M. Sc. Biotechnology

Syllabus

AFFILIATED COLLEGES

Program Code:

2021 – 2022 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A" Grade by NAAC,
Ranked 13th among Indian Universities by MHRD-NIRF,
World Ranking: Times -801-1000,Shanghai -901-1000, URAP - 982)

Coimbatore - 641 046, Tamil Nadu, India

Program Educational Objectives (PEOs)	
The **M. Sc. Biotechnology** program describe accomplishments that graduates are expected to attain within five to seven years after graduation	
PEO1	Graduates will establish themselves in various sectors of Biotechnology related industries such as Pharma, clinical diagnostics, Agriculture, Food, textiles etc
PEO2	Graduates will exhibit their effective skills in Research & Development in Biotechnology field at the National and International levels
PEO3	Graduates gain thorough knowledge in the subject, develop effective communication skills and be good academicians
PEO4	Graduates are encouraged and motivated to become entrepreneurs

Program Specific Outcomes (PSOs)	
After the successful completion of Biotechnology program, the graduates	
PSO1	Demonstrate the ability to design, conduct experiments and analyze data in the field of biotechnology
PSO2	Demonstrate the ability to independently carry out the research and development work in biotechnology
PSO3	Learn to apply appropriate modern tools and techniques in genome modifications for the welfare of mankind
PSO4	Acquire knowledge of norms and ethics in biotechnology/product development/patent writing
PSO5	Will develop effective entrepreneurial skills, winning business opportunity
PSO6	Develop skills to resolve scientific and technological problems in biotechnology based industries

Program Outcomes (POs)	
On successful completion of the M.Sc. Biotechnology program	
PO1	Acquires Scientific Knowledge on the various subjects related to Biotechnology field
PO2	Develops skills pertaining to various fields of Biotechnology
PO3	Trained to implement their knowledge in research
PO4	Understand the implications on the environment and society at large
PO5	Understand the ethical issues pertaining to the subject
PO6	Students will be able to design new biotechnological products or processes by applying innovative knowledge of different disciplines of biotechnology
PO7	Develops ability to successfully carry out advanced tasks and projects independently in various streams of biotechnology disciplines.
PO8	Demonstrate the ability to carry out the research projects independently
PO9	Develops the ability to conceptualize and carry out collaborative ventures across the disciplines
PO10	Develop skill sets for employability in diverse areas of biotechnology as well as for the higher studies

BHARATHIAR UNIVERSITY: COIMBATORE 641 046

M. Sc. Biotechnology Curriculum (AFFILIATED COLLEGES)

(For the students admitted during the academic year 2021 – 22 onwards)

Course Code	Title of the Course		Hrs. / week	Credits	Hours		Maximum Marks		
					Theory	Practical	CIA	ESE	Total
	FIRST SEMESTER								
13A	Paper – I	Molecular Biology and Genetics	4	4	3		50	50	100
13B	Paper – II	Biochemistry	5	4	3		50	50	100
13C	Paper – III	Applied Microbiology	4	4	3		50	50	100
13D	Paper - IV	Bioinstrumentation & Biostatistics	4	4	3		50	50	100
	Practical I		5	-	-	-	-	-	-
	Practical II		4	-	-	-	-	-	-
1EA/ 1EB	Elective paper I		4	4	3		50	50	100
	Total		30	20					500
	SECOND SEMESTER								
23A	Paper – V	Immunology & Immunotechnology	5	4	3		50	50	100
23B	Paper -VI	Genetic Engineering	4	4	3		50	50	100
23C	Paper – [illegible]	Plant Biotechnology	4	4	3		50	50	100
23D	Paper - VIII	Animal Biotechnology	4	4	3		50	50	100
23P	Practical – I		5	4		6	50	50	100
23Q	Practical – II		4	4		6	50	50	100
2EA/ 2EB	Elective paper II		4	4	3		50	50	100
	Industrial Training		-	-	-	-	-	-	-
	Total		30	28					700
	THIRD SEMESTER								
33A	Paper IX	Bioprocess Technology	4	4	3		50	50	100
33B	Paper X	Pharmaceutical Biotechnology	4	4	3		50	50	100
33C	Paper XI	Genomics & Proteomics	4	4	3		50	50	100
33D	Paper XII	Bio-entrepreneurship	4	4	3		50	50	100
	Practical III		5	-	-	-	-	-	-
	Practical IV		5	-	-	-	-	-	-
3EA/ 3EB	Elective Paper III		4	4	3		50	50	100
36A	Industrial Training			2			50*		50
	Total		30	22					550
	FOURTH SEMESTER								
47V	Project		16**	8	-	-	-	-	200***
43P	Practical III		5	4		6	50	50	100
43Q	Practical IV		5	4		6	50	50	100
4EA/ 4EB	Elective Paper IV		4	4	3		50	50	100
	Total		30	20					500
	Grand Total		**120**	**90**					**2250**
	ONLINE COURSES (Optional)								

