006) Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet..Blackwell Publishing Ltd

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3	4		
CO3			3	4		
CO4		2	3			
CO5				4		

Mean = 3.2

The course is planned to gather knowledge on historical development of microbiology, ultrastructure of bacteria, methodology adopted in microbiology and Microbial positive and negative interactions

Upon successful completion of the course, students will be able to

- i. Explain about historical perspectives, contributors in development of microbiology, structural organization and functions of bacterial cell and its parts
- ii. Know and analyse the principles of sterilization techniques, size determination and various staining of microbes
- iii. Exert information about nutritional types of bacteria, types of media, bacterial growth and role of microbes
- iv. Find the sources of microbes in different environment and role microbes in contamination and food borne illness
- v. Analyze normal microflora of human as well as pathogenesis of various human diseases caused by pathogenic microorganisms

UNIT-I

Evolution of Microbiology – Contributions of Antonie van Leuwenhoek, Joseph Lister, Robert Koch, Louis Pasteur, Edward Jenner, John Tyndall, Sergei N. Winogradsky, Selman A Waksman, Alexander Fleming, Paul Ehrlich, Elie and Metchnikoff-Morphology and Ultra structure of bacteria - Structure and Function of Bacterial Cell Walls (Gram Positive and Gram Negative), capsule, pili, flagella, plasma membrane, ribosomes, mesosomes, nucleoid and inclusion bodies

UNIT-II

Sterilization and disinfection- Methods of sterilization- Physical methods (Heat, Filtration and Radiation) and Chemical methods- Measurement of Microorganisms- Micrometry- Staining of bacteria- Simple, Gram staining, Negative staining, Capsule staining, Spore staining, Flagellar staining, Nuclear staining and Acid fast staining

UNIT-III

Microbiological media- composition and types- Nutritional groups of bacteria- bacterial growth curve- Factors influencing microbial growth- Microbial interactions- role of microbes in biogeochemical cycle-carbon, nitrogen, phosphorous and sulphur- Photosynthesis in microbes-Bioluminescence

UNIT-IV

Microorganisms in Environment- soil, water and air; Sources of microbial contamination in food; Microbial spoilage of food; Food borne illness; Food poisoning- Staphylococcal intoxication

UNIT-V

Medical Microbiology Normal microflora of healthy human- causative organism, symptom, pathogenesis and controlling measure of Cholera, Typhoid, AIDS, Polio, Malaria, Amoebiasis, Mycetoma and Candidiasis.

TEXT BOOKS

1. Pelczar Tr. MJ, Chan ECS & Kreig NR (2006). Microbiology. 5th Edition, Tata McGraw-Hill Companies Ltd.
2. Dubey, RC and Maheswari DK (2005) A Text book of Microbiology. S. Chand & Company Ltd., New Delhi.
3. H.G. Schlegel, 1993. General Microbiology, 7th edition. Cambridge University Press, New York

REFERENCE BOOKS

1. Microbiology - Prescott LM, JP Harley and DA Klein (2005). 6th international Edition, McGraw Hill companies Ltd.
2. Ronald M. Atlas, Richard Bartha, Microbial Ecology (1994) 4th Edition, Wesley Longman, Inc.
3. Moat Albert. G, Foster. John. W, Speeter, Michel P (2002) Microbial Physiology, 4th ed. Wiley Liss Publishers
4. C.J. Alexopoulos, Mims, Blackwell (1996) Introductory Mycology. 4th ed. WSE, Wiley
5. Michael P. Doyle, Larry. R. (2001) Food Microbiology – Fundamentals & Frontiers, American Society for Microbiology
6. M.T. Madigan, J.M. Martinko, J.Parker (2002.) Brock's Biology of Microorganisms, 10th ed, Prentice Hall

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3			
CO3			3	4		
CO4				4		
CO5				4		

Mean = 3.5

This course is framed to give fundamental technical skill in sterilization methods, media preparation for culturing of bacteria and fungi, analysis of microorganisms based on physical and techniques.

Upon successful completion of the course, students will be able to

1. Perform sterilization techniques, isolate and characterise microbes from different environments.
2. Design and carryout experiments on microbial growth, staining methods and antimicrobial properties.

LAB EXPERIMENTS

1. Sterilization techniques- Autoclaving & Filtration techniques
2. Media preparation- Broth, semisolid and solid
3. Pure culture technique – streak plate methods
4. Enumeration of microorganisms from soil.
5. Enumeration of microorganisms from water
6. Enumeration of microorganisms from air
7. Staining of bacteria – simple staining
8. Staining of bacteria by Gram's staining
9. Identification of bacterial spore by Spore staining;
10. Biochemical Identification – IMViC – test, Oxidase, Catalase, TSI –test, Hydrolysis of starch, casein, and lipids.
11. Identification of fungus by Slide culture technique
12. Growth curve of bacteria
13. Antimicrobial sensitivity test – Disk diffusion method.

REFERENCE BOOKS

1. Cappuccino and James G. Microbiology: A Laboratory Manual.2014. 10th Edition. Pearson India
2. Kannan, N. (2002) Lab manual in Microbiology, Panima Publication, New Delhi
3. Anitha Rozgar (2002). Practical methods for environmental Microbiology and Biotechnology, Krishna Prakash Ltd. Meerut.
4. Amitajain, Vumala Venkatesh, Jyotsna Agarwal (2019) Microbiology Practical Manual.1st Edi. Elsevier – Saunders, Mosby, Churchil

The course is designed to develop technical and application skill of various instruments used in biological sciences such as centrifugation, electrodes, colorimetry, spectroscopy, chromatography and radiography.

Upon successful completion of the course, students will be able to

- i. Apply skill on working principle mechanism and applications of different types of centrifugation, kinds of centrifuges and rotors used in centrifuges
- ii. Explain about the electrochemical techniques includes the working mechanism and components of different kinds of electrodes
- iii. Deliver knowledge on colorimetric and different spectrophotometric principle and applications in biological sciences
- iv. Understand and execute the skill on concepts in various chromatography and their application
- v. Comprehend about radioactive substances and techniques involved in measuring their activities

UNIT- I

Centrifugation – Basic Principles of sedimentation- Sedimentation Coefficient- Types of Centrifuges-Small bench centrifuges, refrigerated centrifuges, High speed centrifuges, continuous flow centrifuges, preparative ultracentrifuges and analytical centrifuges and their uses- Types of rotors- Swing bucket rotors, Fixed angle rotors, Vertical tube rotor, Zonal rotors and Elutriator rotor -types of centrifugation – Differential centrifugation- Density gradient centrifugation

UNIT-II

Principles of electrochemical techniques- Potentiometry-Voltammetry-Types of electrodes-pH electrodes-Ion selective and gas sensing electrodes-The Clark oxygen electrode- pH meter-working principle and applications

UNIT-III

Colorimetry- Beer-Lambert's Law-Colorimeter- working principle and application- Spectroscopy: Electromagnetic spectrum- Spectrophotometer- working principle and application- UV spectroscopy-Turbidometry- nephelometry-Atomic spectroscopy-Infrared spectroscopy and Raman Spectroscopy

UNIT-IV

Concept of Chromatography- distribution coefficient- Types, principle and applications of chromatography- Paper Chromatography, Thin layer chromatography, Adsorption Chromatography, Partition Chromatography, Ion Exchange Chromatography, High performance liquid chromatography, Gas Liquid Chromatography, Gel filtration Chromatography and Affinity Chromatography

UNIT-V

Radiation- Basic concepts of radiography- Measurement of radioactivity: GM counter, Liquid and solid scintillation counter- Advantage and disadvantage of radio active compounds.

TEXT BOOKS

1. Principles and Techniques of Practical Biochemistry, Keith Willson, Jo (2000), 5th Ed. Cambridge University Press.
2. P. Palanivelu. (2013) Lab in analytical Biochemistry. Twenty first Centaury publications

REFERENCE BOOKS

1. John.G Webster (2017) Bioinstrumentation. Wiley publication
2. M.H. Fulekar, Bhawana Pandey. (2019) Bioinstrumentation. Dreamtech Press

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3	4		
CO2			3	4		
CO3				4		
CO4				4		
CO5				4		

Mean = 3.71

The objective of the course is to highlight the importance of enzymes and its mechanism in life process. A deeper insight into the various metabolic pathways, energetics and disorders, their interrelations is also dealt. It also amalgamates disorders of carbohydrates, amino acids, lipids and nucleic acid metabolisms.

At the end of the course, students will be able to:

- i. Explain the basic concepts, classification, nomenclature, mechanism of action of enzymes and their kinetics.
- ii. Compare and evaluate the sequence of reactions, energetics and regulation of the different pathways of carbohydrate metabolism and disorders.
- iii. Analyze the high energy yielding lipid, their metabolism and disorders.
- iv. Discuss the metabolism of amino acids and disorders.
- v. Compute the knowledge on the biosynthesis, breakdown of nucleic acids and their disorders.

Unit I – Enzymes

9 Hrs

Definition – general characteristics - nomenclature & classification — functions – mechanism of action – enzyme kinetics - Michaeli's - Menten equation, V_{max} , K_m and its significance, LB plot, Eadie – Hofstee plot, factors affecting enzyme activity – inhibitors.

Unit II – Carbohydrate metabolism and disorders

10Hrs

Introduction, reaction sequence and energetics – glycolysis, Kreb's cycle, electron transport chain, Oxidative phosphorylation, gluconeogenesis, glycogen metabolism, HMP shunt pathway.

Disorders – diabetes mellitus, glycosuria, GSD.

Unit III – Lipid metabolism and disorders

9 Hrs

Introduction, reaction sequence – saturated and unsaturated fatty acids – beta -oxidation of fatty acids – biosynthesis of fatty acids – synthesis of cholesterol phospholipids, triglycerides – metabolism of ketone bodies.

Disorders – hyper & hypo cholesterolemia, Niemann-Pick's Disease, Faber's disease and Gaucher's disease.

