

Syllabus

UG - Biotechnology

2017-18



Since 1951

PG & Research Department of Biotechnology
JAMAL MOHAMED COLLEGE (Autonomous)

College with Potential for Excellence
Reaccredited (3rd Cycle) with 'A' Grade by NAAC
(Affiliated to Bharathidasan University)

Tiruchirappalli – 620 020.

UG (BIOTECHNOLOGY) – Course Structure under CBCS (2017-2018 Onwards)

SEM	COURSE CODE	PART	COURSE	COURSE TITLE	HRS/ WEEK	CREDIT	MARKS		TOT AL
							CIA	ESE	
I	17U1LT1/LA1/ LF1/LH1/LU1	I	Language - I	Tamil* /other Languages	6	3	25	75	100
	17UCN1E1	II	English –I		6	3	25	75	100
	17UBT1C1	III	Core – I	Cell Biology	5	5	25	75	100
	17UBT1C2P		Core –II	Cell Biology - Practical	3	2	20	80	100
	17UBT1A1		Allied –I	Plant Diversity	5	4	25	75	100
	17UBT1A2P		Allied – II	Plant Diversity - Practical	3	2	20	80	100
	17UCN1VE	IV	Value Education		2	2	--	100	100
TOTAL					30	21	--	--	700
II	17U2LT2/LA2/ LF2/LH2/LU2	I	Language -II	Tamil* /other Languages	6	3	25	75	100
	17UCN2E2	II	English -II		6	3	25	75	100
	17UBT2C3	III	Core– III	Principles of Genetics and Molecular Biology	6	5	25	75	100
	17UBT2C4P		Core– IV	Principles of Genetics and Molecular Biology - Practical	3	2	20	80	100
	17UBT2A3		Allied –III	Biophysics and Biochemistry	4	3	25	75	100
	17UBT2A4P		Allied– IV	Biophysics and Biochemistry - Practical	3	2	20	80	100
	17UCN2ES	IV	Environmental Studies		2	2	--	100	100
TOTAL					30	20			700
III	17U3LT3/LA3/ LF3/LH3/LU3	I	Language - III	Tamil* /other Languages	6	3	25	75	100
	17UCN3E3	II	English –III		6	3	25	75	100
	17UBT3C5	III	Core – V	Bioinstrumentation	4	4	25	75	100
	17UBT3C6		Core – VI	Animal Diversity	3	2	25	75	100
	17UBT3A5		Allied – V	Microbiology	4	3	25	75	100
	17UBT3A6P		Allied – VI	Microbiology-Practical	3	2	20	80	100
	17UBT3N1	IV	Non Major Elective – I [#]		2	2	--	100	100
	17UCN3S1		Skill Based Elective – I [@]	Soft Skill Development	2	2	--	100	100
TOTAL					30	21			800
IV	17U4LT4/LA4/ LF4/LH4/LU4	I	Language - IV	Tamil* /other Languages	6	3	25	75	100
	17UCN4E4	II	English –IV		6	3	25	75	100
	17UBT4C7	III	Core – VII	Recombinant DNA Technology	5	5	25	75	100
	17UBT4C8P		Core – VIII	Recombinant DNA Technology- Practical	3	2	20	80	100
	17UBT4A7		Allied –VII	Immunology	5	3	25	75	100
	17UBT4A8P		Allied – VIII	Immunology- Practical	3	2	20	80	100
	17UBT4N2	IV	Non Major Elective - II [#]		2	2	--	100	100
17UCN4EA	V	Extension Activities	NCC, NSS, etc.,	-	1	-	-	-	
TOTAL					30	21			700
V	17UBT5C9	III	Core – IX	Plant Biotechnology	6	5	25	75	100
	17UBT5C10		Core–X	Animal Biotechnology	5	5	25	75	100
	17UBT5C11		Core –XI	Environmental Biotechnology	5	5	25	75	100
	17UBT5C12P		Core –XII	Plant Biotechnology, Animal Biotechnology and Environmental Biotechnology - Practical	5	5	20	80	100
	17UBT5M1A/B	IV	Major Based Elective – I ^{**}		5	4	25	75	100
	17UBT5S2 A/B		Skill Based Elective – II [@]		2	2	--	100	100
	17UBT5S3A/B		Skill Based Elective – III [@]		2	2	--	100	100
17UBT5EC1		Extra Credit - I	Ethnobotany and Herbal Medicine	-	4*	--	100*	100*	
TOTAL					30	28			700
VI	17UBT6C13	III	Core –XIII	Bioprocess Technology	5	5	25	75	100
	17UBT6C14		Core –XIV	Developmental Biology and Human Physiology	5	5	25	75	100
	17UBT6C15		Core –XV	Bioinformatics	5	5	25	75	100
	17UBT6C16P		Core–XVI	Bioprocess Technology, Developmental Biology and Human Physiology, Bioinformatics - Practical	5	5	20	80	100
	17UBT6M2A/B	IV	Major Based Elective – II ^{**}		5	4	25	75	100
	17UBT6M3A/B		Major Based Elective – III ^{**}		4	4	25	75	100
	17UCN6GS		V	Gender Studies		1	1	--	100
	17UBT6EC2		Extra Credit - II	Marine Ecology and Biodiversity Conservation	-	4*	--	100*	100*
TOTAL					30	29			700
GRAND TOTAL					180	140			4300

* Not considered for Grand Total and CGPA

@ Skill Based Electives

SEMESTER	COURSE CODE	COURSE TITLE
V	17UBT5S2A	Biostatistics and Computer Applications in Biology
	17UBT5S2B	Forensic Science
	17UBT5S3A	Transgenic Foods
	17UBT5S3B	Frontiers in Biotechnology

**** Major Based Electives**

SEMESTER	COURSE CODE	COURSE TITLE
V	17UBT5M1A	Pharmacognosy and Pharmacology
	17UBT5M1B	Genomics and Proteomics
VI	17UBT6M2A	Cancer and Stem Cell Biology
	17UBT6M2B	Food Biotechnology
	17UBT6M3A	IPR, Biosafety and Bioethics
	17UBT6M3B	Analytical techniques in Biotechnology

SEMESTER I: CORE - I
CELL BIOLOGY

Course Code: 17UBT1C1
Hours/week:5
Credit:5

Max Marks:100
Internal Marks:25
External Marks:75

Objectives:

- Cell biology is the study of the structure and function of prokaryotic and eukaryotic cells.
- The students will learn different areas of cellular biology including the structure and functions of cell and its organelles.

Unit I: **15 hours**

Fundamentals of cell structure: Discovery of cells; physiological properties of cells; structure of Prokaryotic and eukaryotic cells. Cell division: Cell cycle; mitosis; meiosis, #binary fission#.

Unit II: **15 hours**

Cellular membranes and matrices: Chemical composition; dynamic nature of membranes; transportation across cell membrane; membrane potentials; extracellular matrices – structure and function; cytoskeleton – structure and function.

Unit III: **15 hours**

Cellular organelles: Structure and functions of Endoplasmic reticulum – smooth & rough; Golgi complex; Ribosomes. Morphology and functions of peroxisomes and glyoxisomes; Plant cell vacuoles.

Unit IV: **15 hours**

Cellular organelles: Mitochondria – structure and function; Chloroplast – structure and function. Structure of nucleus – nuclear membrane, nucleolus, chromatin, structure of nucleic acids.

Unit V: **15 hours**

Methods in cell biology: Microscopy - Light microscope- bright field, dark field, phase contrast, fluorescence microscope, electron microscopy- Scanning electron microscope (SEM), Transmission electron microscopy (TEM), Staining procedures, #CLSM, AFM#.

#...# Self-study portion

Text Books:

1. Lodish. H., Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. Molecular Cell Biology, W.H. Freeman and Company, New York, (2013).
2. Arumugam. N., Cell Biology, SRS Publication, Tamilnadu, (2007).
3. Aruna Sarangi., Principles of Cell Biology, Pacific Publication, Delhi, (2010).

Unit I Chapter IV, T.B-2, pg. 60-75

Unit II Chapter X, T.B-1, Pg. 443-445

Unit III Chapter XI-XV, T.B-2, Pg. 167-218.

Unit IV Chapter IV, T.B-3, Pg. 97-120.

Unit V Chapter II, T.B-2, Pg. 16-29.

Books for References:

1. Brown T.A., Introduction to genetics: A molecular approach. IInd Edition. Garland Science. (2016).
2. Watson J.D., Tania A. Baker, Stephen P. Bell, Michael Levine and Richard Losick. Molecular Biology of the Gene. 7th Edition. Benjamin/Cummings Publ. Co., Inc., California (2015).
3. Benjamin Lewin. Genes XI. 9th Edition. Jones & Bartlett Learning, (2015).

SEMESTER I: CORE – II
CELL BIOLOGY - PRACTICAL

Course Code:17UBT1C2P

Hours/Week :3

Credit:2

Max Marks:100

Internal Marks:20

External Marks:80

Objective

To understand & develop skill and hands on training in basics of cell biology

1. Microscope – Bright field and Dark field
2. Micrometry-Size and shape of an organism (prokaryote) – simple staining, use of ocular micrometer
3. Structure observation - Prokaryotic & Eukaryotic cell
4. Cell count - Prokaryotic & Eukaryotic cell
5. Observation of different types of cells – parenchyma, collenchymas, sclerenchyma, epithelium.
6. Cell Staining – Cytochemical methods - Demonstration of Cellular and sub-cellular components
7. Osmosis and tonicity
8. Cell division - Mitotic stages - Preparation of Onion Root Tip
9. Cell division - Meiotic stages - Preparation of *Tradescantia* Flower bud
10. Cell division – Binary fission of yeast

Books for References:

1. Gunasekaran P., Laboratory Manual in Microbiology. New Age International, (2007).

**SEMESTER I: ALLIED - I
PLANT DIVERSITY**

Course Code: 17UBT1A1
Hours/Week:5
Credit:4

Max Marks: 100
Internal Marks: 25
External Marks: 75

Objective: To study the fundamental knowledge about plant and their reproductive biology.

UNIT I **ALGAE:** General characteristics and economic importance of algae, Structure, reproduction and life cycle of *Oscillatoria*, *Chlorella*, *Oedogonium*, *Sargassum* and *Gracilaria*, *Spirullina*.

15 Hours

UNIT II **FUNGI:** General characteristics and Economic importance of Fungi, Structure, reproduction and life cycle of *Plasmodiophora*, *Albugo*, *Peziza*, *Puccinia* and *Cercospora*.

15 Hours

UNIT III **BRYOPHYTES AND LICHENS:** General characteristics and economic importance of Bryophytes, Structure, reproduction and life cycle of *Marchantia*, *Anthoceros* and *Funaria* and #*Usnea*#.

15 Hours

UNIT IV **PTERIDOPHYTES:** General characteristics and economic importance of pteridophytes, Structure, reproduction and life cycle of *Lycopodium*, *Equisetum*, *Adiantum* and #*Marsilea*#.

15 Hours

UNIT V **GYMNOSPERMS AND ANGIOSPERMS:** General characters and economic importance of Gymnosperm, Structure, reproduction and life cycle of *Cycas* and *Gnetum*. Angiosperm – Type study of Annonaceae, Apocynaceae, Amaranthaceae, Liliaceae, Taxonomy – Classification – Artificial (Linnaeus system) – Natural (Bentham and Hooker’s system). Binomial Nomenclature- Herbarium Preparation.

15 Hours

#....# *Self-study portion*

Text Books:

T.B. 1. Gangulee Das and Datta. College Botany (Vol- I). New central Book Agency P. Ltd. 6th Edition, (2007).

T.B. 2. Gangulee Das and Datta. College Botany (Vol- II). New central Book Agency P. Ltd. 6th Edition., (2007).

Unit I Chapter I, T.B. 2
Unit II Chapter II, T.B. 2
Unit III Chapter III and VII, T.B.2
Unit IV Chapter IX, T.B. 2
Unit V Chapter X, T.B.1.

Books for References:

1. Alexopoulos, C. J., Introduction to Mycology, John Wiley & Sons, New York, (1952).
2. Pandey, B. P. Simplified course in Botany. S. Chand and Company Ltd., New Delhi, (2015).
3. Pandey, B. P., Taxonomy of Angiosperms, S. Chand & Co. Ltd., New Delhi, (2015).
4. Sharma, O. P., Text Book of Fungi, Tata McGraw Hill, New Delhi, (2014).
5. Vasishta BR & Sinha AK., Botany for degree students Fungi. S Chand and Company Ltd., New Delhi, (2016).
6. Vasishta P. C, Sinha AK & Anilkumar,. Botany for degree students, (2015).