*Industrial Training has to be undergone during II semester vacation period. Mark shall be given based on training report and presentation

** Sixteen hours should be allotted for Project Guidance to the respective guides. As per the university norms 16 hours of project guidance should be considered equivalent to 8 hrs of teaching while calculating the workload of respective guides.

*****For Project Report – 100 marks Viva-voce – 100marks**

List of Group Elective papers (Colleges can choose any one of the Group papers as electives)

Paper/ Sem	GROUP A	GROUP B
I	Occupational health and industrial safety	Plant system Physiology
II	Bioethics, biosafety and IPR	Animal System Physiology
III	Biotechniques	Developmental Biology
IV	Conservation biology	Evolution and behavior

PROJECT GUIDELINES

1) Project is pertain to the field of Biotechnology

2) Three review meetings should be conducted at regular intervals in the presence of HOD and respective guide. The evaluation for the review as follows

Review	Maximum Marks
I Review	15
II Review	15
III Review	20

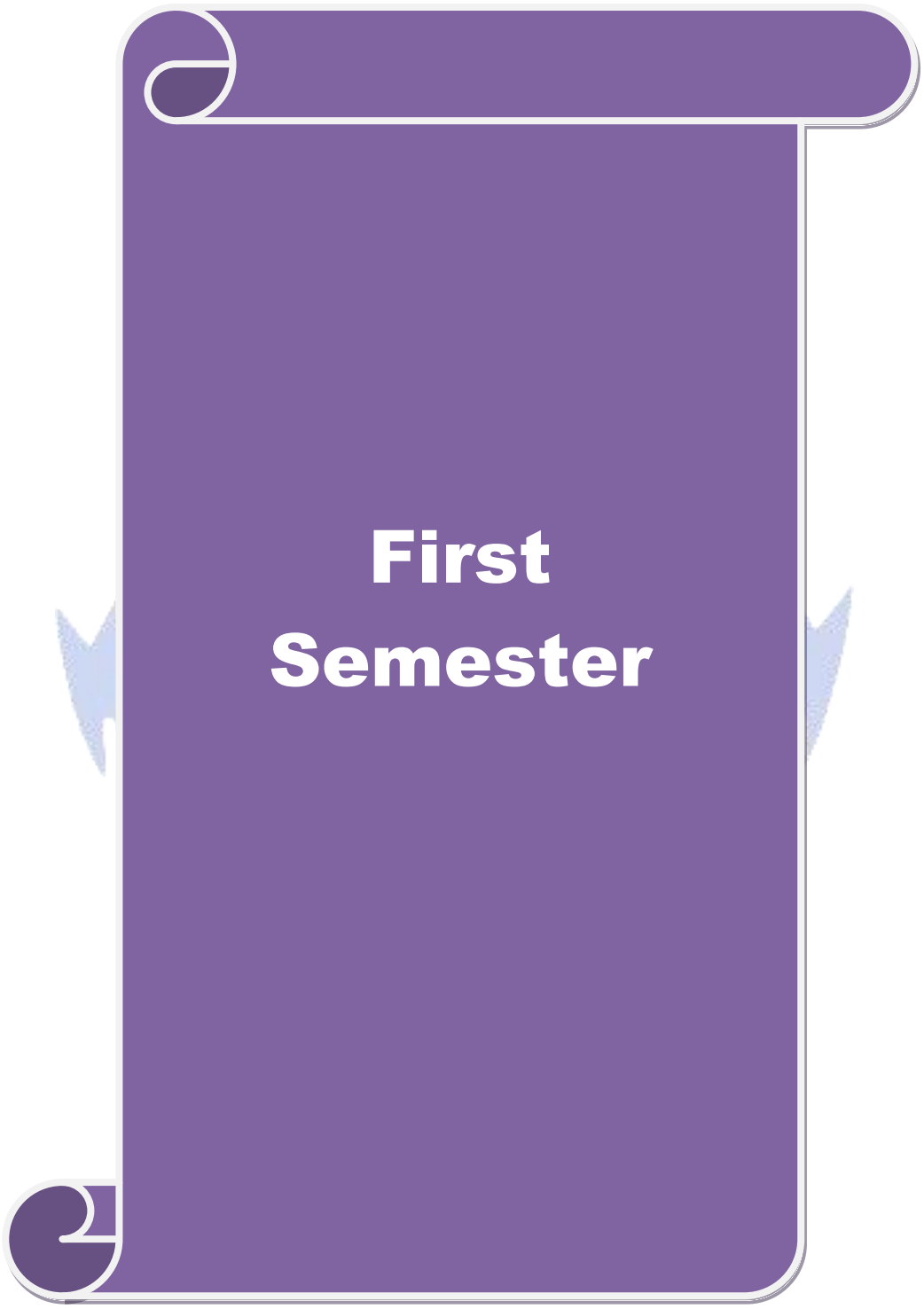
Dissertation evaluation by External Examiner	50