Unit IV – Amino acid Metabolism& disorder **9 Hrs**

Introduction – biosynthesis and catabolism of amino acids – tyrosine, tryptophan, phenyl alanine, cysteine, glutamic acid - formation and disposal of ammonia – urea cycle. Disorders – maple syrup disease, phenylketonuria, albinism, Hartnup’s disease, urea cycle disorder.

Unit V – Nucleotide Metabolism& disorder **8 Hrs**

Introduction, reaction sequence - Purines and pyrimidines – De novo biosynthesis – salvage pathways. Disorders - Gout – Oroticaciduria – xanthinuria – Lesch -Nyhan syndrome.

LAB EXPERIMENTS

1. Assay of salivary amylase activity.
2. Study of effect of pH on enzyme activity.
3. Study of effect of temperature on enzyme activity.
4. Estimation of blood sugar – OT method
5. Estimation of protein by Lowry’s method
6. Estimation of serum cholesterol. – Zak’s method
7. Estimation of uric acid from urine/blood – Caraway Method
8. Isolation of genomic DNA from liver cells.

REFERENCES:

1. Dr. P. Asokan (2003), Enzymes, 1st edition Chinnaa Publications, Vellore.
2. LubertStryer (2019), Biochemistry, 9th edition, W. H. Freeman and Company, New York. *ISBN:9781319234362*.
3. MN Chatterjee, RanaShinde (2007), Textbook of Medical Biochemistry,7th edition,Jaypee Brothers medical publishers, New Delhi, *ISBN81-8448-134-9*.
4. Robert K. Murray, Robert K. Murray, Peter A. Mayes, Victor W. Rodwell (2018), Harper’sIllustrated Biochemistry, 31st edition.Lange Medical Books/McGraw-Hill medicalpublications division. New Delhi,*ISBN13 9781259837937*.
5. Donald Voet& Judith G. Voet (2018), Principles of Biochemistry 5th edition. Globaledition. New York. *ISBN: 978-1-119-45513-4*.
6. Jayaraman J. (2011), Laboratory Manual in Biochemistry, 5th edition, New AgeInternational Publishers (P) Ltd., New Delhi.*ISBN: 978-8122430493*.
7. Harold Varley, (2005), Practical Clinical Biochemistry, 4thedition, CBS Publishers, NewDelhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2			3			
CO3				4		
CO4		2				
CO5				4		

Mean: 3.4

This course is framed to provide thorough knowledge about concepts in entrepreneurship, entrepreneurship opportunities in biotechnology sector, commercialization process and strategies of various kinds of bioproducts.

Upon successful completion of the course, students will be able to

- i. Know about entrepreneurship, types of Entrepreneurs and Entrepreneurship in the context of Biotechnology
Provide information about Bioentrepreneur, Types of Enterprises and
- ii. Commercialization Process and Strategic management of biotechnological products
- iii. Bring out complete skill about mass production of *Azolla* and *Nostoc*
- iv. Deliver technical knowledge on single cell protein production, *Dunaliella* cultivation and production of Baker's yeast
- v. Give industrial skill about biopesticide, mushroom and vermicompost production techniques

UNIT-I

Development biotechnology industries- Entrepreneurship- Enterprise- Startups- Entrepreneur Process of Entrepreneurship- Competencies of an Entrepreneur- Types of Entrepreneurs- Advantages and Disadvantages of Entrepreneurship- Characteristics of Biotechnology Industry- Entrepreneurship in the context of Biotechnology- comparison between the biotechnology and IT industries

UNIT-II

Bioentrepreneurship- Bioentrepreneur- Technopreneurs- Profiling the Bioentrepreneur- Types of Enterprises- Private sector enterprises - Public sector enterprises -Joint sector- Commercialization Process &Strategy- Management of Intellectual Property Rights- Patents- Trademarks- Copyrights- Geographical Indications- Trade Secrets- Geographical Indications

UNIT-III

Azolla- biology of *Azolla-Anabaena* – Mass cultivation of *Azolla*-Field applications of *Azolla*- Uses of *Azolla*; *Nostoc*- Biology of *Nostoc*-Mass production of *Nostoc*-Isolation of *Nostoc*- Media formulation-Preparation of starter culture-Mass culture of *Nostoc*-Trough method-Pit method-Field method-Nursery cum field method-utilization of *Nostoc* inoculants

UNIT-IV

Single cell Protein Production- *Spirulina*- Biology, constituents, Mass production methods and application; *Dunaliella* –Biology, medium formulation, Fermentation, recovery of biomass and applications; Production of Baker's yeast- steps in Mass production-purification-packaging-active dry yeast

UNIT-V

Production of biopesticides-Biopharma-Mushroom production –Vermicomposting

TEXT BOOKS

1. Holger Patzelt and Thomas Brenner. Handbook of Bioentrepreneurship.2008.1st Edition. Springer-Verlag New York
2. V.Kumaresan. Biotechnology. (2015).Saras Publication

REFERENCE BOOKS

1. U. Satyanarayana and U. Chakrapani (2019) Biotechnology, 12th Edition, Books & Allied (P) Ltd
2. Swati Agarwal, Sonu Kumari and Suphiya Khan. Bioentrepreneurship and Transferring Technology into Product Development. IGI Global

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3	4		
CO3				4		
CO4			3			
CO5				4		

To acquire knowledge on the origin of life, evolutionary theories, evidences, objections and deals with isolation, adaptation and evolution of man.

Upon successful completion of the course, students will be able to

- i. Know about the origin of life and evidences
- ii. Explain about various evolutionary classical and modern theories
- iii. Understand the concepts of Challenges to Darwinism
- iv. Comprehend the principles isolating mechanism and adaptation
- v. Discuss about the evolution of man

UNIT I

Origin of life: Life definition-origin-theories- abiogenesis- cosmozoic and naturalistic theories-chemical evolution and origin of life-evidences and objections. Lamarckism-mutationism and Darwinism-modern synthesis

UNIT II

Theories: Lamarckism and Neo-Lamarckism, Darwinism and Neo-Darwinism, supplementary theories of Darwin, HMS Beagle, Galapagos Island and Darwin's Finches, Modern Synthetic theory of Evolution.

UNIT III

Current challenges to Darwinism: DNA and protein phylogenies-protein evolution and neutrality theory-molecular evolutionary clock-group selection-altruism and kin selection-sexual selection-punctuated equilibria

UNIT IV

Isolation, speciation and adaptation: isolating mechanism-pre and post zygotic-origin of isolation-Koopman's experiment, speciation-definition-sympatric-allopatric and quantum speciation - Adaptation Types –Mimicry – Coloration – Adaptive radiation in Darwin finches and mammals– Adaptive convergence.

UNIT V

Evolution to man: Uniqueness of man-fossil history and phylogeny of man-cultural evolution and evolutionary future of mankind-exobiology

TEXT BOOKS

1. P. S. Verma and V. K. Agarwal. (2005)Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Revised Edition. S. Chand Publication.
2. Rastogi, V.B. (2018) Organic Evolution, KedarnathRamnath, Meerut.13th Ed.

REFERENCE BOOKS

1. Strickberger.(2002). Evolution. 5th edition, Prentice Hall.
2. Theodore H., Jr Eaton. Evolution. (1970)1st Edition. W. W. Norton Publication.
3. Moody, P.A.,2002, An introduction to Evolution 3rd Edition, Kalyani Publishers, Ludhiana.
4. Dobzansky, T (1976) Genetics and the origin of species. Oxford and TBH Publishing Co., New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2	3			
CO2		2		4		
CO3				4		
CO4				4		
CO5				4		

Mean = 3.28

This course is prepared to understand the development of molecular biology, types and structural aspects of genetic materials, molecular basis of replication, transcription, translation, gene transfer and concepts of mutation and DNA repair

Upon successful completion of the course, students will be able to

- i. Deliver knowledge on types, structure and forms of genetic material (DNA and RNA)
- ii. Understand the concept of genome organization as well as molecular mechanism of replication in prokaryotes and eukaryotes
- iii. Develop skill on molecular events in transcription and gene regulation
- iv. Acquire the facts on genetic code and molecular basis of translation in both prokaryotes and eukaryotes
- v. Realize the conception of mutation and various mechanisms of DNA transfer

UNIT-I

Introduction to genetic materials: Historical perspective of molecular biology- in vitro experiments- Griffith's experiment- one gene-one enzyme hypothesis-Hershey-Chase experiment-DNA double helix model- Structure of DNA - Unusual DNA secondary structures -Slipped structures, Cruciform structures and Triple helix DNA-Forms of DNA (B-DNA, A-DNA and Z-DNA)- Structure of mRNA, rRNA and tRNA

UNIT-II

Genome organization: Eukaryotic genome-bacterial genome-organelle genomes (Mitochondria and Chloroplast)-plasmid- denaturation and renaturation of DNA, melting temperature (T_m), UV absorption and hyperchromic effect- DNA replication- Semiconservative nature of DNA replication (Messelson and Stahl's experiment), Enzymology and mechanism DNA replication in prokaryotes (bidirectional) and eukaryotes

UNIT-III

Transcription: Transcription in prokaryotes (*E. coli* as model system) and Eukaryotes: RNA polymerase, initiation, elongation and termination of transcription- rho dependent and independent termination- post transcriptional modification- Mechanism of gene regulation- lac operon and trp operon

UNIT-IV

From gene to protein- The central dogma- Genetic code: Features of Genetic code-Wobble hypothesis- Translation in prokaryotes and Eukaryotes: Charging of t-RNA, aminoacyl t-RNA synthetases, initiation, elongation and termination of protein synthesis-post translational modification

UNIT-V

Mutation- Types of mutation- Transition and transversion- Mutagen – physical (UV radiation) and chemical-Base analogs, Intercalating agents-, Alkylating agents- Ames test- DNA repair- Photo reactivation, mismatch repair, base excision and nucleotide excision repair, SOS repair- Mechanism of Gene Transfer-Transformation-Conjugation–Transduction (Generalized and specialized)- Transposon

TEXT BOOKS

1. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.
2. Brown TA. (2007) Genomes-3. Garland Science Publishers.
3. Rastogi SC. (2012) Cell and Molecular Biology. New age international publication
4. David Freifelder , (2020) Molecular Biology, Narosa Publication

REFERENCE BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology.VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Gardner EJ, Simmons MJ, Snustad DP.(2008) Principles of Genetics.8thEd.Wiley-India.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2				4		
CO3				4		
CO4			3			
CO5				4		

Mean- 3.6

This course is aimed to gain practical knowledge in isolation of mutants, effect of mutagens and gene transfer methods

Upon successful completion of the course, students will be able to

1. Demonstrate the techniques in molecular biology at various levels at cell, DNA, RNA and proteins.
2. Interpret the mutations in nucleic acids and their effects in the cell.