PLANT DIVERSITY – PRACTICAL

Course Code:17UBT1A2P

Hours/Week :3

Credit:2

Max Marks:100

Internal Marks:20

External Marks:80

Objective: To study the morphological and anatomical structure of plants

1. ALGAE: *Oscillatoria, Chlorella, Oedogonium, Sargassum, Gracilaria, and Spirulina.*

2. FUNGI: *Plasmodiophora, Albugo, Peziza, Puccinia and Cercospora.*

3. LICHEN: *Usnea.*

4. BRYOPHYTES: *Marchantia, Anthoceros and Funaria.*

5. PTERIDOPHYTES: *Lycopodium, Equisetum and Marsilea.*

6. GYMNOSPERMS: *Cycas and Gnetum.*

7. ANGIOSPERM: Identification of one species from the families with local flora, Annonaceae, Apocynaceae, Amaranthaceae, Liliaceae.

Text Books:

1. Vasishta P. C, Sinha AK & Anilkumar,. Botany for degree students, Published by S. Chand & Company Ltd, (2013).
2. Gangulee, H. C. & Kar, AK. College Botany, Vol - I, II & III, Books & Allied Pvt. Ltd. Calcutta, (2007).

Course Code: 17UBT2C3
Hours/week: 6
Credit: 5

Max. Marks: 100
Internal Marks: 25
External Marks: 75

OBJECTIVE:

On completion of this course, the student will be able

- To comprehend what is genetic material and Mendelian's principles in genetics, chromosome structure & gene expression in both prokaryotes and eukaryotes.
- To understand the structures and various molecular functions of macromolecules found in cells.

UNIT I:

18 hours

Transmission and distribution of genetic material: Introduction to Genetic Material, Mendel's laws of inheritance, Mono and Dihybrid crosses, Test cross, Back cross, Tri and Polyhybrid crosses, Incomplete dominance and Codominance, Multiple alleles, Phenotype & Genotype, Pleiotropy, #Penetrance and expressivity#.

UNIT II:

18 hours

Cellular Division, Structure, change and arrangement of chromosomes: Structure and morphology of chromosomes, Linkage & crossing over, Sex determination in humans, Recombination in bacteria - Transformation, Conjugation & Transduction. Mutation - physical, chemical and biological. Transposons & various types of transposons.

UNIT III:

18 hours

Nucleic Acids and DNA Replication: Structure, properties and function of DNA & RNA, Various forms of DNA, Genome organization - Prokaryotic and Eukaryotic, DNA replication - Semiconservative method, Enzymology of DNA replication, Discontinuous Replication, #Prokaryotic and eukaryotic replication#.

UNIT IV:

18 hours

Expression of genetic information: Central Dogma, Codon usage, Process of Transcription and Translation - Initiation, Termination and Elongation, Comparison of Prokaryotic and Eukaryotic Transcription and Translation, #Regulation of Transcription and Translation#, Post Transcriptional and Translational modifications.

UNIT V:

18 hours

DNA Repair and Gene regulation: DNA damage and various repair mechanisms - Photoreactivation, Excision repair, Recombination repair and SOS Repair, Gene Regulation - Operon model - Lactose, Galactose, Arabinose, Tryptophan, #Relative positions of Promoters and Operators#.

#.....# Self - study portion

Text Books:

1. Strickberger MW., Genetics, 3rd Edition, Asoke K. Ghosh, Prentice-Hall of India Pvt Ltd, (2005).
2. Freifelder D., Molecular Biology, 2nd Edition, Jones and Barlett Publishers, USA. (2004).

UNIT 1: TB.1, Part - I, Page No. 3-6, 103-151.

UNIT 2: TB.1, Part - I, Page No. 12-25, TB.1, Part- III, Page No. 273-285. TB.1, Part- III, Page No. 342-364. TB.2, Chapter - 11, Page No. 293-312, TB.2, Chapter - 21, Page No. 679-704.

UNIT 3: TB.2, Chapter - 9, Page No. 223-273, Chapter - 12, Page No. 333-342. Chapter 13 - Page No. 381.

UNIT 4: TB.2, Chapter - 12, Page No. 315-363, Chapter - 13, Page No. 367-412, Chapter - 14, Page No. 415-450.

UNIT 5: TB.2, Chapter - 10, Page No. 277-292, Chapter -15, Page No. 453-488.

Books for References:

1. Gardner EJ, Simmons MJ, Snusted DP. Principles of Genetics, John Wiley and Sons, New York, (1991).
2. Weaver RF. and Hedrick PW. Genetics, 3rd Edition, W.M.C. Brown Publishers, London, (1997).
3. Hotter P. Textbook of Genetics, IVY Publishing House, New Delhi, (2002).
4. Klug WS, Cummings MR, Spencer CA, Palladino MA. Concepts of genetics, 9th Edition, Pearson International Edition, (2009).

SEMESTER II: CORE - IV
PRINCIPLES OF GENETICS AND MOLECULAR BIOLOGY - PRACTICAL

Course Code: 17UBT2C4P
Hours/week: 3
Credit: 2

Max. Marks: 100
Internal Marks: 20
External Marks: 80

OBJECTIVE:

On completion of this course, the student will be able

- To comprehend the principles of genetics and gain hands on experience on various techniques of molecular biology and apply the gained knowledge in different fields.
1. Watson and Crick double helical DNA model.
 2. Effect of UV light on bacteria.
 3. Isolation of Antibiotic Resistant bacteria.
 4. Isolation of genomic DNA from bacteria - Phenol-Chloroform Method.
 5. Isolation of Plasmid DNA from bacteria - Alkaline lysis method
 6. Agarose gel electrophoresis and quantification of DNA.
 7. Preparation of competent cells and transformation.
 8. Experiments with *lac* operon- induction and assay of *beta*-galactosidase.

Text Books:

1. Snustad DP, Simmons MJ, Jenkins JB.. Principles of genetics, John Wiley & Sons, USA, (1997).
2. Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA, Struhl K.
Current Protocols in Molecular Biology, John Wiley & Sons, USA, (2003).

Books for References:

1. Sambrook J, Russell DW. Molecular Cloning - A Laboratory Manual, Volume 1, 3rd Edition, Cold Spring Laboratory Press, New York, (2001).
2. Sambrook J, Russell DW Molecular Cloning - A Laboratory Manual, Volume 2, 3rd Edition, Cold Spring Laboratory Press, New York, (2001).

SEMESTER II: ALLIED - III
BIOPHYSICS AND BIOCHEMISTRY

Subject code: 17UBT2A3

Hrs/week: 4

Credit: 3

Max Marks: 100

Internal Marks: 25

External Marks: 75

Objectives:

- To ensure students have a strong foundation in structures and reactions of biomolecules.
- To introduce them to metabolic pathway of the major biomolecules and relevance to clinical conductors.

UNIT I:

12 hours

Bioenergetics and Biomolecular interactions: Thermodynamics – Principles of bioenergetics- free energy functions – ATP as main carrier of free energy. Energy molecules, Biological oxidation reduction reaction. Structure and properties of H₂O. Solute-Solvent interactions- Bonding; #Strong and weak interactions-hydrogen bonding#.

UNIT II:

12 hours

Carbohydrates: Carbohydrates (mono, di, oligo & polysaccharides) stereoisomerism and optical isomerism of sugars. Proteoglycans, glycosaminoglycans, mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars and non- reducing sugars.

UNIT III:

12 hours

Lipids: Fatty acids, glycerol, reactions of lipids- saponification, iodination, hydrogenation, rancidity, esterification. phospholipids, glycolipids, sphingolipids, cholesterol, biological role of cholesterol, steroids and prostaglandins.

UNIT IV:

12 hours

Amino acids and Nucleic acids:

Amino Acids, Peptides, Proteins, hierarchy of primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Topology of DNA, RNA and DNA reactions, properties, measurement, #nucleoprotein complexes#.

UNIT V:

12 hours

Enzymes and enzyme kinetics: Enzyme nomenclature and classification, coenzymes and cofactors, mechanism of enzyme catalysis, specificity of enzymes, factors influencing enzyme action (pH, temperature, substrate concentration), pre-steady state and steady state kinetics, Michaelis-Menten equation and Line- Weaver Burk plot.

#...# - Self - study portion

Text Books:

1. Voet, D and Voet, J.G., "Biochemistry", 3rd Edition, John Wiley & Son. (2004).

Unit-1 Chapter 12 Page no 476-490

Unit-2 Chapter 17 Page no 581-618

Unit-3 Chapter 25 Page no 909-969

Unit-4 Chapter 28 Page no 1069-1098

Unit-5 Chapter 26 Page no 985-1044.

Books for References:

1. Conn, E.E., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, (1987).
2. Nelson, D.L. and Cox, M.M., "Lehninger's Principles of Biochemistry", 4th Edition, W.H. Freeman & Co. (2005).
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill. (2003).
4. Satyanarayana, U. and Chakerapani U., "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., (2006).

SEMESTER II: ALLIED - IV

BIOPHYSICS AND BIOCHEMISTRY - PRACTICAL

Subject code: 17UBT2A4P

Hrs/week: 3

Credit: 2

Max Marks: 100

Internal Marks: 20

External Marks: 80

1. General guidelines and laboratory safety measure for working in Biochemistry laboratory.
2. Units of volume, weight, density and concentration measurements and their range in biological measurements.
3. Demonstration of proper use of volume and weight measurement devices.
4. Determination of pH - pH meter.
5. Preparation of buffer –titration of a strong acid and a weak base.
6. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars
7. Estimation of reducing sugar by DNS method.
8. Quantitative estimation of amino acid using Ninhydrin.
9. Protein estimation by Lowry et.al (1951).
10. Effect of enzyme activity- Salivary amylase.
11. Chromatography- paper and TLC.

Books for References:

1. Robert L.Switzer and Liam F.Garrity., “ Experimental Biochemistry”, W.H.Freeman and Company, New York. (1999).

**SEMESTER III: CORE - V
BIOINSTRUMENTATION**

Subject code: 17UBT3C5
Hrs/ week: 4
Credit: 4

Max Marks:100
Internal Marks:25
External Marks:75

Objectives:

To educate the students the different types of bioinstrumentations (microscopes, centrifugation, spectroscopy, chromatography, electrophoresis and radio isotopes) and its applications.

UNIT I

12 hours

Centrifugation: Basic principles of sedimentation. Low-speed and high - speed centrifuges. Ultracentrifuge - instrumentation and applications. Subcellular fractionation by differential centrifugation. #Density- gradient centrifugation (CsCl method) - rate zonal and isopycnic#.

UNIT II

12 hours

Spectroscopy: Properties of electromagnetic ionic radiation, laws of absorption and absorption spectrum. Principle, mode of operation and applications of UV- visible, IR spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Atomic Absorption Spectroscopy (AAS), and Mass Spectrometry.

UNIT III

12 hours

Chromatography: Principles, mode of operation and applications of Paper Chromatography, Thin layer Chromatography (TLC), Column chromatography- Ion Exchange and Affinity and Molecular Sieving Chromatography. High Performance Liquid Chromatography (HPLC) and Gas liquid Chromatography (GLC).

UNIT IV

12 hours

Electrophoresis and Radioisotope techniques: Electrophoresis: Agarose gel electrophoresis, Electrophoresis of proteins- #SDS-PAGE#, Native gels, 2D- PAGE, Nature of radioactivity, detection and measurement of radioactivity: detection based on gas ionization- Geiger Muller Counter, Liquid Scintillation Counter, Autoradiography. Application of radioisotope in Biology.

UNIT V

12 hours

Electrophysiological methods and Methods in field Biology: Single neuron recording, ECG, PET, MRI, fMRI, CAT. Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization: ground and remote sensing methods.

Self -study portion

Text Books:

1. Boyer, R., "Modern Experimental Biochemistry" 3rd Edition. Addison Wesley Longman. (2000).
2. Prescott, L.M.- Harley, J.P. Klein, D.A., "Microbiology"- Wm.C. Brown Publishers. (1996).