Viva-voce	100

ONLINE COURSES (NPTEL/SWAYAM):

Students can choose any one of the Courses offered by NPTEL/SWAYAM

- It's Optional for the students to avail online course
- On Successful completion of the course additional credits will be awarded


First
Semester

Course code 13A	PAPER – I MOLECULAR BIOLOGY AND GENETICS	L	T	P	C
Core		4			4
Pre-requisite	Should have a basic knowledge on Molecular biology	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Introduce knowledge on basic concepts of molecular biology techniques
2. Implement, organize and design different vectors for gene cloning and expression

Expected Course Outcomes (CO) :

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

1	Describe the genetic structure and types of chromatin	K1,K2
2	Elucidate the types, damage and repair of DNA, types of RNAs, genetic code	K1.K3
3	Understand the concept of mutations	K1,K2
4	Explicate the mechanism of gene regulation in prokaryotes	K1,K4
5	Understand the concept of gene expression in eukaryotes	K4,K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	CHROMATIN AND GENE COMPLEXITY	12 hours

Gene Structure: Fine Structure Of Gene, Split Genes, Pseudogenes, Overlapping Genes And Multigene Families. DNA And RNA As Genetic Material; Chemistry And Structure Of DNA. Chromosome- Structure, Organization, Banding, Karyotyping, And Labeling. Special Types Of Chromosome - Sex Chromosomes, B-Chromosome, Polytene and Lambrush Chromosomes; Numerical And Structural Changes In The Chromosome, Techniques In The Study Of Chromosomes And Applications.

UNIT: 2	REPLICATION, TRANSCRIPTION, TRANSLATION AND REGULATION OF GENE EXPRESSION	13 hours

DNA Replication In Prokaryotes And Eukaryotes: Mechanism Of Replication, Transcription: Initiation, Elongation And Termination (Rho-Dependent And Independent) Of RNA Synthesis; Eukaryotic Promoters, Enhancers, Transcription Factors, RNA Polymerases; Various Protein Motifs Involved In DNA-Protein Interactions During Transcription. Translation: Prokaryotes And Eukaryotes Translation And Their Regulation, Processing Of mRNA For Translation (E.G. 5' Capping And Splicing) And Involvement Of Different Translational Factors At Different Stages Of The Process. Regulation Of Gene Expression In Prokaryotes And Eukaryotes.