LAB EXPERIMENTS

1. Isolation of antibiotic resistant mutant by gradient plate technique
2. Isolation of auxotrophic mutant by replica plating
3. Effect of UV Radiation on *E.coli*
4. AMES Test
5. Isolation of petite mutant.
6. Induction of β -galactosidase
7. F x F⁻ conjugation
8. Determination of phage titer
9. Isolation of chromosomal DNA from *E.coli*
10. Determination of DNA purity by spectrophotometer

REFERENCE BOOKS

1. Sue Carson, Heather Miller, Melissa Srougi and D. Scott Witherow (2019) Molecular Biology Techniques-A Classroom Laboratory Manual, Elsevier publication
2. Chowdhury Madhumita Roy (2014). Laboratory Manual For Molecular Genetic Tests. Jaypee Brothers Medical Publishers
3. S.K. Gakhar, Monika Miglani and Ashwani Kumar (2019) Molecular Biology: A Laboratory Manual, Wiley publication

This course is designed to understand the concepts of taxonomical classification of animal, plant and microbes, binomial nomenclature and modern methods of identification of organism

Upon successful completion of the course, students will be able to

- i. Learn the general concepts vital for better understanding of taxonomy
- ii. Understand taxonomic concepts of animal
- iii. Gain knowledge on the classification and concepts of plant taxonomy
- iv. Perceive the wide variety of microbes based on its taxonomic characteristics
- v. Grasp the recent trends of taxonomy applicable in modern biological studies

UNIT-I

General Concept: Definition, Aim, Importance and Scope of Taxonomy – Development and Phases of classification – Systems of classification – Artificial: Linnaeus system, Natural: Bentham and Hooker system, Phylogenetic: Engler, Pratil and Hutchinson system (Comparative study). Binomial nomenclature – Species concept. Elementary idea of taxonomic methodology.

UNIT-II

Animal taxonomy: History of animal taxonomy – classification – basics of taxonomic characteristics- invertebrates – vertebrates- chordate – type study – earthworm, frog, pigeon, human

UNIT-III

Plant taxonomy: History of plant taxonomy – classification – basics of taxonomic characteristics- flowering and non – flowering plants – gymnosperms – angiosperms- monocot-dicot- type study – maize and pea plant

UNIT-IV

Microbial Taxonomy: Basics of taxonomic characteristics (Polyphasic Taxonomy) of bacteria –Bergey’s system of classification- Classification of Archaea- General properties of viruses- Properties used in viral taxonomy- LHT system of viral classification- Type study- Adenovirus

UNIT-V

Algal and Fungal Taxonomy: General characteristics and economic importance of algae- classification of algae by Fritsch- Type study- *Chlorella* sp; General properties and importance of fungi- basis of fungal classification- Alexopoulos and Mims classification of fungi-Type study-*Aspergillus* sp

TEXT BOOKS

1. O. P. Sharma (2009) Plant Taxonomy, Tata Mc Grow Hill, New Delhi
2. Kapoor VC. (2008) Theory and practice of animal taxonomy. 6th Ed. Oxford & IBHPublication, London.
3. Mehrotra, R. S. and Aneja, K.R. (1990). An Introduction to Mycology. New agepublishers
4. Brodie, J. and Lewis, J. (2007). (Ed.) Unravelling the algae: the past, present and futureof algal systematics. CRC press, New York
5. Jacquelyn G. Black (2013) Microbiology: Principles and explorations 6th Edition, JohnWiley & Sons, Inc

REFERENCE BOOKS

1. M. S. Subrahmainayam (2011) Modern Plant Taxonomy, Vikash Publishing House, New Delhi.
2. Simpson G. G. – (1962) Principles of Animal Taxonomy, Oxford University Press, London.
3. Alexopolus, C. J., Mims, C. W. and Blackwell, M. (1999). (4th edn) Introductory Mycology. Wiley, New York. Alford, R. A.
4. Breed and Buchanan. (2003) Bergey's Manual of Systematic Bacteriology. 2nd Edition,(Vol. 1-5)

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2	3			
CO2			3			
CO3				4		
CO4			3	4		
CO5				4		

Mean-3.28

This course is planned to understand the concepts of tissues and muscles organization, physiology of nervous, digestive, excretory, respiratory, circulatory and endocrine system of mammals.

This course is also useful for the students to acquire the knowledge of plant physiological functions such as absorption of water, transpiration and sensory photobiology

Upon successful completion of the course, students will be able to

- i. Become familiar with Structural organization of tissues and muscles
- ii. Realize the physiological concept of nervous, digestive and excretory system
Understand the concepts of respiratory, circulatory and endocrine system of
- iii. Mammals
Enhance the knowledge on plant physiological activities such as water absorption
- iv. and transpiration
- v. Get acquaintance of growth hormones, photo periodism and photosynthesis of plants

UNIT I

Structural organization of Tissues and Muscles: Structure and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue; Structure and types of bones and cartilages, Ossification, bone growth and resorption; Types of muscle- Ultra structure of skeletal muscle- Mechanism of muscle contraction

UNIT II

Nervous, Digestive and Excretory system- Division of nervous system-structure of nerve tissue – structure, types and function of Neurons- Neuroglia- Neuron doctrine- Nerve impulse- spinal cord reflexes-reflex arc- autonomic Nervous system- neurotransmitters- Structural organization and functions of gastrointestinal tract-Mechanism of food digestion; Absorptions of nutrients- Renal Physiology -Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance

UNIT III

Respiratory, Circulatory and Endocrine system-Homeostasis- Blood Composition- Respiratory pigments- Histology of trachea and lung- Mechanism of respiration; Physiology of Heart-Structure of mammalian heart- Coronary circulation- Cardiac cycle-Blood pressure and its regulation; Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; mechanism of hormone action

UNIT IV

Plant Physiology-Theory of water absorption : Imbibition, Diffusion, Osmosis, Plasmolysis, - Mechanism of water absorption (Active and Passive)- Ascent of sap - Transpiration – Types and Mechanism of stomatal transpiration - factors Affecting Transpiration- Guttation and exudation- mechanism of translocation-Organic solutes theories- Translocation of path of transport-evidence, -pressure flow hypothesis, cytoplasmic streaming and electro osmosis.

UNIT V

Sensory Photobiology: Plant growth hormone- Auxins, gibberellins, cytokinins, abscisic acid ethylene location physiological role-Seed dormancy, circadian rhythms -Physiology of flowering – Photoperiodism- Structure and function of Phytochromes- phototropin & cryptochromes- vernalization and devernialization- Photosynthesis: CO₂ fixation-CAM, C₄, and C₃ pathways.

LAB EXPERIMENTS

1. Estimation of haemoglobin using Sahli's haemoglobinometer
2. Preparation of haemin and haemochromogen crystals
3. Recording of blood pressure using a sphygmomanometer
4. Estimation of chlorophyll content in plant
5. Determination of osmotic pressure potential of living cells by plasmolytic method
6. Separation of photosynthetic pigments by chemical method
7. Determination of the percentage of water imbibed by gram seeds.
8. Observation of distribution of stomata in plant leaves
9. Demonstration of plasmolysis using onion cells

TEXT BOOKS

1. Guyton, A.C. & Hall, J.E. (2006). Text book of Medical Physiology. XI Edition. HercourtAsia PTE Ltd. W.B. Saunders Company.
2. N. Arumugam and A. Mariakuttikan.(2019). Animal Physiology, I Edison SarasPublication
3. Jain V.K. (2017) Fundamentals of Plant Physiology. IXX Edition .S Chand Publishing
4. A.K.Jain (2017) Manual of Practical Physiology, Arya Publications

REFERENCE BOOKS

1. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition JohnWiley & sons
2. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanismof Body Function. XIII Edition, McGraw Hills
3. Lincoln Taizand Eduardo Zeiger (2006) .Plant Physiology. Sinauer Associates Inc.,U.S.publication
4. Don W. Bailey (1983) Laboratory Manual for Animal Physiology, Tichenor Publication
5. Kramer PJ (1983). Water relations of plants. Academic Press, Inc. London, U.K.
6. Moore TC (1974). Research Experiences in Plant Physiology. A Laboratory Manual

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3			
CO3			3			
CO4				4		
CO5				4		

Mean-3.4

This course is intended to get information about the values and the need for conservation, management of biodiversity, strategies to conserve wild life and impact on biodiversity.

Upon successful completion of the course, students will be able to

- i. Understand the basic concepts and measures of biodiversity
- ii. Gain knowledge about biodiversity systems and get aware on the factors affecting primary production
- iii. Acquire the facts on the causes and consequences of loss of biodiversity
- iv. Inform about the strategies to conserve and manage the wildlife
- v. Become skilled at intellectual property rights and its impact on biodiversity

UNIT I

Biodiversity definition, concept, scope, Levels of biodiversity - Genetic, species and ecosystem diversity, Magnitude of biodiversity; Concept of Hot Spots; distribution of hotspots in India and the world; values of biodiversity; Island biogeography theory; Endemic diversity, Measures of biodiversity – alpha, beta and gamma diversity – Diversity indices – dominance and Evenness – methods of studying diversity.