Unit I Chapter I, II, III, T.B-1

Unit II Chapter V, T.B-1

Unit III Chapter 7, T.B-1

Unit IV Chapter 3 T.B-1

Unit V Chapter 4 T.B-1

Book for Reference:

1. Wilson and Walker. "Principles and techniques of biochemistry and molecular biology", 6th Edition. Cambridge University Press, (2005).

ANIMAL DIVERSITY

Subject code: 17UBT3C6

Hrs/week: 3

Credit: 2

Max Marks: 100

Internal Marks: 25

External Marks: 75

Objective: To study the fundamental knowledge about animals and its behaviors.

Unit I: Classification of invertebrates and characteristic feature study of Phylum – Protozoa (Euglena), Porifera (Leucosolenia), Coelenterata (Hydra), Platyhelminthes (Taenia), Aschelminthes (Ascaris), #Mollusca (Pila- Apple snail), Annelida (Earthworm), Arthropoda (Prawn)#.

9 Hours

Unit II: Vertebrata and chordate: The general plan of chordate organization- the variety of chordate life and classification of chordates; Fishes, amphibians, Reptiles, Aves and Mammals – general characters.

9 Hours

Unit III: Insect Diversity: characters and types, Apis (Honeybee) – Bombyx (Silkworm)– Termites (White ants) – Lepidoptera (Butterfly) and Musca (House fly). Economical importance of insects, Conservation and management.

9 Hours

Unit IV: Animal Behavior: Innate behavior – Learned behavior; Animal movement - Kinesis – Taxis – migration, Animal communication and Animal social behavior.

9 Hours

Unit V: Wild life conservation of management. Remote sensing techniques in wild life management. Biodiversity – Types – Mega diversity with reference to India – conservation strategies, measuring diversity.

9 Hours

#....# Self -study portion

Text Books:

1. EkambaranathaAyyar, Outlines of Zoology. Vol – I: S. Viswanathan (Printers and Publishers) Pvt. Ltd. Chennai. (2015).
2. VermaTyagi and Agarwal. Animal Physiology. S. Chand and Co. Delhi. (2016).
3. Jordan, E.L., and Verma, P.S., Invertebrate Zoology, S.Chand and Company Ltd., New Delhi. (2010).
4. T.B.4. Young J.Z., The Life of Vertebrates, Oxford University Press, Delhi-110031, (2010).

Unit I Chapter 1 T.B.1

Unit II Chapter 11 to 19, T.B.3

Unit III Chapter 5, T.B.4

Unit IV Chapter 8 T.B.3

Unit V Chapter 5 T.B.2

Books for References:

1. Leelavathy. S. Nair, Revised enlarged Edition. A Text book of Invertebrates, Saras Publication. (2011).

SEMESTER III: ALLIED - V

MICROBIOLOGY

Course code: 17UBT3A5

Total Mark: 100

Hrs/week: 4

Internal Mark:25

Credit: 3

External Mark:75

- Objectives:** 1. To study the diversity of microbial lifestyles, growth and its characterization.
2. To study the structure of plant, animal viruses and methods involved in control of microorganisms.

UNIT I

15 Hours

Fundamentals of Microbiology – History of Microbiology, Systematic classification - Binomial Nomenclature, Concepts of Domain: Haeckel's three kingdom, Whittaker's five kingdom, Cavalier-Smith's six kingdom and outline of Bergey's Manual of Systematic Bacteriology. Scope and application of microbiology in various fields.

UNIT II

15 Hours

Prokaryotic and Eukaryotic cell structure: Prokaryotic cell organization – plasma membrane, cytoplasmic matrix – inclusion bodies, cell wall, peptidoglycan structure, Structures internal to the cell wall – cytoplasm, ribosomes and nucleus, Components external to cell wall – Capsules, slime layer, flagella and motility, Structural classification of Bacteria and Fungi, fungal fruit bodies, dimorphic fungi and cell structure of yeast.

UNIT III

15 Hours

Nutritional Requirements and Microbial growth: Aerobic and anaerobic nutritional requirements – macro nutrients – growth factors, Culture media and their types - selective / differential media – enrichment media – microbial assay media. Sterilization of media, Pure Culture Techniques - Serial dilution methods - spread plate – pour plate – streak plate technique. Mathematical expression of growth, growth curve. Synchronous culture and Continuous culture. Factors affecting microbial growth. Bacteriological examination of water and milk.

UNIT IV

15 Hours

Viruses: Properties of viruses, cultivation of viruses, virus purification and assays, Structure of viruses – virion size, general structural properties, helical and icosahedral capsids, viral nucleic acid and viral envelopes. Bacteriophages – Classification, lytic and lysogenic cycle. Animal virus – Influenza virus, Plant virus – TMV, #Viriods and Prions#.

UNIT V

15 Hours

Control of microorganism: Conditions influencing the effectiveness of antimicrobial agent activity, Physical method – heat, low temperature, filtration and radiation. Chemical method – phenolics, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases. #Evaluation of antimicrobial agent effectiveness – phenol co-efficient test#.

#...# *Self-study portion*

Text Books:

T.B 1. Prescott, LM, Harley JP and Klein DA., Microbiology, 6th Edition. McGraw Hill, (2005).

Unit I: Part I & 7, Chapter 1 & 19. Page no: 1-35, 409-431. T.B 1

Unit II: Part I, Chapter 3 & 4. Page no: 39-84. T.B 1

Unit III: Part II, Chapter 5 & 6. Page no: 93-118. T.B 1

Unit IV: Part VI, Chapter 16, 17 & 18. Page no: 351-405.. T.B 1

Unit V: Part II, Chapter 7. Page no: 133-146. T.B 1

Books for References:

1. Pelczar, M. J, Chan ECS, and Krieg NR, Microbiology, 5th Edition Tata McGraw Hill Publishing Company. (2006).
2. Anantha Narayanan R and Panikar CKJ. 6th Edition. General Microbiology, Orient Longman Pvt. Ltd., (2002).

SEMESTER III: ALLIED - VI

MICROBIOLOGY - PRACTICAL

Course code: 17UBT3A6P

Hrs/week: 3

Credit: 2

Total Mark: 100

Internal Mark:20

External Mark:80

Objective: To give an understanding about the basic techniques in Microbiology

1. Sterilization and preparation of microbiological media – liquid and solid.
2. Isolation & Enumeration of Micro-organism from air, water and soil.
3. Types of culture method- pour plate, spread plate, streak plate method.
4. Staining Techniques – Gram's staining, Negative staining, Spore's staining, Lactophenol cotton blue staining.
5. Motility - Hanging drop method
6. Measurement of Growth - Spectrophotometry
7. Biochemical characterization of micro organisms – carbohydrate utilization, IMViC, catalase, oxidase test.
8. Water quality analysis – MPN method
9. Methylene blue reduction test for milk.

Books for References:

1. James G. Cappuccino and Natalie Sherman. Microbiology: A laboratory Manual. 10th Edition. Benjamin Cummings, (2013).
2. Kannan N. Laboratory Manual in General Microbiology. Panima Publishing Corporation, (2002).

**SEMESTER III: NON MAJOR ELECTIVE – I
MUSHROOM TECHNOLOGY**

Course Code: 17UBT3N1
Hours/week: 2
Credit: 2

Max Marks: 100
Internal Marks: --
External Marks: 100

Objectives:

- To provide an adequate knowledge on mushroom cultivation techniques.

UNIT I

6 Hours

Introduction - History - scope of edible mushroom cultivation - Types of edible mushrooms available in India – *Pleurotus citrinopileatus*, *Agaricus bisporus*.

UNIT II

6 Hours

Pure culture - preparation of medium (PDA and Oatmeal agar medium) sterilization - preparation of test tube slants to store mother culture – culturing of *Pleurotus* mycelium on petriplates, preparation of mother spawn in saline bottle and polypropylene bag and their multiplication.

UNIT III

6 Hours

Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Mushroom bed preparation - paddy straw, sugarcane trash, marine straw and banana leaves. #Factors affecting the mushroom bed preparation - Low cost technology#.

UNIT IV

6 Hours

Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

UNIT V

6 Hours

Food Preparation: Types of foods prepared from mushroom; Soup, Cutlet, Omelette, Samosa, Pickles, Curry. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

....# *Self -study portion*

Text Books:

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore, (1991).
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore -560018.

Unit I Chapter – 1 and 2. T.B -1
Unit II Chapter – 6 and 10. T.B -1
Unit III Chapter – 7. T.B -1
Unit IV Chapter – 8. T.B -2
Unit V Chapter – 5. T.B -2

Books for Reference:

1. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
2. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol.II.

**SEMESTER IV: CORE - VII
RECOMBINANT DNA TECHNOLOGY**

Course code: 17UBT4C7
Hrs/week: 5
Credit: 5

Total Mark: 100
Internal Mark:25
External Mark:75

- Objectives:** 1. To study the various principles underlying the basis of Recombinant DNA Technology.
2. To study the applications of Recombinant DNA Technology.

18 Hours

UNIT I: Introduction of Recombinant DNA Technology – Importance of Recombinant DNA Technology in day today life, isolation of genes. Enzymes of rDNA technology - Restriction endonucleases, exonuclease, S1 nuclease, *Taq* DNA Polymerase, Reverse transcriptase, DNA Polymerase, Terminal deoxynucleotidyl Transferase, alkaline phosphatase, polynucleotide Kinase and Ligase.

18 Hours

UNIT II: Vectors – Plasmids – size, copy number, amplification, isolation of plasmid DNA, Criteria for plasmid cloning, Phage vectors, Cosmids, Phagemids, Cloning vector for *E.coli*, Virus vectors (Retro virus and Adeno virus), Shuttle vectors and expression vectors, Yeast Artificial Chromosome[#], Bacterial Artificial Chromosome.

18 Hours

UNIT III: Cloning Strategies - Methods of transformation, Construction of genomic libraries and cDNA libraries, DNA amplification using polymerase chain reaction (PCR): key concepts, Analysis of amplified products. Applications of PCR, Ligase chain reaction, RFLP, RAPD, DNA Finger printing. Principles of Southern, Northern and Western blotting techniques.

18 Hours

Unit IV: Recombinant selection, screening and Gene Sequencing - Analysis of recombinant DNA - Selection methods – direct antibiotic resistance screening, Blue-White screening, Positive selection vector, colony hybridization and nucleic acid hybridization techniques.

Sequencing - Maxam-Gilbert sequencing, Chain-termination methods, Shotgun sequencing, #Massively parallel signature sequencing (MPSS) #.

18 Hours

Unit V: Applications of Recombinant DNA Technology - Transgenic plants: virus resistance (TMV in tobacco plant), pest resistance (*Bt* cotton), herbicide tolerance (glyphosate) and stress tolerance (cold and salt), delayed fruit ripening, Transgenic animals (mice and sheep), Pharmaceutical products using Recombinant DNA Technology – Insulin and vaccines (Hepatitis B vaccine).

#.....# Self - study portion

Text Books:

T.B.1 Brown TA., Gene cloning and DNA Analysis. 6th edition, Wiley Blackwell Publishing. (2010).

T.B.2. S.B. Primrose, R.M. Twyman., Principles of Gene Manipulation and Genomics. S.B.University Press, (2013).

Unit I – Chapter 4, Page no: 45-69. T.B.1
Unit II – Chapter 6 & 7, Page no: 88-124. T.B.1
Unit II – Chapter 5. T.B.2
Unit III – Chapter 9, Page no: 147-160. T.B.1
Unit III – Chapter 3. T.B.2
Unit IV – Chapter 10, Page no: 165-183. T.B.1
Unit IV – Chapter 2. T.B.2
Unit V – Chapter 14, Page no: 245-280. T.B.1

Books for References:

1. Brown TA. Genomes. 3rd Edition. New York: Garland Publishing Co. New York: Garland Science. (2008).
2. Freifelder D., Malacinski, GM., Essentials of molecular biology. Jones and Bartlett Publishers. (1993).
3. Glover D.M. & B.D. Hames, DNA Cloning I & II, IRL Press. (1995).