UNIT: 3	MUTATION AND DNA REPAIR MECHANISMS	13 hours

Gene Mutation And Its Mechanism; Types Of Mutation: Forward; Reverse; Intragenic Suppressor; Extragenic Suppressor; Point Mutations; Missense; Nonsense; Somatic Versus Germinal Mutation. Mutagenesis- Spontaneous And Induced. DNA Repair Mechanisms- Direct Reversal; Excision Repair (Base Excision, Nucleotide Excision And Mismatch); Recombinational Repair; SOS Response And SOS Bypass.

UNIT: 4	**RECOMBINATION**	**13 hours**
Recombination - Models; Rec A, Recbcd, Ruv Abc, And Molecular Mechanism Of Recombination. Conjugation; Transformation And Transduction. Transposons - Simple And Complex In Prokaryotic And Eukaryotic Systems.		
UNIT: 5	**GENE EXPRESSION**	**13 hours**
Introduction To Epigenetics: Gene Expression Without A Change In DNA Sequence Changes In Gene Expression Arising From Chemical Modification Of DNA Or Histone Proteins. Genes For Development In Drosophila, Genes For Development In Arabidopsis, Fertilization And Development; Genetic Control Of X Inactivation; In Vitro Fertilization And Embryo Transfer.		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert Lectures, Online Seminars - Webinars		
	Total Lecture hours	**66 hours**

Text Book(s)

1	Robert H. Tamarin, 2002. Principles Of Genetics, 7th Ed, TATA Mcgraw-Hill Edition, New Delhi, India
2	Daniel L. Hartl & Elizabeth W. Jones, 1999. Essential Genetics, 2nd Ed., Jones & Bartlett Publishers
3	Cell And Molecular Biology - Gerald Karp. Published By John Wiley, 2009 Edition: 6
4	Principles of Genetics – Gardner, MJ Simmons Published By John Wiley, 2012 Edition: 8

Reference Books

1	Molecular Cell Biology- Darnell, Lodish, Baltimore. Published By Scientific American Books, Inc., 1994
2	Molecular Cell Biology" By Harvey Lodish And James E Darnell
3	Genetics: A Conceptual Approach By Benjamin A Pierce. Published By Freeman And Company, New York. 2005. Edition: 2

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Molecular Biology - Part 2: Transcription and Transposition in Edx https://www.edx.org/course/molecular-biology-part-2-transcription-and-transposition
2	Cell biology at MIT https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2007/
3	Introduction to Genetics and Evolution – Coursera https://www.coursera.org/learn/genetics-evolution

Course Designed By:
Mr. T. Purushothaman, Head & Asst Prof, Dept. of Biotechnology, SNMV CAS Coimbatore
Dr. Vijayakumar, Asst. Prof, Dept. of Biochemistry & Biotechnology, Annamalai University, Chidambaram

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	M	S	S	S	M	L	M
CO2	S	S	M	M	S	M	S	S	M	M
CO3	S	S	M	S	M	M	S	L	L	M
CO4	M	S	S	S	S	S	S	M	M	S
CO5	S	S	S	S	L	L	S	M	M	S

*S-Strong; M-Medium; L-Low

Course code 13B	PAPER – II BIOCHEMISTRY	L	T	P	C
Core		5			4
Pre-requisite	Should have basic knowledge on Biochemistry	Syllabus Version		2020-2021	

Course Objectives:

The Main Objective Of This Course Is To:

1. Understand the Structure and Functions of Biomolecules

Expected Course Outcomes (CO) :

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

1	Classify Carbohydrates Based On Their Structure, Characteristics And Various Metabolic Pathways	K1, K2
2	Describe The Structure, Properties And Metabolism Of Amino Acids And Proteins	K2, K3
3	Acquire The Knowledge On Categorization, Structure And Catabolism of Lipids	K1, K3
4	Explicate Classification Of Enzymes & Mechanism Of Their Action	K1, K2
5	Appreciate The Structure, Biosynthesis, Degradation Of Nucleic Acids; Types, Properties And Deficiency of Vitamins	K2, K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	BIOENERGETICS AND BIOLOGICAL OXIDATION	13 hours

Structure of atoms, molecules and chemical bonds; classes of organic compounds and functional groups. Covalent and non-covalent interactions - van der waals, electrostatic, hydrogen bonding and hydrophobic interactions; respiration and photosynthesis. Energy metabolism (concept of free energy); principles of thermodynamics; kinetics, dissociation and association constants; bioenergetics.