UNIT II

Biodiversity system – features, primary, secondary and tertiary production – methods for measuring the productivity – factors affecting primary production – general account of productivity in different oceans – red tide – harmful algal blooms – causes and effects.

UNIT III

Causes and consequences of biodiversity loss; Impact of exotic species on local biodiversity; extinction of species; Key stone species and their significance. Climate Change mediated Impacts on Biodiversity – El-Nino Southern Oscillation phenomenon (ENSO) and its impacts- sea surface water temperature (SST) elevation and coral reef bleaching, impacts of coral bleaching on coral biodiversity; Red Data Book and its importance.

UNIT IV

Wildlife Conservation and management - need for conservation–*in situ* conservation; Sanctuaries, National parks, biosphere reserves – *ex situ* conservation, Zoological parks, gene banks and cryopreservation –Role of indigenous people in conservation–sacred species, sacred groves; role of remote sensing in biodiversity conservation; Biodiversity conservation – human animal conflicts.

UNIT V

Indigenous knowledge, Bioprospecting, Biopiracy, Intellectual property rights and its impact on biodiversity; Impact of new technologies- biotechnology and genetic engineering.

TEXT BOOKS

1. Krishnamoorthy, K.V. 2009. An Advanced Text Book on Biodiversity – Principles and Practice, Oxford & IBH Publishing co, PVT. Ltd., New Delhi.
2. Kumar, H.D.(1999). Biodiversity and Sustainable Conservation. Oxford and IBM publishing Company, New Delhi.

REFERENCE BOOKS

1. Gadgil, M., Ghate, U, and Pramod, P. (1996) Biodiversity resource materials, center for ecological sciences. Indian Institute of Sciences, Bangalore and Biodiversity Unit, JawaharlalNehru, Centre for Advanced Scientific Research, Bangalore.
2. Gillson, L. (2015) Biodiversity Conservation and Environmental Change, Oxford University Press, Oxford.
3. Melchias, G. (2001) Biodiversity and Conservation, Oxford and IBM publishing company Pvt., Ltd. New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3				4		
CO4				4		
CO5				4		

Mean-3.4

To familiarize the cells involved in immunity, organization of Immune system, various types, immune responses immunological reactions and immunization practices.

Upon successful completion of the course, students will be able to

- i. Understand the basics of immunology
- ii. Widen their knowledge in classical and molecular immunology
- iii. Become familiar with immunization practices and their importance
- iv. Enabling their learning in techniques of immunology
- v. Gain knowledge about autoimmunity and hypersensitivity

UNIT I

History and scope of immunology – Overview of the immune system – Immunity, types, factors and mechanisms.

UNIT II

Lymphoidal organs- primary and secondary lymphoid organs- Immune cells, antigen presenting cells and their importance in antigen recognition.

UNIT III

Antigens and antigenicity – structure, properties- Types and Structure and functions of immunoglobulins; Development and differentiation of B and T lymphocytes – antigen recognition of B & T cells.

UNIT IV

Antigen processing and presentation by Class I and Class II MHC molecules; HLA and their relevance in medicine, vaccine and vaccine development, Immunity to infectious agents – bacteria, viruses and parasites. Immune reaction against host – allergy, autoimmunity, transplantation, Tumor immunology, hypersensitive reactions.

UNIT V

Antigen – Antibody interactions: Antibody affinity, antibody avidity, precipitation reactions – radial immune diffusion, double immune diffusion, immune electrophoresis. Agglutination reactions – hemagglutination, bacterial agglutination, passive agglutination. Radio immune fluorescence. Immunodiagnosis – monoclonal antibodies, principles and construction of monoclonal antibodies and their applications.

LAB EXPERIMENTS

1. Route of immunization, Immunization schedule.
2. Collection of blood from animal.
3. Separation of serum and plasma.
4. Haematology: Enumeration of WBC and RBC, Differential count.
5. Agglutination Test: Blood grouping and Rh typing, Widal, Haemagglutination assay, Pregnancy test.
6. Separation of Lymphocytes
7. Isolation of Splenocytes
8. Precipitation test: ODD, Single radial immunodiffusion.
9. Immunoelectrophoresis: Rocket Immunoelectrophoresis.
10. Labeled assay: ELISA
11. Western blotting

TEXT BOOKS

1. Kuby Immunology, Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, 2000, 4th Edition. W.H. Freeman & Co.
2. Immunology: An Introduction, Ian Tizard, 1995, Thomson Learning.
3. Kanai L. Mukherjee (1998). Medical Laboratory Technology – A Procedure Manual for Routine Diagnostic Tests, Vol. I–IV, Tata McGraw–Hill Publishing Company Limited, New Delhi,
4. Talwar G.P., and Gupta S.K. (1992) A Hand Book of Practical Immunology, Vol. I–II, Vikas Publishing House Private Limited, New Delhi.

REFERENCE BOOKS

1. Essentials of Infectious Diseases by Lionel A. Mandell, Edward D. Ralph (1985) Black Well Science Inc.
2. Robert M. Chanock, Fred Brown, Richard A. Lerner (1986) Vaccines: New approaches to immunization: Developing vaccines against Parasitic, bacterial & viral diseases, Cold Spring Lab Press.
3. Hay F.C., and Westwood O.M.R. (2002) Practical Immunology, 4th Edition, Blackwell Publishing, London,
4. Weis D.M., (1986) Hand Book of Experimental Immunology, Vol. I–IV, Blackwell Scientific Publishers, London

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2		2				
CO3			3			
CO4				4		
CO5				4		

Mean- 3.2

This course is planned to acquire basic cloning principle, tools, methods, strategies (enzymes, vectors, screening of recombinants, blotting and DNA sequencing applied in genetic engineering studies

Upon successful completion of the course, students will be able to

- i. Know about various enzymes and probes involved in cloning methods
- ii. Gain the knowledge on types of hosts and vector used in cloning
- iii. Become familiar with different cloning strategies and construction of genomic library
- iv. Understand the concepts and applications of blotting and sequencing
- v. Enrich the knowledge on various kinds of PCR techniques and molecular markers used in gene manipulation

UNIT I

Basics in genetic engineering – Enzymology of genetic engineering- Nucleases – nomenclature, classification and applications of exonuclease and endonuclease; DNA polymerases-DNA modifying enzymes – DNA methylase, alkaline phosphatase, polynucleotide kinase, DNA ligases, Taq DNA polymerase and Terminal transferase-Probes- Oligonucleotide probes, DNA probes and cRNA probes (riboprobes)

UNIT II

Cloning hosts and vectors-Host cells for cloning- Prokaryotic and eukaryotic hosts- Vector: Choice of Vectors – plasmid vectors– pBR322 and pUC18, cosmid, phagemid, expression vector, shuttle vector, lamda phage vectors- baculoviral vector-artificial chromosome vectors- animal vectors-plant vectors

UNIT III

Cloning strategies – linkers, adaptors and homopolymer tailing; screening strategies for recombinants selection – Direct selection, Insertional inactivation, plaque lifting method, Immunochemical method and Colony hybridization; Site directed mutagenesis; construction of genomic and cDNA library.

UNIT IV

Blotting techniques – Southern, Northern, Western and Dot blotting; Autoradiography; Gene sequencing methods – chemical, enzymatic, pyrosequencing and automated sequencing

UNIT V

Methods in genetic engineering- Chemical synthesis of DNA– PCR- principle, types and applications, RAPD, RFLP, RACE, SNPs and AFLP- DNA fingerprinting

TEXT BOOKS

1. H.K. Das (2017)Textbook of Biotechnology 5th Edition, Wiley Publication
2. U. Satyanarayana (2020) Biotechnology, Books & Allied Ltd, Kolkata

REFERENCES

1. S.B. Primrose and R.M. Twyman (2006) Principles of Gene Manipulation, 7th Edition,Blackwell Publication.
2. Bernard R.Glick and Jack J.Pasterneck (2008) Molecular Biotechnology, AmericanSociety for Microbiology, Canada,

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3				4		
CO4				4		
CO5				4		

Mean- 3.4

This course is aimed the students to get hands on technical knowledge on gene cloning techniques

Upon successful completion of the course, students will be able to

1. Design and perform experiments in genetic engineering with microbes and plants.
2. Acquire practical knowledge on PCR, RFLP, and RAPD

LAB EXPERIMENTS

1. Isolation of plasmid DNA
2. Analysis of DNA by agarose gel electrophoresis
3. Restriction digestion of DNA – single and double
4. Competent cell preparation and transformation of plasmid (Blue-White selection)
5. Demonstration of PCR
6. Demonstration of RFLP
7. Demonstration of RAPD

REFERENCE BOOKS

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

This course is framed to acquire knowledge about cloning in microbes, production of bioproducts by using microorganisms and the application oriented microbial biotechnology concepts.

Upon successful completion of the course, students will be able to

- i. Gain information about microbial biotechnology
- ii. Understand the importance of microbes in production of recombinant proteins
- iii. Widen their knowledge in production of metabolites by altering metabolic pathways
Become familiar with the production of polysaccharides and bioplastic production
- iv. for environmental protection
- v. Know the applications of microbes as SCP and industrially important products

UNIT I

Gene cloning of industrial microorganisms: Gene cloning – strategies in gene cloning – Importance, advantage and methods of gene cloning in *Bacillus*, *Pseudomonas*, *Streptomyces* and yeast.