SEMESTER IV: CORE – VIII

RECOMBINANT DNA TECHNOLOGY - PRACTICAL

Course code: 17UBT4C8P

Hrs/week: 3

Credit: 2

Total Mark: 100

Internal Mark:20

External Mark:80

Objective:

- To isolate the DNA from plant, animal, bacteria and to explain the underlying mechanisms of gene cloning.
1. Isolation of plant genomic DNA– CTAB method
 2. Isolation of animal genomic DNA
 3. Isolation of bacterial genomic DNA
 4. Isolation of plasmid DNA - *E. coli* Boiling lysis Plasmid preparation
 5. Analysis of genomic and plasmid DNA by Agarose gel electrophoresis
 6. Quantitation of DNA using Spectrophotometer
 7. Estimation of DNA by Diphenylamine method
 8. Restriction digestion – single & double digestion
 9. Ligation of restricted DNA fragments
 10. Polymerase Chain Reaction (PCR) - Demonstration

Books for Reference:

1. Sambrook, J and D.W. Russel. Molecular Cloning: A Laboratory Manual, Vols 1-3. CSHL. (2001).

**SEMESTER IV: ALLIED - VII
IMMUNOLOGY**

Course Code: 17UBT4A7
Hours/week: 5
Credit: 3

Max. Marks: 100
Internal Marks: 25
External Marks: 75

OBJECTIVE:

On completion of this course, the student will be able

- To comprehend the different type of cells, organs and mechanisms involved in immune system and their contributions in elucidating immune response.
- To understand the various components and the techniques associated with the specific immunological reactions.

UNIT I: 12 hours

Overview of the Immune system: Historical perspectives in development of immunology, Immune system - innate and adaptive immunity, Haematopoiesis, Cells of the immune system - lymphoid cells (T and B lymphocytes, NK cells), Macrophages, Granulocytes, Organs of the immune system - Primary and secondary lymphoid organs.

UNIT II: 12 hours

Antigens and Antibodies: Antigens - Properties and Classes, Epitopes, Haptens, Adjuvants. Antibodies - structure, biological functions and different classes. Organization and expression of immunoglobulin genes.

UNIT III: 12 hours

Activation and immune response of B cell, T cell and Complement: B cell - Activation, proliferation and humoral response, T cell - Activation, differentiation and Cell mediated response, #Cytokines#, Complement - Functions and activation pathways.

UNIT IV: 12 hours

Antigen Presentation, Hypersensitivity and Immune response to infectious diseases: Major Histocompatibility complex - class I and class II, T cell receptors, Processing and Presentation pathways - Cytosolic and Endocytic, Hypersensitive reactions - types, #Immune response to viral, bacterial and protozoan infections#.

UNIT V: 12 hours

Antigen - Antibody interactions and Vaccines: Precipitation and Agglutination reactions, Blood grouping, ELISA, RIA, Western blotting and #FACS#, Vaccines - active and passive, purified, recombinant, subunit and DNA vaccines.

#....# Self - study portion

Text Books:

1. Goldsby RA, Kindt TJ, Osborne BA, Kuby J Immunology, 5th Edition, W.H. Freeman and Company, New York, (2003).
2. Abbas AK, Lichtman AH, Pillai S Cellular and Molecular Immunology, 7th Edition, Elsevier Health Sciences, (2011).
3. Latha PM A Text Book of Immunology, 1st Edition, S.Chand & Company Ltd, New -Delhi, (2003).

UNIT 1: TB.1, Part - I, Page No. 1-16, 24-52.

UNIT 2: TB.1, Part - II, Page No. 57-132.

UNIT 3: TB.1, Part - II, Page No. 221-238, 247-265, 276-324.

UNIT 4: TB.1, Part - II, Page No. 161-174, 185-215, 361-404.

UNIT 5: TB.1, Part II, Page No. 137-150, 154, 413-425.

Books for References:

1. Roitt I., Essential Immunology, 10th Edition. Blackwell Scientific Publication, (2002).
2. Pandian MR and Kumar BS Immunology and Immunotechnology, Panima publishing corporation, New Delhi, (2007).
3. Weir DM and Stewart J Immunology, 10th Edition. Churchill Livingstone, New York, (2000).

**SEMESTER IV: ALLIED - VIII
IMMUNOLOGY - PRACTICAL**

Course Code: 17UBT4A8P

Hours/week: 3

Credit: 2

Max. Marks: 100

Internal Marks: 20

External Marks: 80

OBJECTIVE:

On completion of this course, the student will be able

- To gain hands on experience and develop ideas on various immunological techniques that include antigen - antibody interactions and quantification of antigen (or) antibody.
- To develop the knowledge on DNA isolation and cell counting from the blood sample.

1. Blood Grouping.
2. Total Leukocytes Count using Hemocytometer.
3. Radial Immunodiffusion.
4. Ouchterlony double diffusion.
5. Immunoelectrophoresis.
6. Rocket immunoelectrophoresis.
7. ELISA.
8. Isolation and quantification of DNA from blood.

Text Book:

1. Goldsby RA, Kindt TJ, Osborne BA, Kuby J Immunology, 5th Edition, W.H. Freeman and Company, New York, (2003).

Book for Reference:

1. Sambrook J and Russell DW Molecular Cloning: A Laboratory Manual. CSH Laboratory Press, Cold Spring Harbor, New York, (2001).

SEMESTER IV: NON MAJOR ELECTIVE - II
BIOFERTILIZER AND ORGANIC FARMING

Course Code: 17UBT4N2

Hours/week: 2

Credit: 2

Objectives:

Max. Marks: 100

Internal Marks: --

External Marks: 100

- To discuss the impacts of chemical based agriculture.
- To discuss the importance of Biofertilizer and organic farming.

Unit I

6 Hours

Soil-Physical, chemical properties. Soil Pollution-oil, chemicals-fertilizers, pesticide and herbicide – non degradable solids, biomagnifications. Cosequence of land pollution-damage to soil and crops, heavy metals contamination.

Unit II

6 Hours

Biofertilizers-classification, nitrogen fixers-Rhizobium, Azotobacter, Cyanobacteria, Azolla, Frankia, Azospirillum and Vasicular Mycorrhizae.

Unit III

6 Hours

Organic farming-definition, basic concept of organic farming, integrated plant nutrient supply management, integrated insect pest and disease management- sustainable agricultural practice-crop rotation, crop diversification, mixed cropping, #biological nitrogen fixation#.

Unit IV

6 Hours

Management of organic waste and green manure-Farm manures, composts, Mulches, Tillage and control. Organic manures-organic residue, chemical nature of organic manure, #green manure, importance of green manure#.

Unit V

6 Hours

Animal based organic manure-cow dung, poultry waste, Production of vermicompost and Panchakavya, production and commercialization of Organic products – conversion period, Inspection and certification (National and International Level).

#...# Self - study portion

Text Books:

1. Sharma, A.K., Biofertilizers for sustainable agriculture, Agrobios. (2003).
2. Aravind Kumar, Verms and Vermitechnology, APH Publishing Corporation, New Delhi, (2005).
3. Veeresh, G.K., Organic Farming, Foundation Pvt.Ltd., (2006).

Unit I Chapter – 1 and 3. T.B -1
Unit II Chapter – 6 and 9. T.B -1
Unit III Chapter – 7. T.B -1
Unit IV Chapter – 8. T.B -2
Unit V Chapter – 5. T.B -3

Books for References:

1. NIIR Board, The Complete Technology Book on Biofertilizer and organic farming, National Institute of Industrial Research, (2004).
2. Online Resources.

<http://ec.europa.eu/agriculture/organic/organic-farming/what-organic-en>.
<http://attra.ncat.org/organic.html#list>
<http://www.epa.gov/agriculture/tbio.html>

**SEMESTER V: CORE - IX
PLANT BIOTECHNOLOGY**

Course Code: 17UBT5C9
Hours/week: 6
Credit: 5

Max. Marks: 100
Internal Marks: 25
External Marks:75

Objectives:

To study the principles and techniques involved in plant tissue and the concepts of transformation and achievements of biotechnology in Plants.

UNIT I

18 hours

Introduction: History of plant tissue culture – laboratory organization – aseptic techniques – nutritional requirements and culture media – #Types of cultures# – Solid – Liquid.

UNIT II

18 hours

Micropropagation: Mass production of plantlets – hardening and mist chambers – techniques for maintaining plantlets in the field – Callus induction - somatic embryogenesis – induction of multiple shoots – production and exploitation of haploids and triploid – embryo rescue – protoplast culture, Somaclonal variations, #synthetic seeds#.

UNIT III

18 hours

Genetic Engineering in Plants: Molecular biology of Agrobacterium mediated DNA transfer- Ti plasmid Vectors- Technique of hairy root production. Physical method of transfer- Biolistics –Electroporation.

UNIT IV

18 hours

Selectable Markers: Reporter genes- Promoters used in Plant vectors genetic engineering for- heat, drought and saline tolerance - Virus resistance - Pest resistance - #Herbicide resistance#.

UNIT V

18 hours

Application of Plant Transformation and transgenic plants: Insect (pest) resistance – Virus resistance- fungal and bacterial disease – Herbicide resistance – Tolerant to water deficit stresses – genetic engineering for extended shelf life of fruits – Golden rice, #Delayed fruit ripening#.

#...# *Self -study portion*

Text Books:

- T.B. 1. Kalyankumar De. An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata. (2007).
- T.B. 2. Satyanarayana U., Biotechnology, Books and Allied P.Ltd, Kolkata. (2015).

Unit I – Chapter 1, T.B. 1

Unit II – Chapter 2 - 14, T.B. 1

Unit III – Chapter 7, section 49, T.B. 2

Unit IV – Chapter 7, Section 50, T.B. 2

Unit V – Chapter 7, Section 51, T.B. 2

Books for References:

1. Bernard R. Glick and Jack J. Pasternak. Molecular Biotechnology, Principles and applications of recombinant DNA technology. ASM Press Washington DC. (2015)
2. Bhojwani, S.S. and M.K. Razdan Plant Tissue culture: theory and practice a revised edition Elsevier science. (2014).
3. Chrispeels, M.J. and D.F. Sadava. Plants- Genes and Agriculture Jones and Bartlett. (1994).
4. Dixon, R.A. and R.A. Gonzales. Plant cell culture, IRL press. (2012).
5. Erbisch, F.H. and K.M. Mareida. Intellectual property in agricultural Biotechnology, Edited by, University Press. (2000).
6. Glick and Paster mark Molecular Biotechnology by Panima. (2002).
7. Hammond, J., P. McGarvey and V. Yusibov (eds). Plant Biotechnology – New products and Applications. By Springer Publication, (2012).

SEMESTER V: CORE - X
ANIMAL BIOTECHNOLOGY

Subject code: 17UBT5C10

Hrs/week: 5

Credit: 5

Max Marks: 100

Internal Marks: 25

External Marks: 75

Objectives:

To provide an overview and current developments in different areas of animal biotechnology for development in animal breeding, reproductive technology and cloning of the cells, To study about the structure of cell, method and maintenance of the cell culture that increases the life span.

UNIT I

15 hours

Structure and organization of animal cell, cell physiology. Equipments and materials for animal cell culture technology. Laboratory design and practice. #Aseptic Technique for cell cultures#; Identification and characterization of contaminations. Cryopreservation.

UNIT II

15 hours

Preparation and Sterilization of cell culture media and reagents. Introduction to the balance salt solutions and simple growth medium. Growth factors promoting proliferation of cells. #Chemical, physical and metabolic functions of different constituents of culture media#. Role of carbon dioxide in animal cell culture.

UNIT III

15 hours

Role of serum and supplements, Serum and protein free defined media and their applications. Primary cell culture techniques, establishment and maintenance of cell line culture, Measurement of viability and cytotoxicity. Biology and characterization of cultured cells, #Application of animal cell culture#.

UNIT IV

15 hours

Embryo Technology and Animal Breeding- *In vitro* fertilization, Embryo transfer, ICSI, Embryo splitting, Fertility control and regulation, test tube babies. Animal cell cloning, #Transgenic animals-sheep, goat, Mice, fish#.

UNIT V

15 hours

Sericulture and Aquaculture: Types of silk, Stages of Production, life cycle of silkworm and Biotechnological applications in sericulture. Aquaculture, principles, methods and culturable species, Freshwater and marine Aquaculture, Aquaculture nutrition- live and supplementary nutrition, Value added fishery products, #Genetic modifications in aquaculture#.

#...# Self study portion

Text Books:

1. John and Masters, R.W., “Animal Cell Culture - Practical Approach”, 3rd Edition. Oxford University Press. (2000).
2. Pillay, T.V.R. and Kutty, M.N., “Aquaculture; principles and practices” Blackwell publication Pvt. Ltd., (2005).