UNIT: 2	CARBOHYDRATES AND ITS METABOLISM	12 hours

Carbohydrates, Polysaccharides - Classification And Reactions: Occurrence, Isolation, Purification, Properties And Biological Reactions. Structural Features Of Homoglycans, Heteroglycans And Complex Carbohydrates Glycolysis And TCA Cycle; Glycogen Breakdown And Synthesis; Gluconeogenesis; Interconversion of Hexoses And Pentoses

Unit: 3	LIPIDS, PROTEIN STRUCTURE AND PURIFICATION	12 Hours

Oxidation of fatty acids. Biosynthesis of fatty acids; triglycerides; phospholipids; sterols. Primary structure of proteins, structural comparison at secondary tertiary and quaternary levels (Ramchandran map). Purification and criteria of homogeneity-salting out, dialysis, column chromatography.

UNIT: 4	NUCLEIC ACID METABOLISM AND INBORN ERRORS OF METABOLISM	14 hours

Biosynthesis Of Purines and Pyrimidines, Nucleic Acids: Structure of Double Stranded DNA (B, A, C, D, T And Z DNA). Physical Properties of Double Stranded DNA, Types of RNAs and their Biological Significance. DNA Bending, DNA Supercoiling. Conformational Properties Of Polynucleotides, Secondary And Tertiary Structural Features And Their Analysis. Biochemistry and Molecular Basis Of Different Disorders Related To Carbohydrate, Protein, Fat and Nucleic

Acids, Inborn Errors Of Metabolism		
UNIT: 5	**ENZYME KINETICS AND COENZYMES**	**13 hours**
Enzyme kinetics (negative and positive co-operativity); regulation of enzymatic activity; enzyme catalysis in solution, kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Active sites; enzymes and coenzymes: coenzymes interactions: activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes; ribozyme, hammerhead, hairpin and other ribozymes. Abzyme: structure and drug targets (enzymes and receptors).		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert Lectures, Online Seminars - Webinars		
	Total Lecture hours	**66 hours**

Text Book(s)

1	Biochemistry- Donald Voet, Judith G. Voet, Published By J. Wiley & Sons, 2010, Edition: 4
2	Lehninger Principles Of Biochemistry- Albert L. Lehninger, David Lee Nelson, Michael M. Cox, Published By W.H. Freeman, 2008, Edition: 5
3	Enzymes: Biochemistry, Biotechnology And Clinical Chemistry-Trevor Palmer, Published By Horwood Publishing Limited, 2001, Edition: 5
4	Teitz Text Book Of Clinical Biochemistry 3rd Edition – Burtis Et Al., William Heinmann Medical Books, Ltd., 1999

Reference Books

1	Harper's Illustrated Biochemistry- Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell, Published By Mcgraw-Hill Professional, 2012, Edition: 29.
2	Clinical Chemistry – Principles, Procedures And Correlations, Bishop, Lipppincott, 2000

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Principles Of Biochemistry By Harvard University – Edx https://online-learning.harvard.edu/course/principles-biochemistry-1?delta=0

Course Designed By:
Dr. P Bhuvaneswari, Asst. Prof, Biochemistry, Vellalar College for Women, Erode

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	S	M	S	M	S
CO2	S	M	S	L	S	M	M	S	M	L
CO3	S	S	S	S	M	M	S	S	M	L
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	M	M	S	L	L	S	S

*S-Strong; M-Medium; L-Low

Course code 13C	PAPER – III APPLIED MICROBIOLOGY	L	T	P	C
Core		4			4
Pre-requisite	Should have studied about Microbiology	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Establish an understanding of the basic techniques (concept of aseptic work, cultivation and identification) in microbiology
2. Describe different aspects of microbial nutrition and growth
3. Describe microbial interactions and their significance in environment