UNIT II

Production of recombinant vaccines - Subunit, peptide, Attenuated, DNA vaccine and Vector vaccine and its applications – Microbes as food and feed -Probiotics, prebiotics and synbiotics

UNIT III

Metabolic Engineering – engineering of metabolic pathway for production of Amino acid (Tryptophan), vitamin C and pigments- protein production in bacteria – recombinant insulin production – recombinant Interferon production

UNIT IV

Production of Microbial polysaccharides and their application; microbial polyesters- types and applications; Bioplastics- methods of production- advantages and disadvantages

UNIT V

Application of Bioprocess technology: Production of microbial biomass - SCP (*Spirulina*, yeast); Production of industrially important extracellular enzymes: Microbial production of vitamins; Production of medically important products (penicillin & bacterial toxoids)

TEXT BOOKS

1. Alexander N. Glazer (2007) Microbial Biotechnology: Fundamentals of Applied Microbiology, Cambridge University press Publication.
2. Joginder Singh (2020) Microbial Biotechnology: Basic Research and Applications, 1st ed.,Kindle Edition, Springer Publication by (Editor),
3. Murray Moo Young (1985) Comprehensive Biotechnology – Vol. 1, 2, 3 and 4 ElsevierScience.

REFERENCE BOOKS

1. Paul Prave, Uwe Faust, Wolfgang Sitting (1987) Fundamentals of Biotechnology, VCHpublishing.
2. Stephen J.Hall, Peter Stanbury and Allan Whittaker (1999) Principles of fermentationtechnology, 2nd ed. Butterworth – Heinemann Publication

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2		2				
CO3			3			
CO4				4		
CO5				4		

Mean- 3.4

This course is useful for the students to explore the fundamental concept of environment, role of biotechnology in environmental monitoring, bioremediation of contaminants and alternate energy generation

Upon successful completion of the course, students will be able to

- i. Develop the basic knowledge on components and problem of environment
Get familiarized with applications of biotechnology in environmental monitoring
- ii. and abatement of heavy metals
Understand the various methods of bioremediation and their application in
- iii. environmental protection
- iv. Analyze the various methods involved in disposal of liquid and solid wastes
- v. Explicate the different methods to generate fuel from biological resources

UNIT I

Components of Environment – Hydrosphere, lithosphere, atmosphere and biosphere- Global Environmental Problems – Green House Effect, Acid rain, El Nino, Ozone depletion, deforestation, desertification, salination, biodiversity loss; chemical and radiation hazards

UNIT II

Biotechnology of Environmental Monitoring– Biomonitoring- Bioindicators –Biomarkers – Biosensors technology –role of biotechnology in abatement of heavy metal pollution-heavy metal tolerance in microbes-mechanism of heavy metal resistance-bioleaching

UNIT III

Biotechnology in Bioremediation-Biodegradation of hydrocarbon and pesticides - Biotransformation of xenobiotic compound - Bioremediation of soil and water contaminated with oil spills - Microbially Enhanced Oil Recovery; Phytoremediation- Phytoextraction- Phytodegradation -Phytovolatilization- Rhizodegradation-Phytostabilization- Mycorrhizoremediatio- Dendroremediation- Bioscrubbers- Biopulping.

UNIT IV

Biotechnology of wastewater treatment- Domestic sewage-single dwelling unit(septic tank) Industrial wastewater - Primary treatment, Secondary Treatment–Advanced treatment-Final Treatment –Solid waste disposal- Dump and Landfills- Anaerobic sludge digestion- Composting

UNIT V

Biotechnology of Biofuel production- Conventional fuels and their environmental impact: Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Production of Bioethanol, Biobutanol, Biogas and Biohydrogen

TEXT BOOKS

1. Pramod Kumar, Vipin Kumar and Pravin Kumar Sachan (Editor). (2019). Textbook of Environmental Biotechnology, WPI Publishing
2. M. H. Fulekar (2010) Environmental Biotechnology, CRC Press
3. Daniel Vallero (2015) Environmental Biotechnology -A Biosystems Approach, Elsevier Science

REFERENCE BOOKS

1. Judy Furlong and Gareth G. Evans. (2010) Environmental Biotechnology: Theory and Application. Wiley publication
2. B.C. Bhattacharyya and Rintu Banerjee (2007) Environmental Biotechnology, Oxford University Press
3. Ranbir Chander Sobti, Naveen Kumar Arora and Richa Kothari (2019). Environmental Biotechnology: For Sustainable Future, Springer publication

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3			3			
CO4				4		
CO5				4		

Mean-3.2

This course deals with the role of Biotechnologists in industries. This course also explains the screening, development and preservation of industrially important strains of microorganisms, industrial production of enzymes and recombinant vaccines.

Upon successful completion of the course, students will be able to:

- i. Understand their role as biotechnologists in industries.
- ii. Discuss the production methods of Food and Dairy products.
- iii. Discuss the steps involved screening and development of industrially important microorganisms.
- iv. Demonstrate fermentation.
- v. Discuss the steps in downstream processing and product extraction.

UNIT I

History of fermentation – Chronological development of Fermentation process –. Microbial culture selection processes – Screening of microbes - Media Formulation – Process optimization – Inoculum development – Preservation — Strain improvement.

UNIT II

Sterilization of industrial equipment and media – Media for industrial fermentation – media optimization. Types of fermentation – Batch, Fed batch, Continuous.

UNIT III

Bioreactors – Bioreactors design, parts and their function. Types of Fermenter – Packed bed , Fluidized bed, tower fermenter, submerged, solid state. Bioprocess control and monitoring of temperature, pH, pressure and agitation.

UNIT IV

Recovery of intracellular and extra cellular products – biomass separation, centrifugation, filtration, chemical and electroflocculation. Cell disintegration – Physical, chemical and enzymatic methods. Extraction – solvent extraction - Purification - concentration by precipitation, ultra filtration, chromatography. Drying and filtration.

UNIT V

Immobilization of enzymes and cells. Production of enzymes – amylases and proteases. Production of recombinant vaccines (hepatitis B vaccine, cholera vaccine). Production of Cheese, wine, vinegar, yoghurt

TEXT BOOKS

1. Industrial Microbiology by Samuel Cate Prescott and Cecil Gordon Dunn.
2. Crueger, W., Crueger, A., and Brock, T. D. (2005) Biotechnology: A Textbook of Industrial Microbiology, 3rd Edn, Panima Publishing Corporation, New Delhi.
3. El – Mansi E.M.T and C.F.A. Bryce (2005) Fermentation Microbiology and Biotechnology, Replika Press Pvt. Limited, India.

REFERENCE BOOKS

1. Peter F. Stanbury, Allan Whitaker, Stephen J. (2009) Principles of Fermentation Technology, 2nd Edition Hall Elsevier Science Ltd.
2. Prescott L.M, Reed G. Dunn (2004) Industrial Microbiology, 4th Edition, CBS Publishers & Distributors, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3				4		
CO4			3			
CO5				4		

Mean = 3.4

The main objective of the course is to get hand on experience to produce various bioproducts such as antibiotic, enzymes, organic acid and wine using different fermentation process

Upon successful completion of the course, students will be able to

1. Isolate microorganisms with potential to produce industrially important products like enzymes and acids.
2. Understand the principle and factors influencing fermentation process and their applications.

LAB EXPERIMENTS

- i. Isolation of antibiotic producing microorganisms from soil by crowded plate technique.
- ii. Screening of enzyme producing organisms by fermentation.
- iii. Production of Wine.
- iv. Production of citric acid by *Aspergillus niger*.
- v. Immobilisation of yeast cells.
- vi. Production of alcohol from sugarcane molasses.
- vii. Laboratory scale production of biofertilizer.
- viii. Production of biopolymer

TEXT BOOKS

1. Chellapandi P. (2007), Laboratory Manual in Industrial Biotechnology, Pointer Publications.
2. Kulandaivel and Janarthanan, S. (2012) Practical Manual on Fermentation Technology, ISBN: 9789381141809.

REFERENCE BOOKS

1. Daniel Lim, Microbiology, 2nd Edition; McGraw-Hill Publication
2. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition.

The course is aimed to acquire knowledge on basic in bioinformatics, biological data bases, nucleic acid & protein analysis using various tools, docking and drug designing.

Upon successful completion of the course, students will be able to:

- i. Understand the basic concept in bioinformatics
- ii. Deliver the information about biological databases such as nucleic acid and protein databases
- iii. Apply and analyze the sequence alignment tool
- iv. Explicit the role bioinformatics in analysis of protein and phylogenomics
- v. Exert the principles drug designing and molecular docking

UNIT I

Introduction to Bioinformatics- Definition and History- Importance of Bioinformatics in various fields; Useful Bioinformatics web sites; Codes Used in Sequence Description (Amino acid and Nucleic acid)

UNIT II

Introduction to Biological Databases - Nucleotide Sequence databases (NCBI, DDBJ, and EMBL) - Protein databases -Primary (UnitProt & UniParc) – Secondary (Prosite & Pfam)- Composite (Swissprot & OWL); Structure databases (CATH, SCOP, and PDBsum); Metabolic Pathway Databases (ENZYME & KEGG); Specialized Genome databases: (SGD, TIGR, and ACeDB).

UNIT III

Sequence alignment- Global and local alignment; pairwise alignment – Dot-matrix method- Dynamic programming- Word or k-tuple method- BLAST and FASTA ; Multiple Sequence Alignment-Exhaustive algorithms- Heuristic algorithm

UNIT IV

Protein Analysis- Protein structure visualization tools – Rasmol & PyMol- Protein structure alignment methods –DALI & SSAP; Protein secondary structure prediction –Chou & Fasman; Phylogenetics analysis – CLUSTAL & PHYLIP- protein- protein interaction – STRING

UNIT V

Gene prediction- method and tools. Drug design – Structural and ligand based drug design, Lipinski rules - ADMET properties; Basics of Molecular Docking; Active site determination of enzymes (GASS)

EXPERIMENTS

1. Retrieval of genbank entry using an accession number
2. Retrieval and analysis of gene sequence in FASTA
3. Finding the official symbol alias name, chromosome number and ID for gene using NCBI
4. Retrieval and analysis of a protein sequence from protein database
5. Pairwise and multiple sequence alignment using ClustalW
6. Pairwise and multiple sequence alignment using BLAST
7. Similarity search using BLAST and interpretation of results
8. Phylogentic analysis – phylogenetic tree and bootstrapping

TEXT BOOKS

1. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.
2. David W.Mount.Bioinformatics: Sequence and genome analysis. Cold Spring Harbour Laboratory Press, New York, 2001.
3. Rastogi S.C Namitha Mendiratta, Parag Rastogi. Bioinformatics, Concepts, Skills, Application CBS publishers & distributors, New Delhi, 2004.