UNIT 1: Chapter 4 T.B 1

UNIT 2: Chapter 8 T.B 1

UNIT 3: Chapter 9 T.B 1

UNIT 4: Chapter 13 T.B 1

UNIT 5: Chapter 2 T.B 2

Books for References:

1. Ian Freshney, R., “Culture of Animal Cells – A manual of Basic techniques”. Wiley Publication Pvt. Ltd., (2005).
2. Yadav, P.R. and Rajiv Tyagi., “Biotechnology of Animal Tissue”, Discovery Publishing House, New Delhi. (2008).

ENVIRONMENTAL BIOTECHNOLOGY

Subject code: 17UBT5C11

Hrs/week: 5

Credit: 5

Max Marks: 100

Internal Marks: 25

External Marks: 75

Objectives: To study the basic concept and issues of environmental pollution biotechnological treatment to clean up polluted environments and to create valuable resources for the human society.

UNIT I BASIC CONCEPTS AND ISSUES: Types of pollution methods for measurement of pollution, methodology of environmental management- the problem solving approach and its limitations. Global environmental problems- Ozone depletion, climate change, #Green house effect#, Acid rain, global warming, sea level raising, El Nino Southern Oscillation. **15 Hours**

UNIT II POLLUTION: Primary, secondary and tertiary methods for water pollution treatment. Waste water treatment of some industries: Waste water treatment for tannery, dairies, distillery, textile, pulp, paper and Antibiotics. **15 Hours**

UNIT III BIODEGRADATION: Biodegradation and xenobiotics in environment: Ecological considerations, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants. Biodegradation of plastics, #Biosensors#. **15 Hours**

UNIT IV PHYTOREMEDIATION: Process of phytoremediation - Rhizofiltration, Phytostabilization, phytodegradation, phytovolatilization, phytoaccumulation, phytochelation, biotrasformation, Cellur and subcellular compartmentalization. Phytoremediation of heavy metals from soil, Phytoremediation of heavy metal from water, phytoremediation of soil polluted with herbicides and pesticides. **15 Hour**

UNIT V BIOLEACHING: Leaching of ores by microorganisms (gold, copper and uranium). Environmental significance of genetically modified (GM) microbes, plants and animals. #Waste disposal and management, legislation of environmental problems#. Microbial association in environment. **15 Hours**

#...# *Self -study portion*

Text Books:

- T.B. 1. A.K. Chatterji. Environmental Biotechnology, Prentice Hall of India Pvt. Ltd. (2007).
- T.B.2. K. Pradipta.Environmental Microbiology, I.K International Publishing House Pvt. Ltd. (2008).
- T.B.3. Environmental Science and Biotechnology, Saras Publication. (2008).
- T.B.4. V. Kumaresan.A Text Book of Biotechnology, Saras Publication. (2009).

Unit I Chapter I, T.B. 3

Unit II Chapter XII, T.B.2

Unit III Chapter XIII, XIV, T.B.4

Unit IV Chapter XIII, XIV, T.B. 4

Unit V Chapter VIII, T.B.4

Books for References:

1. Agarwall K.V., Environmental Biotechnology, Nidhi Publishers. (2005).
2. Chatterji, A.K., Introduction to Environmental Biotechnology, Prentice-Hall of India. (2002).
3. Eugenia J.Olguin and Taylor and Francis.. Environmental Biotechnology and cleaner Bioprocesses, (2000).
4. Murugesan, A.G andC.Rajakumari,.Environmental Science and Biotechnology: theory and Techniques. (2005).
5. William P. Conningham and Mary Ann Conningham. Principle Environmental Science , Tata McGraw-Hill publishing Company. (2003).

**PLANT BIOTECHNOLOGY, ANIMAL BIOTECHNOLOGY AND ENVIRONMENTAL
BIOTECHNOLOGY - PRACTICAL**

Course Code: 17UBT5C12P
Hours/week: 5
Credit: 5

Max Marks: 100
Internal Marks: 20
External Marks: 80

PLANT BIOTECHNOLOGY

1. Laboratory organization and Introduction to plant tissue culture techniques
2. Plant tissue culture media preparation.
3. *In vitro* Seed Germination.
4. Micropropagation- Shoot induction- multiplication- root induction and hardening.
5. Callus induction – leaf and stem
6. Haploid plant production using anther explants.
7. Protoplast isolation using mechanical method.
8. Agrobacterium-mediated transformation - Demonstration

ANIMAL BIOTECHNOLOGY

1. Preparation of animal cell culture medium
2. Preparation of single cell suspension from animal tissue
3. Preparation of animal cell monolayer
4. Sub culturing of cell lines
5. Cell counting- quantitation of cells in culture
6. Cell viability assay

ENVIRONMENTAL BIOTECHNOLOGY

1. Estimation of Dissolved Oxygen in water
2. Determination of Total hardness in water
3. Analysis of Carbonates and bicarbonates in water and soil sample
4. Estimation of Calcium and Magnesium in water and soil sample.

Books for References:

1. Kalyankumar De. An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata. (2007).
2. Agrawal K.C., Environmental Biotechnology, Nidhi Publishers (India), Bikaner. 2004.
3. Nigel Jenkins, “Animal cell biotechnology methods and protocols”, 1st Edition 1, Humana press, (1997).
4. John R.W. Masters., “Animal cell culture”, 3rd Edition, Oxford university press. (2004).

**SEMESTER V: MAJOR BASED ELECTIVE - I
PHARMACOGNOSY AND PHARMACOLOGY**

Course Code: 17UBT5M1A
Hours/week: 5
Credit: 5

Max. Marks: 100
Internal Marks: 25
External Marks: 75

Objectives:

- To educate the students on the basic principles and methodology involved in Pharmacognosy and Pharmacology.
- To gain knowledge concerned with medicinal drugs obtained from plants or natural sources.
- To understand the general principles of drug action and handling of drugs by the body and the factors affecting the drug action in body and drugs used in disorders.

UNIT I

15 hours

Introduction: Definition, history, scope and development of Pharmacognosy. Sources of drugs: Biological, marine, geographical. Classification of drugs: Alphabetical, morphological, taxonomical and pharmacological classification, traditional and alternative systems of medicine and scheme for pharmacognostic studies of a crude drug.

UNIT II

15 hours

Cultivation, collection, processing and storage of crude drugs: factors influencing cultivation of medicinal plants. Types of soils and fertilizers of common use. Pest management and natural pest control agents. Biopesticides for crop protection and Indian trade in medicinal and aromatic plants.

UNIT III

15 hours

Extraction: Various methods of extraction of crude drugs namely infusion, decoction, percolation, maceration and factors affecting extraction process, phytochemical investigation, physical, biological evaluation and quality control of herbal drugs.

UNIT IV

15 hours

General Principle of pharmacology, sources of drugs. Routes of administration with special reference to their advantages and disadvantages. Tolerance and dependence, Drug ADME. Mechanism of drug action, pharmacogenetics and pharmacoinformatics.

UNIT V

15 hours

Factors modifying the actions of drugs, Drug toxicity in humans-toxic effects of drugs LD₅₀, ED₅₀. Purgatives and antidiarrheals, antispasmodics, herbal drugs used in the treatment of hyperacidity, wound healing, inflammation, analgesic, pyretic, diabetic and cancer.

#...# *Self-study portion*

Text books:

1. Gokhate, S. B., Purohit, A. P., Kokate, C. K., “Pharmacognosy”, Nirali; Pharmacognosy edition. (2008).
2. Satoskar, “Pharmacology and Pharmacotherapeutics”, 24th edition Elsevier Health – INR. (2015).

Unit-1 Chapter 1 A, B, C, D T.B.1

Unit-2 Chapter 2, 3, 4 A, B T.B.1

Unit-3 Chapter 6, 7 T.B.1

Unit-4 Chapter 1,2 T.B.2

Unit-5 Chapter 3, 4 T.B.2

Books for References:

1. Simone Badal McCreath and Rupika Delgoda, “Pharmacognosy: Fundamentals, Applications and Strategies” 1st edition, Academic press (2016).
2. Randa Hilal- Dandan and Laurence L. Brunton., “Manual of Pharmacology and Therapeutics” 2nd edition, McGraw Hill Professional (2013).

SEMESTER V: MAJOR BASED ELECTIVE - I GENOMICS AND PROTEOMICS

Course Code: 17UBT5M1B
Hours/week: 5
Credit: 4

Max. Marks: 100
Internal Marks: 25
External Marks: 75

OBJECTIVE:

On completion of this course, the student will be able to understand the principles, various databases and tools associated with genomics and proteomics.

15 Hours

UNIT I GENOMICS: NUCLEOTIDE SEQUENCE DATABASES, ANALYSIS GENE IDENTIFICATION - Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences. Sequence databases: GenBank, EMBL, DDBJ, database formats.

15 Hours

UNIT II FUNCTIONAL GENOMICS AND DNA MICROARRAY- Introduction, concept of microarrays; spotted arrays, oligonucleotide arrays, designing the experiment, Two-color microarray experiments, Clustering gene expression profiles; Agglomerative, Hierarchical, Nearest neighbour (Single-linkage), complete-linkage, average-linkage, weighed pair-group, k-means clustering, self-organizing maps (SOM) clustering, Tools for microarray analysis; soft-finder, xCluster, MADAM, SAGE, #Microarray design, microarray experimentation, fabrication computational analysis of Microarray data, Applications of microarray technology#.

15 Hours

UNIT III PROTEOMICS - Protein Sequence Databases and Analysis - Protein sequence information, composition and properties, sequence comparison; Primary and Secondary databases. Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250, BLOSUM62, local and global sequence alignment, multiple sequence alignment, Protein Microarray- Proteomics classification; Tools and techniques in proteomics; 2-D gel electrophoresis, PAGE, isoelectric focusing, Mass spectroscopy for protein analysis, #MALDI-TOF, Tandem mass spectroscopy (MS/MS) analysis; Protein Micro array *in protein* expression, profiling and diagnostics, drug target discovery. Database searching - 3-dimensional structure determination by X-ray and NMR#.

15 Hours

UNIT IV **PHYLOGENETIC ANALYSIS** - Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, comparison of genetic sequence of organisms, phylogenetic analysis tools-Phylip, ClustalW; Comparative Transcriptomics-Differential Gene expression, Transplastomics.

15 Hours

UNIT V **PHARMACOGENETICS:** High Throughput Screening for Drug Discovery-Identification of Drug targets, Pharmacophore, Pharmacogenetics and Drug development. ADME Properties, Metabolome and Metabolomics. Systems Biology - Model systems. Global databases and analysis and statistical Modelling; Drug Discovery And Computer - Aided Drug Designing: Introduction, drug discovery area, pharmacogenetics and pharmacogenomics applications, SNPs, parameters in drug discovery identification of drug target molecules, drug design and its approaches, computer-aided drug designing methods; computer aided molecular design (CAMD), #Quantum CAChe and project leader, ligand design methods, docking programs; De novo design#.

#...# Self study portion

Text Books:

1. Cantor C and Smith CL., Genomics: The Science and technology behind the human genome project, Wiley-Inter science, New York, (2000).
2. Davis JM., Genome Analysis - A practical Approach, Oxford University press, Oxford. (1995).
3. Dear PH., Genome Mapping A practical Approach, Oxford University press, Oxford. (1997).

Unit-1 Chapter 1 T.B.1

Unit-2 Chapter 3, 4 T.B.1

Unit-3 Chapter 6, 7 T.B.2

Unit-4 Chapter 1,2 T.B.2

Unit-5 Chapter 3, 4 T.B.3

Books for Reference:

1. Chirikjian JG., Biotechnology: Theory and Techniques, Mc Graw Hill Publication. (1995).
2. Serre JL. Diagnostic Techniques in Genetics, John Wiley & Sons. (2007).
3. Katoch R, Springer. Analytical Techniques in Biochemistry and Molecular Biology. (2011).

SEMESTER V: SKILL BASED ELECTIVE - II
BIOSTATISTICS AND COMPUTER APPLICATIONS IN BIOLOGY

Subject code: 17UBT5S2A

Hrs/week: 2

Credit: 2

Total Marks: 100

Internal Mark: --

External Mark: 100

Objectives:

This course aims to providing basic knowledge of computer and operating systems and their application in biological sciences such as packages related to data analysis, data processing and generating graphs. It also provides sufficient knowledge on the recent advances in computer application in biology filed.

6 Hours

UNIT I: Measures of central tendency – mean, median and mode, Measures of dispersion – range, variance, standard deviation, Theories of probability, Students t-test, chi square test for goodness of fit - #statistical error (definition and types) SPSS #.