Expected Course Outcomes (CO) :

On the Successful Completion of The Course, Student will be able To:

1	Identify microbiological techniques, the defining characteristics of the major groups of microorganisms and apply to study microbial phylogeny	K1, K2, K3
2	Classify The Nutritional Types of Microorganisms And Measure Microbial Growth	K1, K2
3	Evaluate How Microorganisms Interact with The Environment In Beneficial or Detrimental Ways	K3, K5
4	Assess Impact of Plant- Microbe Interaction On Agriculture in both beneficial and detrimental ways. Identify Industrially Important Microbes	K2, K3, K5
5	Determine Ways In Which Microorganisms Play An Integral Role In Disease, and The Microbial And Immunological Methodologies Are Used In Disease Treatment And Prevention	K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	INTRODUCTION TO MICROBIOLOGY	12 hours

History of microbiology - ultra structure of bacterial cell - growth phases - generation time. Kinetics of growth, batch culture, continuous culture, synchronous culture (definition and brief description). Physical factors influencing growth - temperature, pH, osmotic pressure, salt concentration. Classification of algae, protozoa and fungi. General properties and outline classification of viruses - structure and properties of t4 phage, tobacco mosaic virus and hiv. Pure culture techniques. Control of growth of microorganisms. Principle and construction of bright field, dark field, phase contrast and electron microscopy.

UNIT: 2	FOOD MICROBIOLOGY	13 hours

Normal microflora in milk, meat, poultry, eggs, fruits and vegetable; fresh food, canned food and stored grains; milk quality tests; preservation of food: high temperature (boiling, pasteurization, appertization), low temperature (freezing), dehydration, osmotic pressure. Chemical preservations, radiation. Microbiologically fermented food: cheese and yogurt. Microorganisms as food - scp: *spirulina* and edible mushroons; food borne diseases: salmonellosis - shigellosis.

UNIT: 3	INDUSTRIAL MICROBIOLOGY	12 hours

Primary screening & secondary screening of industrially important strains; strain improvement through random mutation (random & rational selection). Microbial production of organic acids - citric acid; antibiotics - penicillin & streptomycin; enzymes- amylase and lipase; vitamins - b12; alcoholic beverage - beer; production of recombinant proteins in bacteria and yeast - vaccine production in microbes

UNIT: 4	ENVIRONMENTAL MICROBIOLOGY	13 hours

Brief account of microbial interactions (symbiosis, neutralism, commensalism, competition, ammensalism, synergism, parasitism, and predation); biological nitrogen fixation - symbiotic and asymbiotic; biofertilizers, biological pest control. Plant disease (brown spot of rice, black stem rust of wheat) dissemination and control. Different types of microorganisms in the air, aerosols, sampling techniques. Coliform test - detection of faecal and non-faecal coliform.

UNIT: 5	XENOBIOTICS	13 hours

Ecological Considerations, Decay Behaviour And Degradative Plasmids; Hydrocarbons, Substituted Hydrocarbons, Oil Pollution, Surfactants, Pesticides. Bioremediation Of Contaminated Soils And Wastelands. Mineral Leaching By Microorganisms

UNIT: 6	CONTEMPORARY ISSUES	2 hours

Expert Lectures, Online Seminars - Webinars

	Total Lecture hours	65 hours

Text Book(s)

1	Microbiology - Presscott L M, Harley J P And Klein D A, Tata Mc Graw Hill, New Delhi. 2005, Edition: 6
2	Principles Of Microbiology - Atlas R M, WCB Mcgraw Hill Publications, New Delhi, 1997, Edition: 2
3	A Textbook Of Basic And Applied Microbiology – K R Aneja 2008

Reference Books

1	Environmental Microbiology - Mitchell R., John Wiley And Sons, New York. 1992
2	Microbial Biotechnology: Fundamentals Of Applied Microbiology

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Small And Mighty : Introduction To Microbiology Https://Www.Futurelearn.Com/Courses/Introduction-To-Microbiology

Course Designed By:

Mr. T. Purushothaman, Head, Asst. Prof, Dept. of Biotechnology, SNMV CAS, Coimbatore