REFERENCE BOOKS

1. Andreas D.Baxevanis, B.F. Francis Ouellette, Bioinformatics A practical guide to the analysis of genes and proteins, Wiley Interscience, 2000
2. Attwood T.K and Parry - Smith D.J, Introduction to Bioinformatics, Pearson Education Ltd., New Delhi, 2003.
3. Phillip E. Brune, Helge Weissig, Structural Bioinformatics , A John Wiley& Sons Publications, 2011

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3				4		
CO4				4		
CO5			3			

Mean-3.4

This course is useful for the students to explore the basic concept of genome analysis, human and *E.coli* genome projects, protein analysis and the applications of genomics and proteomics.

Upon successful completion of the course, students will be able to:

- i. Know about basics of genomics , SNP and EST
- ii. Learn about the gene identification methods and functional genomic studies
- iii. Understand the concepts in transcriptomics and genome projects in *E.coli* and Human
- iv. Analyze the protein - protein interaction and techniques involved in protein analysis
- v. Discuss the applications of genomics and proteomic

UNIT I

Introduction to Genomics- Genes to protein- construction of genetic map- Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), Gene-disease association- FISH to identify chromosome landmarks

UNIT II

Gene identification and expression- Genome annotation- detecting open-reading frames-identifying the function new gene- gene ontology - Functional genomic studies with model system- Drosophila- Next Generation Sequencing –principles,methods and application

UNIT III

Transcriptomics – Global expression profiling, analysis of mRNA expression- DNA microarray technology – Whole transcriptome analysis – SAGE (Serial Analysis of Gene Expression)- Genome projects on *E.coli*-Human genome project

UNIT IV

Proteomics – Introduction, concepts of proteome analysis –Protein – 2D gel electrophoresis - Protein interaction – Yeast two hybrid system - Mass spectrometry for proteome analysis- biomarker for clinical diagnosis - tryptic digestion of protein and peptide fingerprinting

UNIT V

Applications of Genomics and Proteomics- proteomics in drug discovery in humans; capstone project on genomics and proteomics; Metabolomics- metabolic engineering of biomolecule production pathway (Phenyl alanine)

TEXT BOOKS

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

REFERENCE BOOKS

1. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1st Edition, Academic Press, San Diego, 1996
2. Winnaker E.L.X., Genes to Clones: Introduction to Gene Technology, Republic Germany, 2002
3. Brown T.A., Gene Cloning, 4th Edition, Chapman and Hall Publications, USA, 2000.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3				4		
CO4			3			
CO5				4		

Mean-3.4

This course empowers the student to pursue standard research, write scholarly reports and publish them in good journals.

Upon successful completion of the course, students will be able to:

- i. Enhance their approach towards research.
- ii. Discuss the methods of data collection and analysis.
- iii. Discuss the significance of Research report writing and publishing it in a good journal.
- iv. Use Biostatistics tools to interpret their data.
- v. Discuss the ethical issues and types of Intellectual Property Rights

UNIT I

Research methods vs. Methodology - Introduction – Research – Definition – Objectives – Types of research – Descriptive, Analytical, Applied, Qualitative. Quantitative, Conceptual, Empirical, Exploratory – Significance of research. Defining and formulating the research problem, review of literature - importance of literature review in defining a problem, identifying gap areas from literature.

UNIT II

Research process – Definition and steps of research process. Research design – Features of good research design – Experimental design – Informal, formal experimental designs – Steps in sample design – Types of sample design.

UNIT III

Methods of data collection, sampling methods, data processing. Meaning of Interpretation, Technique of Interpretation, Report Writing, Different Steps in Report Writing, Publishing in a journal. Computer and its role in research, Use of statistical software in research.

UNIT IV

Data – Methods of collection and classification of data – Primary and Secondary data, representation of Data, Measures of central tendency: (Mean, Median and Mode) Measure of Dispersion, Standard Deviation, ANOVA – Table construction and uses.

UNIT V

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS)

TEXT BOOKS

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

REFERENCE BOOKS

1. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
2. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
3. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3				4		
CO4			3			
CO5				4		

Mean-3.4

This course is designed to introduce students the importance and issues related to environment. It focuses on the natural resources, energy flow and types of ecosystems. Values of biodiversity, hotspots, endangered species and conservation are emphasized. It also highlights the social issues and population explosion in the environment.

Course Outcomes:

Upon completion of this course, students will be able to

- i. Outline the values of renewable and non-renewable resources.
- ii. Evaluate the concept, functions and types of ecosystems.
- iii. Discuss the values of biodiversity and importance of conservation.
- iv. Compare different types of pollution and assess the various waste management strategies
- v. Critique the importance of environmental issues, climate change and population explosion.

UNIT I - Introduction to Environmental studies

Definition – scope and importance - Need for public awareness – Role of people and institutions in Environment protection - Natural resources: Renewable and Non-renewable resources - Natural resources and management - Concept of sustainability and sustainable development.

UNIT II - Ecosystems

Concept, Structure and functions of ecosystem – Producers - consumers and decomposers. Energy flow in an ecosystem - food chain, food web and ecological succession – Types of ecosystems: Forest – Grassland - Desert - Aquatic.

UNIT III - Biodiversity and its conservation

Introduction- definition - Types of diversity: genetic- species and ecosystem biodiversity - Value of biodiversity: Consumptive use - productive use - social, ethical and aesthetic values - Biodiversity at global, national and local levels. India as a mega diversity nation - Hotspots - Threats to biodiversity: habitat loss, poaching of wildlife, man- wildlife conflicts- Endangered and endemic species of India-Conservation of biodiversity: In- situ and Ex-situ conservation.

UNIT IV - Environmental Pollution

Definition, causes, effects and control measures of air, water, soil, noise and thermal pollution - Nuclear hazards - Global warming: Depletion of ozone layer - greenhouse effect. Solid waste management - Disaster management.

UNIT V - Social issues and the Environment

Environmental movements: Chipko - Appiko- Silent valley - Bishnois of Rajasthan. Rain water harvesting - watershed management - Human rights - Rights of animals. Environment protection Act - Wildlife protection Act - Forest conservation Act - Public awareness - use of Environmental Calendar for Activities - Human Population and the Environment: Population explosion - Family welfare programme - urbanization – town planning - environment and human health.

TEXT BOOKS

1. Chawla S (2017), Textbook of Environmental studies, MC GRAW HILL Education, India.
2. Bharucha E (2013), Textbook of Environmental studies for Undergraduate courses, 2nd edition, Universities press (India) Private Ltd.

REFERENCES

1. Myneni S R (2019) Environmental studies , Asia Law House, Hyderabad.
2. Kaushik A and C.P.Kaushik (2014), Perspectives in Environmental Studies, 4thmulticolour edition, New Age International (P) Limited Publishers.
3. Thatheyus A.J (2011) Textbook of Environmental Studies, Narosa Publishing House, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3			3			
CO4					5	
CO5			3			

Mean-3.2

The course is formulated in such a way the students can able to learn the various recent concepts of Animal Biotechnology including cell culturing for clinical and industrial research.

Upon successful completion of the course, students will be able to:

- i. To understand the animal cell culture, animal diseases and its diagnosis and to gain the knowledge for therapy of animal infections
- ii. To know the concepts of micromanipulation technology and transgenic animal technology and use the knowledge gained in this section to apply in the field of clinical research
- iii. To teach animal cell culture scale up.
- iv. Students will understand the various applications of animal cell technology in research, clinics, and industry
- v. Methods of production of transgenic animals/cells and their application in various arenas of biotechnology will be discussed in detail which will equip the students fit for biotechnology research and industry

UNIT I

Genome Organization: Human Genome Organization. An introduction to animal viral vectors – retroviral vector. Gene transfer methods in animals- Microinjection, macroinjection - Liposome mediated, transfection.

UNIT II

History of animal cell culture -Cell culture media - cell synchronization –primary, secondary and continuous cell culture, Characteristics of cells in culture-Contact inhibition, anchorage dependence, cell-cell communication - Maintenance of cell lines – cryopreservation

UNIT III

Cell culture – scale up in mono layer and suspension – Cell transformation – Genetic instability – Immortalization – Aberrant growth control – Tumorigenicity – Cell cloning – Tissue engineering.

UNIT IV

Transgenic animal technology - Transgenesis for animal improvement. Multiple ovulation,

transgenic animals in xenotransplantation, *invitro* fertilization; Animal cloning concept - Ethical, social, and moral issues related to cloning

UNIT V

Concept of Gene therapy- Gene knock out technology and animal models for human genetic disorders; Animal models for human/animal diseases: Zebrafish, Mouse – Stem cell therapy

TEXT BOOKS

1. Primrose, S. B., & Twyman, R. (2009). Principles of gene manipulation and genomics. Wiley. com.
2. Verma, A., & Singh, A. (Eds.). (2013). Animal biotechnology: models in discovery and translation. Academic Press.
3. Campbell, N.A. and Reese, J.B. 2008. Biology 8th Edition, Pearson Education

REFERENCE BOOKS

1. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000
2. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
3. Ramadass P, Meera Rani S. Textbook of Animal Biotechnology. Akshara Printers, 1997.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3				4		
CO4				4		
CO5			3			

Mean = 3.4

The course is formulated in such a way the students can able to learn the various recent concepts of Plant Biotechnology including cell tissue culture and transgenesis for clinical and industrial research.