6 Hours

UNIT II: Introduction to Computers: Types of Computer, Classification of Computers, Hardware and Software, Programming Languages: Machine Language, Assembly Language , Memory – ROM and RAM, Mass Storage Devices–# Input and Output Devices#.

6 Hours

UNIT III: Internet and world wide web, Client- server organization, FTP, HTTP, Telnet, protocols, Concepts of mail servers and clients, Browsers and mail managers, #Netscape and Internet explorer, Internet domain#.

6 Hours

UNIT IV: Types of operating systems: Office automation tools- Introduction to MS DOS Office automation tools: MS words, MS excel and MS power point – Introduction to windows operating system. Application in biological science.

6 Hours

UNIT V: Web media – networks and application, FAX, voice and information services, Communication Processors, #person to person communication (internet, E-mail, teleconferencing), exchanging files#.

#...# *Self -study portion*

Text Books:

1. Peter Norton Introduction to computers. Tata Mc-Graw Hill Publication Ltd., New Delhi. (2006).
2. Pillai R.S.N., Bagavathi V and S.Chand Statistics S.Chand and Company Ltd., New Delhi. (1984).
3. Sinha P.K., Computer Fundamentals concepts, Systems and Applications, (1990).

Unit I Chapter 9 Section 121, 228. T.B-1

Unit II Chapter 1 Section 3-10 T.B-2

Unit III Chapter 8 Section 285- 292 T.B-1

Unit IV Chapter 6 Section 205-208 T.B-1

Unit V Chapters 16 Section 203- 210 T.B-2

e-book

1. Foundational and Computational Statistics Succinctly.
2. IHM BHUBANESWAR Computer Application (2013).

Books for Reference:

1. Glovery & Mitchell an Introduction to Biostatistics, (2009).
2. Sawyer Williams and Hutchinson. Using Information Technology, McGraw Hill, (1999).

SEMESTER V: SKILL BASED ELECTIVE - II

FORENSIC SCIENCE

Subject code: 17UBT5S2B
Hrs/week: 2
Credit: 2

Max Marks: 100
Internal Marks: --
External Marks: 100

Objectives: To study the sociological aspects, molecular mechanisms and its application in forensic science.

Unit I: Crime Scenario in India: Introduction to crime and history, Sociological aspects of crime and criminals in society, Types of crime and its causes – property crimes, public order crimes, violent crimes, #cyber-crimes. **6 Hours**

Unit II: Forensic Examination of Body and Semen Fluids: Molecular mechanisms for identification of the evidences from the criminal. **6 Hours**

Unit III: Forensic Examination of Hair and Tissue: Molecular mechanisms for identification of the evidences from the criminal#. **6 Hours**

Unit IV: Personal Identification: Personal identification techniques as somatoscopy, somatometry, #osteometry and craniometry their importance in determination of age and sex. **6 Hours**

Unit V: Techniques and Applications: New and future technologies - #DNA chips - SNPs and limitations of DNA profiling. Application of Molecular techniques to Forensic. **6 Hours**

#...# *Self -study portion*

Text Books:

1. Dr. Rukmani Krishnamurthy. Introduction to Forensic Science in Crime Investigation. Selective and scientific books publishers and distributors, New Delhi. (2005).
2. Kirby, LT. DNA Fingerprinting Technology. Palgrave Macmillan UK. (2009).

Unit I – Chapter 3, T.B. 1

Unit II – Chapter 4 - 14, T.B. 1

Unit III – Chapter 6, section 49, T.B. 2

Unit IV – Chapter 7, Section 50, T.B. 2

Unit V – Chapter 8, Section 51, T.B. 2

Books for Reference:

1. Richard Saferstein. Criminalistics: An Introduction to Forensic Science, 9th Ed. (2001).
2. Sharma, B.R., Forensic Science in Criminal Investigation and Trial, 4th Ed. (2008).
3. Stern C, Principles of Human Genetics, Freeman, California. (2012).

**SEMESTER V: SKILL BASED ELECTIVE - III
TRANSGENIC FOODS**

**Course Code: 17UBT5S3A
Hours/week:2**

**Max Marks:100
Internal Marks: -**

Objectives:

- The students will learn the applications of transgenic foods from living organisms.

6 Hours

Unit I: Transgenic plants: Green revolution – Selected examples of crops for quality and yield – Genetic engineering for extended shelf-life of fruits – Biochemical changes during tomato ripening – Genetic manipulation of fruit ripening – Longer shelf-life of fruits and vegetables, *Bt* – Brinjal.

6 Hours

Unit II: Transgenic plants with improved nutrition: Amino acids of seed storage proteins – Transfer of genes encoding methionine rich proteins – Production of lysine-rich glycine in rice – Construction of artificial genes to produce proteins rich in Enhancement of essential amino acids (EAAs) – Genetic engineering for improving palatability of foods – Golden rice-the provitamin A enriched rice.

6 Hours

Unit III: Transgenic Animals: Importance of transgenic animals – Milk as the medium of protein production - Transgenic cattle – Transgenic sheep and goats – transgenic pigs – Transgenic animals as bioreactors for the production of therapeutically improved proteins - Transgenic chickens-Transgenic fish.

6 Hours

Unit IV: Genetically engineered microorganisms for chymosin – genetically engineered strains of *Saccharomyces cerevisiae*-the key organism for the production of alcoholic beverages – genetically engineered artificial protein as animal feed.

6 Hours

Unit V: Benefits of Biotechnology – ELSI of Biotechnology – Risk and ethics of biotechnology –Genetic modifications and food consumption – Recombinant foods and religious belief – eating gene every day – about GM foods safety.

References:

1. U. Satyanarayana, Biotechnology, Uppala Author-Publisher Interlinks, 2005.

Unit I – Chapter 50, T.B. 1

Unit II – Chapter 50, T.B. 1

Unit III – Chapter 41, T.B. 1

Unit IV – Chapter 44, T.B. 1

Unit V – Chapter IX, T.B. 1

Books for Reference:

8. Bernard R.Glick and Jack J.Pasternak. Molecular Biotechnology, Principles and applications of recombinant DNA technology. ASM Press Washington DC.(2001)
9. Yadav, P.R. and Rajiv Tyagi., (2008), “Biotechnology of Animal Tissue”, Discovery Publishing House, New Delhi.

FRONTIERS IN BIOTECHNOLOGY

Subject Code :	17UBT5S3B	Max Marks	:	100
Hours/Week :	2	Internal Marks	:	-
Credit :	2	External Marks	:	100

Objectives: To study the major aspects and its application in the field of biotechnology.

6 Hours

UNIT I FOOD BIOTECHNOLOGY: Origin, scope and development. Fruits: Preservation vegetables, cereals, pulses, nuts, oils and fats in foods. Processing of beverages: Coffee, tea, cocoa, soft drinks, fruit juices. Fermented products: Dairy products. #Fermented vegetable products-Regulatory and social aspects of biotechnology of foods#, safety assessment of nutritionally improved foods and feeds developed through the application of modern biotechnology.

6 Hours

UNIT II CANCER BIOLOGY: Introduction: cancer cell and its properties, Classification of cancer (carcinoma, sarcoma, leukemia, lymphoma), Clonal nature of cancer, Cell cycle (Phases of cell cycle, cyclins and CDKs G2/M checkpoint). Mechanisms: Chemical carcinogenesis (initiation, promotion and progression), Radiation and cancer, genetic effects of ionizing radiation, oncogene activation (c-MYC, RAS superfamily, BCL-2 family) #Apoptosis (Extrinsic and intrinsic pathways)#.

6 Hours

UNIT III STEM CELLS: Definition, classification and sources. Need for stem cell research. Role of stem cell in basic research. Human Embryonic Stem cells: Maintenance – culture - sub cloning - spontaneous and controlled differentiation. Clinical applications of hESCs. #Haemopoietic stem cells: Definition, isolation, Clinical applications of Hematopoietic stem cells#.

6 Hours

UNIT IV BIOTECHNOLOGY IN TEXTILES: Fibre preparation – retting process, enzymes in retting process, carbonization-enzyme application; Fabric preparation – desizing of fabric- Enzymes in fabric preparation - amylase, cellulase, pectinase, Catalase, lipase; oxidoreductases in fabric preparation – laccase, peroxidases, #Fabric finishing – using enzymes, Wool processing applications – degumming of silk; textile after-care –enzymes in laundry detergents – alternative to sodium perborate#.

6 Hours

UNIT V CLINICAL RESEARCH: The History of the Legislation and Regulations, which Govern the Clinical Research Process; which Protect the Rights, Safety, and Well-Being of Human Subjects. Drug Discovery and Pre-Clinical Research: The Clinical Research and New Drug Application Approval Process; #The Biologics Research, Development, and Licensing Process; Medical Device Research and Development#.

.....# Self study portion

Text Books:

1. Bibek Laramie and Bhunia., Fundamentals of Food Microbiology - CRC Press. (2003).
2. Rudson R.W., Cancer Biology, 2nd edition, Oxford University Press, (2015).
3. Stella Pelengaries and Michael Khan., The molecular biology of Cancer. Blackwell Publishing, (2006).
4. Corbman .B.P, Textile – Fiber to Fabric Third Edition, International Students Edition, McGraw Hill, Book Co, Singapore, (2001).
5. Boisseau, P. Houdy and Lahmani M., Nanoscience: Nanobiotechnology and Nanobiology, Springer-Verlag Berlin Heidelberg, New York. (2010).

Unit I : Chapter 1, T.B-1,Chapter A-1,T.B-1

Unit II : Chapter 13, 16, 18, 22, T.B-1,Chapter A-2, T.B-2

Unit III: Chapter 2, T.B-3

Unit IV: Chapter C-2, D-1, T.B-4

Unit V : Chapter C-2, T.B-5

Books for Reference:

1. Siva B., Food Processing & Preservation –PHI Learning Pvt Ltd. (2011)
2. Gordon Cook J., “Hand book of textile fibers” VOL-Ii Manmade Fibers, Wood Head Publishing, (2010).
3. Corbman .B.P, Textile – Fiber to Fabric Third Edition, International Students Edition, McGraw Hill, Book Co, Singapore, (1985).
4. Hester, R.E., R.M. Harrison., Nanotechnology: Consequences for Human Health and the Environment, The Royal Society of Chemistry, UK. (2007)

SEMESTER V: EXTRA CREDIT - I

ETHNOBOTANY AND HERBAL MEDICINE

Course Code: 17UBT5EC1

Hours/week: --

Credit: 4*

Max Marks: 100

Internal Marks: --

External Marks: --

Objective:

To understand the basic knowledge about Ethnobotany and Herbal Medicine Preparation for human health.

UNIT I

Basic Knowledge of tribes in India and Tamil Nadu. Tribal knowledge towards disease diagnosis, Treatment with medicinal plant, Plant conservation and cultivation. Herbal Medicinal practice in your native place.

UNIT II

Importance of ethnobotany in Indian systems of medicine (Ayurveda, Unani, Siddha and Herbal). Anthropological relationship with sacred grooves.

UNIT III

Herbal Preparation, Collection of Wild herbs, Hydrotherapy, Herbal Oil, Liquid extract of medicinal plants.

UNIT IV

Extraction of Phytoconstituents from medicinal plants: Alkaloids, flavonoids, phenolic compounds, Volatile Oils, Resins and Tannins.

UNIT V

Introduction, Origin and basic notion of ethnobotanical study – Ethnobotany as an emerging science and its scope; Ethnobotany in India and Tamil Nadu.

Text Books:

1. Jain S K. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow, (1989).
2. Pal, D C and Jain S K.. Tribal Medicine. NayaPrakash Publishers, Calcutta, (1998).
Unit I Chapter I, T.B-1
Unit II Chapter II, T.B-1
Unit III Chapter VI, T.B-1
Unit IV Chapter II, T.B-2
Unit V Chapter II, T.B-2

Books for Reference:

1. Wallis, T.E.. Text book of Pharmacognosy, J and A Churchill Ltd. (1946).

**SEMESTER – VI: CORE - XIII
BIOPROCESS TECHNOLOGY**

Course Code: 17UBT6C13
Hours/week: 5
Credit: 5

Max. Marks: 100
Internal Marks: 25
External Marks: 75

OBJECTIVE:

On completion of this course, the student will be able

- To comprehend the microbial exploitation in bioconversion technology.
- To understand the various downstream processing methods and production of industrially significant products in fermentation.

UNIT I: 15 Hours
Introduction and Microbiology of Fermentation: Fermentation Microbiology - Historical Perspectives, Microbial biomass, Microbial enzymes and metabolites, Growth cycle, Diauxic growth, cultivation of microbes, Current advances and innovations in fermentation industry.

UNIT II: 15 Hours
Fermentation kinetics and Bioreactors: Kinetic models - Unstructured, Compartment, Single-cell, Molecular mechanistic models. Bioreactors - Batch operation, Continuous operation, Fed - batch culture, Oxygen transfer, Different types of bioreactors, Aeration and Agitation systems, Immobilized cells, Selection of the reactor, #Reactors in Industry#.

UNIT III: 15 Hours
Microbial synthesis of Primary metabolites: Technical Processes, Control of Primary metabolism - Induction, Catabolite repression, Source regulation - Nitrogen, Phosphorus and Sulfur, Feedback regulation, Products - Organic acids, Amino acids, Polysaccharides, Vitamins, #Alcohols and solvents#.

UNIT IV: 15 Hours
Microbial synthesis of Secondary metabolites and Strain Improvement: Process of Secondary metabolite production, Nutrient limitation. Strain Improvement - Random and Recombinant DNA approach, Media formulation. Antibiotics and Secondary metabolites - Penicillins, Cephalosporins, Aminoglycosides and Tetracyclines.

UNIT V: 15 Hours
Downstream Processing and Enzyme Production: Product Recovery and Purification - Microbial cell removal, Foam Separation, Precipitation, Filtration, Centrifugation, Cell disruption, Chromatography, Ultrafiltration, Crystallization. Enzymes - sources, surface and submerged cultures, Industrial enzymes - Proteases, Amylases, Pectinases, Cellulases, β -galactosidase.

#...# *Self - study portion*

Text Books:

1. Stanbury PF, Whitaker A, Hall SJ., Principles of Fermentation Technology, 2nd Edition, Aditya Books (P) Ltd, New Delhi, (1997).
2. Prave P, Faust U, Sittig W, Sukatsch DA., Fundamentals of Biotechnology, Panama Publishing Corporation, Bangalore, (2005).
3. El-Mansi EMT, Bryce CFA, Demain AL, Allman AR., Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor and Francis Group, New York, (2007).

UNIT 1: TB.1, Chapter - 1, Page No. 1-9. TB.3, Chapter - 1 & 2, Page No. 1-36.

UNIT 2: TB.1, Chapter - 2, Page No. 13-31. TB.1, Chapter - 7, Page No. 167-210.

TB.2, Chapter - 6, Page No. 179-216. TB.3, Chapter - 3, Page No. 47-95.

UNIT 3: TB.2, Chapter - 11, Page No. 437-459.

UNIT 4: TB.2, Chapter - 13, Page No. 516-541. TB.3, Chapter - 5, Page No. 131-156.

UNIT 5: TB.1, Chapter - 10, Page No. 277-307. TB.2, Chapter - 12, Page No. 474-506.

Books for References:

1. Glazer AN, Nikaldo H Microbial Biotechnology, W H Freeman and company Network, (1995).
2. Flickinger MC, Drew SW., Encyclopedia of Bioprocess Technology, John Wiley & Sons, (1999).
3. Demain AL, & Davis JE. Industrial Microbiology & Biotechnology, ASM Press, (2004).

DEVELOPMENTAL BIOLOGY AND HUMAN PHYSIOLOGY

Course Code: 14UBT6C14

Hours/week: 5

Credit: 5

Max. Marks:100

Internal Marks: 25

External Marks: 75

Objective:

On completion of this course, the student will be able

- To comprehend the theories and various processes involved in the development of organisms.
- To comprehend the functions of different organs and organ systems involved in human physiology.

UNIT I:

15 hours

Phenomena of Development: Theories - Preformation, Epigenesis, Recapitulation. Gametogenesis - Spermatogenesis, Oogenesis, Ovulation, Structure and functions of Spermatozoa and egg in mammals.

UNIT II:

15 hours

Fertilization and other phases of Development: Fertilization - Involvement of physical, chemical and cytological factors, Physiological changes and activation. Parthenogenesis, Cleavage, Germinal layers, Blastulation, Gastrulation, Neurogenesis. Placenta - characteristics, classification, development and functions.

UNIT - III:

15 hours

Circulatory and Respiratory system - Human Circulatory system - Structure and functions, circulatory organs, circulation, hemoglobin, components and functions of blood. Respiratory system: Structure, types and functions, Respiratory organs, Mechanism of Respiration, CO₂ and O₂ transport, #regulation of respiration#.

UNIT - IV:

15 hours

Digestive and Excretory system: Human Digestive system - Organization, Digestive glands and enzymes, Absorption of Nutrients. Excretory system - Excretory organs and products, Mechanism of Urine and Urea formation, #Kidney stones#.

UNIT - V:

15 hours

Nervous and Reproductive system: Human Nervous Coordination: Central and peripheral nervous systems, structure and functions of neurons and brain, Conduction of Nerve impulse. Reproduction - Male and Female Reproductive systems, Fertilization, Estrus and Menstrual cycles, #Pregnancy and Parturition#.

#...# Self - study portion

Text Books:

1. Arumugam N., Developmental Biology, Saras Publication, Nagercoil, India. (2004).
2. Eckert Roger, Randall D.,. Animal Physiology, CBS Publishers and Distributors Pvt Ltd, India, (2005).
3. Mariakuttikan A, Arumugam N., Animal Physiology, Saras Publication, Nagercoil, India. (2011).

UNIT 1: TB.1, Chapter - 1 to 5, Page No. 1-39.

UNIT 2: TB.1, Chapter - 6 to 12, Page No. 40-97.

UNIT 3: TB.3, Chapter - 8, Page No. 240-294. Chapter - 6, Page No. 200-228.

UNIT 4: TB.3, Chapter - 4, Page No. 66-109. Chapter -11, Page No. 309-333.

UNIT 5: TB.3, Chapter - 13, Page No. 381-428. Chapter - 21, Page No. 515-555.

Books for References:

1. Saunders, J.W., Developmental Biology - Patterns and Principles, Macmillan, New - York. (1982).
2. Verma S, Agarwal VK Chordate Embryology, S.Chand & Co., New Delhi, (2000).
3. Rastogi SC Essentials of Animal Physiology. New Age International Publishers., (2001).

Subject code: 17UBT6C15

Hrs/week: 5

Credit: 5

Total Mark: 100

Internal Marks: 25

External Marks: 75

Objective: This paper introduces the modern fields of Bioinformatics and helps the students to understand the range of applications of biological software's fields.

15 Hours

Unit I: Introduction: Bioinformatics – scope, history and application of Bioinformatics, Emerging areas in Bioinformatics. Introduction to Genomics and Proteomics, Human Genome Project, Biological Software, # Public Database- GenBank, Current Status of Bioinformatics.

15 Hours

Unit II: Workstation: Bioinformatics workstation, Unix system, Scripting languages- Perl and Python, markup languages- HTML, XML. General Purpose Language C Language, Types of Operator, Array, Function and Structure. #Basic ideas of C++ and Java based object oriented programming#.

15Hours

Unit III: Biological sequences and Databases: Introduction to Database Management System. Biological sequences databases – including proteins and nucleic acids sequence – EMBL, DDBJ. Structure databases- CATH, SCOP, Specialized database –Genome data base, #EST- Phylogenetic analysis: PAUP and PHYLIP, Genome Database: GOLD, #.

15 Hours

Unit IV: Database searches and sequence alignment: Database searches: FASTA and BLAST, Sequence Alignment- Pair wise sequence alignment and multiple sequence alignment. Sequences retrieval from database - NCBI. # Protein sequence analysis - SwissProt and PDB,GEM Dock#.

15 Hours

Unit V: Applications: Introduction to Drug Design, Drug Design Approaches, and Computer-aided Drug Designing Methods. # Molecular modeling drug design, Molecular Docking, ChemSketch #,

#.....# *Self -study portion*

Text Books:

1. Attwood T.K & D J Parry Smith. Introduction to Bioinformatics Pearson Education Ltd., New Delhi., (2004).
2. Puneet Mehrotra, Dr. Kumud Sarin Swapna and K.Srivastava, The New Handbook of Bioinformatics., (2005).

Unit I Chapter 1 Section 1 -25. T.B-2

Unit II Chapter 1 Section 1-15 . T.B-2

Unit II Chapter 1 Section 1-12. T.B-1

Unit III Chapter 5 Section 93-123. T.B-2

Unit IV Chapter 6 Section 124-147. T.B-1

Unit V Chapter 16Section 351-364. T.B-2

Books for References:

3. Rastogi, S.C., N. Mendiratta, P. Rastogi,. Bioinformatics Methods and Application – Genomics, Proteomics and Drug Discovery, (2004).
4. Bioinformatics: Sequence, structure and databanks –Des Higgins & Willie Taylor – Oxford University Press, (2000).

PHYSIOLOGY, BIOINFORMATICS -PRACTICAL

Course code: 17UBT6C16P

Hrs/week: 5

Credit: 5

Total Mark: 100

Internal Mark:20

External Mark:80

OBJECTIVES:

On completion of this course, the student will be able

- To understand the principle of bioreactor operating system and exploitation of industrially important microbes in bioconversion technology.
- To visualize the developmental stages of model organisms and to understand the physiology of animals.
- To understand the basic principle of Bioinformatics and Bioinformatics tools.

1. Isolation of antibiotic producing microbes from soil.
2. Effect of pH and temperature on microbial growth.
3. Fermentation of grape juice and production of wine.
4. Enzyme immobilization using sodium alginate.
5. Demonstration of bioreactor operating system.
6. Observation of developmental stages of frog embryo - blastula and gastrula.
7. Study of staging & staining of Chick embryos (18h, 24h, 48h, 72 h).
8. Estimation of Haemoglobin with the help of Haemoglobinometer.
9. Study of Internet resources in Bioinformatics- eg. NCBI,
10. Sequence alignment by BLAST.
11. Phylogenetic analysis using web tools.
12. Pair wise Sequence Alignment.
13. Multiple alignments- using CLUSTAL W
14. Program to convert DNA to RNA.
15. *Web Publishing*: Create a web page for your University / College using HTML. The opening page should provide hyperlinks to other pages (add animation and sound effects appropriately).

Book for References:

1. Stanbury PF, Whitaker A, Hall SJ. Principles of Fermentation Technology, 2nd Edition, Aditya Books (P) Ltd, New Delhi, (1997).
2. Tyler MS., Developmental Biology - A Guide for experimental study, 3rd Edition, Sinauer Associates Publishers, Sunderland, MA., (2000).
3. Balaguruswamy E., Programming in ANSI C- Tata McGraw Hill. (1992).
4. Attwood TK- Parry Smith DJ., Introduction to bioinformatics- Pearson Education Asia. (2001).
5. Rastogi S.C., Namita Mendiratta, Parag Rastogi., Bioinformatics Concepts, Skills & Applications, (2003).

SEMESTER VI: MAJOR BASED ELECTIVE - II CANCER AND STEM CELL BIOLOGY

Course code: 17UBT6M2A
Hrs/week: 5
Credit: 4

Total Mark: 100
Internal Mark:25
External Mark:75

Objectives:

1. To gain deep understanding on the basic processes related to the cancer, growth, causes, and its differentiation.
2. To study the multipotent and pluripotent stem cells from various sources, its application and regulation.

15 Hours

Unit I: Cancer: Definition, Description of cancer, Basic facts about cancer, cancer is clonal in origin, Hallmarks of Cancer, general classification of human cancers, microscopic and macroscopic features of neoplasm's, Grade and stage of neoplasm – Histologic grade of malignancy and tumor staging.

15 Hours

Unit II: Causes of Cancer: Theory of HITS, Chemical carcinogenesis – metabolic activation of chemical carcinogens (donors of simple alkyl group, cytochrome P-450 mediated activation), Mechanism of tumor initiation, promotion and progression. Irradiation carcinogenesis and viral carcinogenesis (Epstein Barr virus and Hepatitis virus).

15 Hours

Unit III: Molecular Genetics of Cancer – Oncogenes, Oncogene families, cell transforming ability of onc gene, functional classes of oncogenes, Characteristics of individual oncogene (ras and erbA). Tumor suppressor genes – suppressor genes (rb and p53). Cancer diagnosis – categories of tumor markers (nucleic acid based markers and gene expression microarray). Cancer prevention[#].