Upon successful completion of the course, students will be able to:

- i. To expose students to various aspects of plant genome organization, plant cloning and culturing techniques
- ii. To educate the basic culturing techniques of plants
- iii. To make the students aware about plant transformation, plant derived useful products, and secondary metabolites
- iv. To teach the advancement in the processes of mutagenesis and transgenesis
- v. To describe the recent trends and applications of transgenesis

UNIT I

Plant genome organization- chloroplast and mitochondrial genome - nucleus encoded genes - model plant - *Arabidopsis thaliana*; Plant viral vectors – caulimoviral vector – Gemini viral vector; DNA delivery to plants - particle bombardment, electroporation and liposome mediated transformation – DEAE dextran mediated transfer

UNIT II

Marker gene for plant transformation; protoplast transformation- leaf disc method - plastid transformation - Surface sterilization of plant materials, composition and preparation of culture media, plant growth regulators – sterilization of media - callus induction, protoplast culture and somatic hybridization *In-vitro* propagation.

UNIT III

Plant tissue culture – history – types of culture – cell culture – techniques and application – types of suspension culture – culture of isolated single cells – production and application secondary metabolites through tissue culture – large scale cultivation of plant cells

UNIT IV

Production of haploid plants – androgenesis – gynogenesis - application and limitation – somoclonal variants - Micropropagation – techniques and applications – Embryo culture -

cryopreservation - Hybrid seed production: Negative selection markers, male sterile and restorer lines - Synthetic seed technology

UNIT V

Transgenic plants - bioethics - inheritance of transgene; Transgenic crops for improved yield and nutritional quality: Delayed fruit ripening, improved protein and vitamin contents, plant architecture and productivity; Transgenic crops with improved stress resistance, edible vaccine

TEXT BOOKS

1. Ignacimuthu.S., Plant Biotechnology, Oxford and IBM Publishing Co., Pvt. Ltd., New Delhi, 1997.
2. Primrose, S. B., & Twyman, R. (2009). Principles of gene manipulation and genomics. Wiley. com.
3. Campbell, N.A. and Reese, J.B. 2008. Biology 8th Edition, Pearson Education Sathyanarayanan U, Biotechnology. 2008, Books & Allied Ltd.

REFERENCE BOOKS

1. An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.
2. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3				4		
CO4				4		
CO5			3			

Mean-3.4

This course is aimed to develop the students' practical knowledge on the preparation of animal and plant tissue culture media, growing animal and plant cells and production of synthetic seeds

Upon successful completion of the course, students will be able to

1. Demonstrate the knowledge on media preparation, plant tissue culture and cell line culture techniques
2. Understand large scale secondary metabolite production from tissue culture techniques.

EXPERIMENTS

1. Preparation of media for animal cell culture
2. Determination of viable cells by trypan blue test
3. Establishment and maintenance of cell lines
4. Preparation of plant tissue culture media
5. Sterilization and inoculation of explants
6. Callus induction
7. Production of synthetic seeds
8. Isolation of protoplast

TEXT BOOKS

1. R.I. Freshney. Culture of Animal Cells: A Manual of Basic Technique, 4th Edition, Wiley-VCH
2. Plant cell culture, A Practical approach, 2nd Edition, Edited by R.A. Dixon and R.A. Gonzales.
3. Natural Products: A Laboratory Guide by Raphael Ikan. Academic Press, 1991.

REFERENCE BOOKS

1. Shalini Mani , Manisha Singh , Anil Kumar. 2023. Animal Cell Culture: Principles and Practice, Springer Link
2. Mohamed Al-Rubeai, 2015 Animal Cell Culture, Springer Link
3. Smith Roberta H, Plant Tissue Culture Techniques And Experiments 3rd Edi, Elsevier

The objective of the course is to gather knowledge on nanomaterials and their properties, types, preparation, characterization and application in various fields such as medical, agriculture and environment

Upon successful completion of the course, students will be able to

- i. Gain the fundamental concepts of nanomaterials
- ii. Prepare nanomaterials and characterize the nanomaterials using various analytical technique
- iii. Understand the concepts of nano- thin films and their importance
- iv. Deliver the information about applications of nanoparticles in health care sector
- v. Discuss the applications of nanomaterials in agriculture and environment

UNIT I

Nanotechnology timeline- nanomaterials- types-One dimensional, two dimensional and three dimensional-applications- Carbon nanotubes, Graphene, Carbon dots, metal nanoparticles, metal oxide-based nanomaterials, semiconductor nanomaterials, quantum dots, hybrid nanoparticles Bio-nanomaterials, polymer nanoparticles and lipid nanoparticles

UNIT II

Synthesis of nanomaterials- different types - Top-Down and Bottom-up approaches; Properties of nanomaterial Structural properties, chemical properties, surface functionalization, physical properties; Characterization of nanomaterials by various analytical methods- optical characterization and spectroscopy such as FTIR, UV-Vis, X-Ray Diffraction, and advanced microscopy (TEM, SEM, AFM)

UNIT III

Nano-thin films: Nanodevices (nanorobots), Nanotubes: Microtubules assembly and its importance, Nano shells- Dendrimers: Liposomes, Nanofibers: Collagen, nano fluidics: Extracellular matrix assembly and its importance- Biomimetics

UNIT IV

Nanobiotechnology in healthcare- Nanopharmaceuticals- biosensors- Delivery vehicles, biomedical applications of nanomaterials- targeted drug delivery, theranostics- Nanoscale devices – DNA microarray for disease diagnosis

UNIT V

Nanobiotechnology for Agriculture and environment: Nanobased Agri and Food Products, role of nanotechnology in food preservation – Nanopesticides- Nanofertilizers-Nano-biostimulants- detection of contaminants

TEXT BOOKS

1. Shanmugam.S, “Nanotechnology”, MJP publishers, 2010.
2. David S. Goodsell, “Bionanotechnology”, John Wiley & Sons Inc., publications, 2004.
3. C.M.Niemeyer, C.A. Mirkin *Nanobiotechnology*, WILEY-VCH Verlag GmbH & Co. KG, Weinheim, 2007.

REFERENCE BOOKS

1. Pradeep T, *Textbook of Nanoscience and Nanotechnology*, McGraw Hill publications, 2012.
2. Rai, Mahendra, and Clemens Posten, *Green biosynthesis of nanoparticles: Mechanisms and applications*, CABI, 2013.
3. Guozhong Cao, *Nanostructures and Nanomaterials, synthesis, properties and applications*, Imperial College Press, 2004.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3				4		
CO4				4		
CO5			3			

Mean-3.4

VALUE ADDED COURSES

Semester	Course No.	Course title	Hrs/ Week	Marks
I	BTC 121V	Mushroom Technology	2	50
II	BTC 122V	Biosafety and Bioethics	2	50
III	BTC 221V	Biofertilizer Technology	2	50
IV	BTC 222V	Marine Biotechnology	2	50
V	BTC 321V	Pharmaceutical Biotechnology	2	50
VI	BTC 322V	Stem cell technology	2	50

This course is aimed to provide theoretical and technical skill about mushroom cultivation technology including mushroom biology, types of mushrooms, nutritional value, infrastructure requirement, cultivation methods-spawn production, disease management and Marketing

Upon successful completion of the course, students will be able to

- i. Deliver the information about historical perspectives, biology, nutritional value and differentiating the types of mushrooms
- ii. Construct mushroom production shed and gain information about equipments and substrate required for mushroom
- iii. Exert knowledge on spawn production and compost preparation for mushroom production
- iv. Scientifically produce various kinds of mushrooms
- v. Manage post-harvest technology and disease management

UNIT-I

History of mushroom cultivation; biology of mushrooms; Nutritional value: (Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins); Medicinal value of mushrooms; Edible mushrooms and cultivation in India and world; Poisonous mushrooms and mushroom poisoning

UNIT-II

Mushroom Cultivation Technology: Infrastructure- Structure and construction of mushroom house; Equipments requirement- vessels, inoculation hook, inoculation loop, sieves, culture racks, water sprayer, tray, boilers, driers, and Polythene bags; Substrates in mushroom cultivation- Sterilization of substrates:

UNIT-III

Spawn production - Spawn: types of spawn- culture media preparation- production of pure culture, mother spawn, and multiplication of spawn; Mushroom bed preparation; Compost: preparation of compost; Casing- raw material used for casing- preparation of casing material

UNIT-IV

Cultivation of important mushrooms- cultivation of *Agaricusbisporus*, *Pleurotusostreatus*and*Volvarellavolvaceae*- Pests and Pathogens of mushrooms and their management in mushroom cultivation

UNIT-V

Post-Harvest Management- Methods of storage of mushroom -Short-term Storage- Long-term Storage of mushrooms-Packing and Transportation- Recipes from mushrooms; Marketingof mushrooms in India and world

TEXT BOOKS

1. Philip G. Miles and S. T. Chang. (1997). Mushroom Biology: Concise Basics and CurrentDevelopments
2. S.Rajan and N.Sivakumar. Mushroom Technology (2020). CBS Publishers & Distributors

REFERENCE BOOKS

1. R.Gogoi, Y.Rathaiah and T.R.Borah. Mushroom Cultivation Technology.2019Scientific Publishers.
2. Barton Press. Mushroom Cultivation: A Practical Guide to Growing Mushrooms at home.2021. More Books LLC.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3	4		
CO2			3	4		
CO3			3			
CO4			3	4		
CO5				4		

Mean = 3.5

This course is framed to learn about biohazards, biosafety levels, Biosafety guidelines Government of India, GMP & GLP and to impart information about IPR and bioethics in biotechnology

Upon successful completion of the course, students will be able to

- i. Describe about biohazards, Biological Safety Cabinets and Biosafety Levels
- ii. Explain about role of Biosafety guidelines Government of India and Risk analysis, assessment, management and communication
- iii. Exert the principles of Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP) and Test system
- iv. Deliver information on IPR , Agreement and Treaties
- v. Bring acquaintance about Principles of bioethics and ethical implications of biotechnological products

UNIT-I

Biosafety- hazardous materials used in biotechnology — handling and disposal- Waste Categories- Chemical waste- Radioactive waste- Biohazardous waste- Sharp material; Instructions for Hazardous Waste Disposal- Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals;

UNIT-II

Biosafety guidelines Government of India- Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; National Regulations and relevant International Agreements including; Cartagena Protocol

UNIT-III

Good Manufacturing Practices (GMP)- Good Laboratory Practices (GLP)- GLP Principle-Test Facility Organisation and Personnel- At minimum it should- Facilities- Apparatus, Material, and Reagents- Test Systems- Test and Reference Substances- Standard Operating Procedures- Performance of the Study- Storage and Retention of Records and Material

UNIT-IV

Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications; Agreement and Treaties - GATT & TRIPS Agreement; WIPO Treaties, Budapest Treaty and Patent Cooperation Treaty

UNIT-V

Bioethics: Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity- Ethical implications of biotechnological products and techniques. Social and ethical Implications of biological weapons.