15 Hours

Unit IV: Stem cells: Introduction to stem cells, Definition, potency of stem cells, general classification and Sources (adult stem cell, hematopoietic stem cells, mesenchymal stem cells, umbilical cord stem cell and iPSC). Embryonic stem cells (ES) – Origins of mouse embryonic stem cells, derivation of embryonic stem cells, factors influencing ES cell derivation and [#]uses of embryonic stem cells[#].

15 Hours

Unit V: Clinical applications of stem cells: Role of stem cells (spinal cord injury, myocardial infarction and heart failure), Comparison of different sources of stem cells, Role of stem cells in basic research, Regulations of stem cell therapy – current regulatory system in India and permissive regulations in other countries, Stem cell ethics – religious and other ethical issues. .

#...# Self - study portion

Text Books:

T.B.1. Cancer Biology, Raymond W. Ruddon. Oxford University Press, USA, (2007).

T.B.2. Stem cell culture, Amita Sarkar. Discovery publishing house Pvt. Ltd. (2009).

T.B.3. Song Li, Nicolas L’Heureux, Jennifer Elisseeff, Stem cell and tissue engineering. World scientific Publishing Co Pvt Ltd. (2011).

T.B.4. Alok Sharma, Stem cell therapy in neurological disorders. Surekha press. (2015).

Unit I & Unit II – Chapter 1, 2. Page no: 3 – 55; Unit III – Chapter 5. Page no: 321 – 376.

T.B.1.

Unit II – Chapter 8. Page no: 157-186. T.B.2.

Unit IV – Chapter 1, 3, 4. Page no: 1-9, 31-41, 49-61. T.B.3.

Unit V - Chapter 6 & 9. Page no: 95-102, 159-173. T.B.3.

Unit V – Section B: 11, 12. Page no: 146 – 162; Section C: 20. Page no: 265-277. T.B.4.

Books for References:

1. Momna Hejmadi, Introduction to cancer biology. Momna Hejmadi & Ventus Publishing ApS. (2010).
2. Peter J.Quesenberry, Stem Cell Biology and Gene Therapy, 1st Edition, Willy-Less, (1998).

**SEMESTER VI: MAJOR BASED ELECTIVE – II
FOOD BIOTECHNOLOGY**

Subject code: 17UBT6M2B
Hrs/week: 5
Credit: 4

Max Marks: 100
Internal Marks: 25
External Marks: 75

Objectives: To study the principles of food processing, preservation and manufacture.

UNIT I: Microorganisms associated with food- bacteria, fungi & yeast (*eg.* fish, meat, vegetables and fruits). #Enzymes in food preparation. **15 Hours**

UNIT II: Food colors (natural & artificial food colourants) – carotenoids, anthocyanins and melanin. #Food flavoring agents. **15 Hours**

UNIT III: Food engineering operations: Characteristics of food rawmaterials, #preparative operations in food industry, cleaning of food raw materials, sorting of foods, grading of foods. **15 Hours**

UNIT IV: Food quality: Sensory evaluation of food quality, quality factors for consumer safety, food safety standards. *Food Safety and Standards Authority of India (FSSAI)*, #Hazard Analysis and Critical Control Point (HACCP) and #*Food and Drug Administration (FDA)*. **15 Hours**

UNIT V: Food preservation & Food spoilage- types. Canned foods. Food borne diseases. #Food adulteration. **15 Hours**

Self -study portion

Text Books:

1. Bibek Laramie and Bhunia. Fundamentals of Food Microbiology - CRC Press. (2003).
2. Michael P. Doyle and Larry. R. Food Microbiology – Fundamentals & Frontiers. ASM Press Catalog. (2006).

Unit I – Chapter 1, T.B. 1

Unit II – Chapter 3 - 14, T.B. 1

Unit III – Chapter 5, section 49, T.B. 1

Unit IV – Chapter 6, Section 50, T.B. 2

Unit V – Chapter 8, Section 51, T.B. 2

Books for Reference:

1. Rao D.G., Fundamentals of Food Engineering – PHI Learning Pvt Ltd. (2010).
2. Siva B., Food Processing & Preservation –PHI Learning Pvt Ltd. (2011).

**SEMESTER VI: MAJOR BASED ELECTIVE - III
IPR, BIOSAFETY AND BIOETHICS**

Course Code: 17UBT6M3A
Hours/Week: 4

Max. Marks: 100
Internal Marks: 25

Objectives:

- To study the intellectual property rights, biosafety of genetically engineered products and guidelines in India.
- To understand the ethical implications in Biotechnological applications.

UNIT –I**12 hours**

Meaning and Justification of patenting an invention: Introduction to Intellectual Property, Concept of IPR, Designs, TrademarksTM, Trade secret, Domain names, geographical indications and copyright. Evolution of patent laws, History of Indian patent system, International conventions and treaties, patent law in other countries.

UNIT –II**12 hours**

Classification of Patents: Classification of patents in India, WIPO, Categories of patents, special patents, provisional patents, patenting biological product. Grant of patent and patenting authorities: Invention, eligible criteria, patentable and non-patentable inventions in India and abroad, patent office and patent authorities.

UNIT –III**12 hours**

Introduction to Biosafety & Regulatory mechanism for GMO: Overview of Biosafety, risk assessment, Cartagena protocol on biosafety. International regulatory bodies, National regulatory bodies, regulatory measures for biosafety. Biosafety guidelines in India evolved by DBT, rules for the manufacture, storage and disposal of hazardous microorganisms, genetically modified organisms and biosafety management.

UNIT –IV**12 hours**

Biosafety of genetically engineered products: Genetically engineered products and Recombinant DNA Technology (RDT), risk assessment of RDT products, regulating RDT, permit for movement and import of GMOs, development of products using RDT and their biosafety issues, #biosafety in gene therapy and ecological safety assessment of recombinant organisms#.

UNIT –V**12 hours**

Introduction to Bioethics: Bioethics and its scope, different approaches to ethics, their social and ethical implications, public and private sector organizations for biosafety and bioethics, Web-

based information of biosafety on GMO – Introduction, biosafety database, importance of good laboratory practices. Myriad’s case on gene patenting – *Bt* brinjal, *Bt* cotton and golden rice.

#....# *Self-study portion*

Text Book:

1. Deepa Goel and Shomini Parashar., “IPR, Biosafety and Bioethics”, Dorling Kindersley Pvt. Ltd. (2013).

Unit I – Chapter 1 & 2, Page no: 1-46.

Unit II – Chapter 3 & 4, Page no: 47-83.

Unit III – Chapter 8 & 10, Page no: 129-137, 150-165.

Unit IV – Chapter 11, Page no: 167-174

Unit V – Chapter 13, 14, 15 & 16, Page no: 182-221

Books for References:

1. Beier, F.K., Crespi R.S., and Straus, T., “Biotechnology and Patent protection”, Oxford and IBH Publishing Co. New Delhi, (2007).
2. “Biosafety issues related to transgenic crops” - DBT guidelines, Biotech Consortium India Limited, New Delhi, (2010).

**SEMESTER VI: MAJOR BASED ELECTIVE - III
ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY**

Course Code: 17UBT6M3B

Max. Marks: 100

Hours/week: 4
Credit: 4

Internal Marks: 25
External Marks: 75

Objective:

On completion of this course, the student will be able to comprehend the principles of analytical techniques involved in Biotechnology.

12 Hours

UNIT I: Analytical Techniques in Biochemistry & Molecular Biology: Preparation of solution – Standard, stock, saturated and acid solutions. Buffers & their preparation. Spectrophotometry, p^H meter, chromatography, centrifugation, isotopic methods. Protein purification techniques, cell disruption and fractionation. PCR, isolation of DNA, RNA, plasmid, quantitative estimation of DNA /RNA, electrophoresis, recovery of DNA fragments from agarose gel, #Isolation of mRNA from affinity chromatography#.

12 Hours

UNIT II: Analytical Techniques in Genetics & Microbiology: probes, labeling and reading of the signal. FISH, *in situ* PCR, ASO technique: dot-blot and reverse dot-blot. ARMS technique, VNTR, microsatellite, SNP. #SSCP, PTT#. Microscope, staining techniques, microbial detection and counting, biochemical and sterility testing, labeled antibody methods for detection and identification of microorganisms.

12 Hours

UNIT III: Analytical techniques in plant and animal biotechnology: RFLP, RAPD, DAF, AP-PCR, AFLP, RAMP, S-SAP, STM, SCARS. CO₂ incubator, Magnet activated cell sorting, staining technique in animal cell culture, Inverted microscope, #DNA STR profiling#.

12 Hours

UNIT IV: Analytical techniques in rDNA technology & Immunology: PFGE, SDS-PAGE, Iso electric focusing, 2-dimensional electrophoresis, blotting techniques, Dot blot technique and autoradiography. Antigen – antibody interactions, ELISA, RIA, FACS.

12 Hours

UNIT V: Analytical techniques in pharmaceutical biotechnology: solid phase extraction, solid phase microextraction, liquid phase micro extraction, molecularly imprinted polymers, turbulent flow chromatography. #Supersomes. Immobilized enzyme reactor#.

#...# *Self-study portion*

Text Books:

1. Chawla, H. S, (2009). Introduction To Plant Biotechnology, Oxford and IBH Publishing.
2. Dr. Istvan Bak, (2011). Modern analytical techniques in the pharmaceutical- and bioanalysis.
3. Ghosal & Srivastava, (2009). Fundamentals of Bioanalytical Techniques and Instrumentation, PHI Learning Pvt. Ltd.

Unit I – Chapter 1, T.B. 1

Unit II – Chapter 3 & 4, T.B. 1

Unit III – Chapter 8 & 10, T.B. 2

Unit IV – Chapter 11, T.B. 2

Books for Reference:

1. J.G. Chirikjian, Jones & Bartlett Learning., Biotechnology: Theory and Techniques, Mc Graw Hill Publication. (1995).
2. Jean Louis Serre., Diagnostic Techniques in Genetics, , John Wiley & Sons, (2007).
3. Rajan Katoch, Springer., Analytical Techniques in Biochemistry and Molecular Biology, (2011).

**SEMESTER VI: EXTRA CREDIT - II
MARINE ECOLOGY AND BIODIVERSITY CONSERVATION**

Subject code17UBT6EC2

Hrs/week: --

Credit - 4*

Max Marks:100*

Internal Marks: --

External Marks:100*

Objective: To encourage self-learning thoughts in the field of Marine ecology and Biodiversity Conservation.

Unit I: Marine ecosystems, division of marine environment, coral reef, deep sea, estuaries and mangroves, concept of food chain, food web, and trophic structure. Estimation of primary products.

Unit II: Phytoplankton – diatoms, dinoflagellates, coccolithophores, foraminifers. Harmful algal blooms – causative species, bloom formation, propagation, decomposition and its impact on ecosystem function.

Unit III: Zooplankton ecology – copepods, euphasids, chaetognaths and other major groups and their role in food chain and food web.

Unit IV: Biodiversity, definition, taxic, phylo-genetic and molecular measurements, indigenous and traditional knowledge.

Unit V: Coastal biodiversity, wild and domesticated, Indian fisheries & status, ecosystem based management traditional and mechanized crafts and gears. Molecular methods in measuring biodiversity.

Text Books:

- T.B.1. Subrahmanyam N.S and A.V. Sambamurty., Ecology, Narosa Publishing House, 2014.
- T.B.2. Mahesh Prasad Singh. Biodiversity, APH Publishing Corporation, (2012).
- T.B. 3. Kumerasan V., Biotechnology, Saras Publication, (2010).
- T.B. 4. Chandrawati Jee Shagufta., Fish Biotechnology, APH Publishing Corporation, (2012).

Unit I Chapter 16, 17, T.B.1

Unit II Chapter 14, 16, T.B.1

Unit III Chapter 14, T.B.3

Unit IV Chapter 31, T.B.2

Unit V Chapter 7, 9, 10, T.B.4

Books for References:

1. Marine Biodiversity - Pattern and Processes, edited by Rupert F.G. Ormond, John.D.Gage and Martin.V.Angel, Cambridge University press, (2012).
2. Biodiversity and Environment by ArvindKumar, Published by S.B.Nangia, A.P.H. Publication Corporation, New Delhi, 110 002, (2014).