TEXT BOOKS

1. Bareact, Indian Patent Act 1970 Acts & Rules. 2007. Universal Law Publishing Co. Pvt.Ltd.,
2. Sateesh MK. Bioethics and Biosafety. 2010. I. K. International Pvt Ltd.

REFERENCE BOOKS

1. Kankanala C., Genetic Patent Law & Strategy. 2007. 1st Edition, Manupatra Information Solution Pvt. Ltd.,
2. Sree Krishna V Bioethics and Biosafety in Biotechnology. .2007. New age international publishers

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3	4		
CO2				4		
CO3				4		
CO4			3	4		
CO5			3			

Mean = 3.57

This course is planned to enrich theoretical and technical knowledge of biofertilizers production and the preparation of biocompost.

Upon successful completion of the course, students will be able to

- i. Deliver the basic knowledge about various kinds of fertilizers
- ii. Describe about bacterial biofertilizers
- iii. Explicit the role and field applications of *Anabaena azollae* and *Nostoc*
- iv. Precise the types, culturing and applications of mycorrhiza
- v. Disseminate the information about phosphate solubilizer and quality control of biofertilizer

UNIT-I

Manures and Biofertilizers: Types of fertilizers and manures; Manure composition- Manures for crop productivity; Differences between fertilizers and biofertilizers; Biofertilizers: Necessity, Scope and Benefits

UNIT-II

Bacterial Biofertilizers: Bacterial cultures used as biofertilizer- *Rhizobium*, *Azotobacter* and *Azospirillum*- general characteristics; Production of *Rhizobium* inoculants- isolation of *Rhizobium*-Identification of *Rhizobium*- Establishing *Rhizobium* starter culture- Masscultivation of *Rhizobium*-making carrier based inoculants-field application-crop response

UNIT-III

Blue green algal Biofertilizers: *Anabaena azollae* and *Nostoc* – General features- Preparation of starter culture-Mass cultivation of *Anabaena azollae* and *Nostoc* -making carrier based inoculants-field application-uses

UNIT – IV

Fungal Biofertilizers: Types of mycorrhizal association- Taxonomy of AM fungi –Isolation and identification AM of spores from soils-Culturing AM fungi and inoculum production of AM-Preparation of trap culture inoculum of AM-Inoculant Application-Biocompost making-types, method of vermicomposting, Panchakavya

UNIT-V

Phosphate Solubilizers; Mechanisms of phosphate solubilization-Isolation of mineral phosphate solubilizer- Inoculant Production-Formulation of inoculants using carrier materials-field application; Quality control of biofertilizers- assessment of bioefficacy of biofertilizer production techniques - Packaging, storage and shelf life

TEXT BOOKS

1. Bergerson FJ. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley and Sons.
2. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and Usage- A Source Book-cum-glossary. FDCO, New Delhi.

REFERENCE BOOKS

1. Subba Rao, N.S. Biofertilizers in Agriculture and Forestry. 1993. Oxford and IBH. Publ.Co., New Delhi.
2. P. Somasegaran and H.J. Hoben (1994). Hand book for Rhizobia; Methods in legume Rhizobium Technology. Springer-Verlag, New York.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3			
CO3			3			
CO4				4		
CO5				4		

Mean-3.4

This course is designed to study about the fundamentals of marine biotechnology, role of microorganisms in the area of marine ecology and marine resources

Upon successful completion of the course, students will be able to

- i. Discuss about marine diversity and resources
- ii. Deliver therapeutic application of marine applications
- iii. Illustrate about the bioremediation of marine pollution
- iv. Describe about mechanism of biofouling and controlling measures
- v. Apply the knowledge on the development of disease resistant marine organisms

UNIT – I

Marine biodiversity – prospective resources of marine ecosystem - Marine natural products - Marine organisms: an alternative source of potentiality valuable natural products

UNIT – II

Pharmaceuticals from marine organisms: anti - cancer, diagnostic and therapeutic, bioadhesives and thermostable enzymes.

UNIT – III

Bioremediation - Marine pollution - Aerobic and anaerobic bioremediation in the marine environment - Marine microorganisms capable, of degrading and detoxing chlorinated hydrocarbons and other pollutants.

UNIT – IV

Biofouling and Control technology - Biofouling organisms - Problems due to biofouling - Antifouling paints and its environmental pollution - Biotechnological approach to biofouling control.

UNIT – V

Genetic engineering- and ploidy manipulation to enhance growth of marine organisms - reproduction and development of disease resistance in aquacultural species crustaceans, molluscans, fin fishes and algae.

TEXT BOOKS

1. Se-Kwon Kim, (2015) Springer Handbook of Marine Biotechnology, Springer Publication.
2. Italy E., New Developments in Marine Biotechnology, Plenum Publication Corporation, 1998.
3. Le Gal Y., and Halvorson H.O., New Development in Marine Biotechnology, 1998.

REFERENCES BOOKS

1. Se-Kwon Kim, (2020) Encyclopedia of Marine Biotechnology: 5 Volumes, Wiley Publication.
2. Millton Figerman and Rachakonda Nagabhasnam.1996.Molecular Genetics of Marine Organisms, Science Publication Inc.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3				4		
CO4				4		
CO5				4		

Mean-3.4

This course aims to enrich the knowledge of students on drug discovery, industrial production and marketing of pharmaceutical products.

Upon successful completion of the course, students will be able to:

- i. Students will understand the series of processes involved in drug development, patenting and drug approval.
- ii. Will learn about Biopharmaceuticals
- iii. Will become familiar with Biotech protein drugs
- iv. Will understand about management of drugs
- v. Will be familiar with Pharmaceutical sectors

Unit I

Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Clinical trials - Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials.

Unit II

Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery - Pharmacognosy .

Unit III

Human Insulin (Humulin), Growth hormones (Humatrope) - Blood coagulating factor (factor VIII - Kogenate) - Vaccines (Pentavac), Biologics (Humira - Adalimumab), - Cancer based biologics (rituximab).

Unit IV

Drug toxicity analysis - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management

Unit V

National and International Drug approval agencies - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.

TEXT BOOKS

1. Chandrakant Kokate and Pramod H.J 1st Edition (2011), Text Book of Pharmaceutical Biotechnology, Elsevier
2. Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd (Eds.) (2019), Pharmaceutical Biotechnology: Fundamentals and Applications, Springer.
3. Ashish Dixit, Pawan Tiwari and Vivekanand Kishan Chatap (2015), Textbook of Pharmaceutical Biotechnology, Studium Press (India) Pvt. Ltd.

REFERENCE BOOKS

1. Gary Walsh (2003), Biopharmaceuticals ; biochemistry and Biotechnology, John Wiley & Sons Ltd.
2. Oliver Kayser and Heribert Warzecha (2012), Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley - Blackwell.
3. Simon Wills, 2nd Edition (2005), Drugs of abuse, Pharmaceutical Press

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2				4		
CO3				4		
CO4			3			
CO5			3			

Mean = 3.6

The course is designed to familiarize the students with stem cell technology and gives a broad view of types of stem cells, cover the basic biology of these stem cells and application of stem cells to potential treatments of human diseases.

UNIT I

Introduction to stem cells-Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.

UNIT II

Types of stem cells- embryonic stem cell- Adult stem cell, culture and the potential benefits of stem cell technology- Stem cell biology: Cell Cycle Control and its Check Points with special reference to markers and telomerase activity

UNIT III

Stem Cells in the epithelium of the small intestine and colon- Embryonal Carcinoma Cells as Embryonic Stem Cells, Trophoblast Stem Cells - Transcriptome profiling of embryonic stem cells

UNIT IV

Hematopoietic stem cells: Repopulating patterns of primitive hematopoietic stem cells and their differentiation in various cell lineages and plasticity- Mesenchymal stem cells of human adult bone marrow- Separation techniques of stem cells

UNIT V

Stem Cells and Neurogenesis: Differentiation of stem cells into neurons and their biomedical applications in disease treatment- Scope of stem cell research in nuclear reprogramming for treatment of diseases such as neural disorder, liver and skin diseases and burns- Stem cells and translational medicine

TEXT BOOKS

1. Stewart Sell. 2003. Stem Cells Handbook, Humana Press, USA
2. Chad A Cowan, Kevin Eggan and Stephen Sullivan.2007. Human Embryonic Stem Cells: The Practical Handbook , Wiley publication.

REFERENCE BOOKS

1. Marshak .2001.Stem Cell Biology Cold Spring Harbour Symposium Publications
2. Ariff Bongso and Eng Hin Lee 2005 Stem Cells World Scientific Publications Co. Pvt. Ltd

	K1 Remembering	K2 Understanding	K3 Applying	K4 Analyzing	K5 Evaluating	K6 Creating
CO1			3			
CO2				4		
CO3				4		
CO4				4		
CO5			3			

Mean = 3.6