Dr. Vijayakumar, Asst. Prof, Dept. of Biochemistry & Biotechnology, Annamalai University, Chidambaram

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	S	S	M	S	M	S
CO2	S	M	S	S	M	M	S	L	S	M
CO3	M	M	S	S	S	S	M	S	M	M
CO4	S	S	M	S	S	L	S	L	S	M
CO5	M	S	S	M	M	S	S	M	M	S

*S-Strong; M-Medium; L-Low

Course code 13D	PAPER - IV BIOINSTRUMENTATION & BIOSTATISTICS	L	T	P	C
Core		4			4
Pre-requisite	Should have a basic knowledge on Bioinstrumentation & statistics	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To impart technical information on Instrumentation related to Biotechnology and statistical analysis
2. Interpret differences in data distributions via visual displays

Expected Course Outcomes (CO) :

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

1	Acquire the knowledge on basic principle, working and applications of Spectroscopy	K2, K3
2	Demonstrate the theoretical basis, procedure and uses of chromatography	K2, K4
3	Depict the principle and types of centrifugation and their applications in biological sciences	K2, K3
4	Acquire the knowledge on statistics in biology	K1,K2
5	Acquire and Apply suitable Statistical Methods for Research	K2,K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	SPECTROSCOPY	12 hours

pH, pK, acids, bases and buffers, Henderson - Hasselbach equation, pH meter, Colorimetry & Spectrophotometry: Principles, types and applications, UV-VIS double beam spectrophotometry, Spectroflurometry, Mass spectroscopy, IR spectroscopy, Flame photometry. NMR Spectroscopy, Circular Dichroism and X- ray diffraction studies

UNIT: 2	CHROMATOGRAPHY	13 hours

Principles, types and applications of chromatography, size exclusion, Ion Exchange chromatography, affinity chromatography. High performance liquid chromatography (HPLC), Gas chromatography (GC), Thin layer chromatography (TLC), Paper chromatography, Mass Spectrometry, MALDI TOF.

UNIT: 3	CENTRIFUGATION, ELECTROPHORESIS RADIOISOTOPE TECHNIQUES	14 hours

Centrifugation: Principles, types and applications of centrifuges; Principles, types and applications of Electrophoresis. Agarose gel electrophoresis PAGE (SDS/Native), Gradient gel, Isoelectric focusing, 2-D gel electrophoresis (2-D PAGE), cellulose, Capillary electrophoresis. Flow cytometry Nature & detection of radio isotopes; Applications of Radio isotope techniques; Detection based on gas ionization - Geiger Muller counter; Detection based on excitation - Liquid Scintillation counter; Supply, storage, purity, specific activity and safety aspects of radiolabelled compounds

UNIT: 4	BIOSTATISTICS	13 hours

Biostatistics – Scope of Biostatistics, Measures of Central tendency – Arithmetic mean, Median and Mode. Calculation of mean, median, mode in series of individual observation discrete series, continuous open end classes.

UNIT: 5	BIOSTATISTICS TOOLS	13 hours

Classification and tabulation of data – Graphical and diagrammatic representations – scale diagrams – Histograms – frequency polygon - Frequency curves. Measures of Dispersion – standard deviation and Range. Chi – square test, student t test, regression, correlation, one way and two way ANOVA. Application of statistical software for biological research

UNIT: 6	CONTEMPORARY ISSUES	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	67 hours

Text Book(s)

1	Principles of Applied Biomedical Instrumentation- Gedder A and L. E. Balsar, John Wiley and Sons
2	Modern Experimental Biochemistry 2nd Edition- Boyer, Rodney F. Benjamin and Cummins
3	Introductory Biostatistics by chap. T. Lee (Wiley – Interscience)

Reference Books

1	Statistical methods edited by Stephen W. Looney (Humana publications)
2	Biostatistics: A Methodology for the Health Sciences, Second Edition, by Gerald Van belle (Wiley – Interscience publication)

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Introduction to Biostatistics – Swayam https://onlinecourses.nptel.ac.in/noc20_bt28/preview

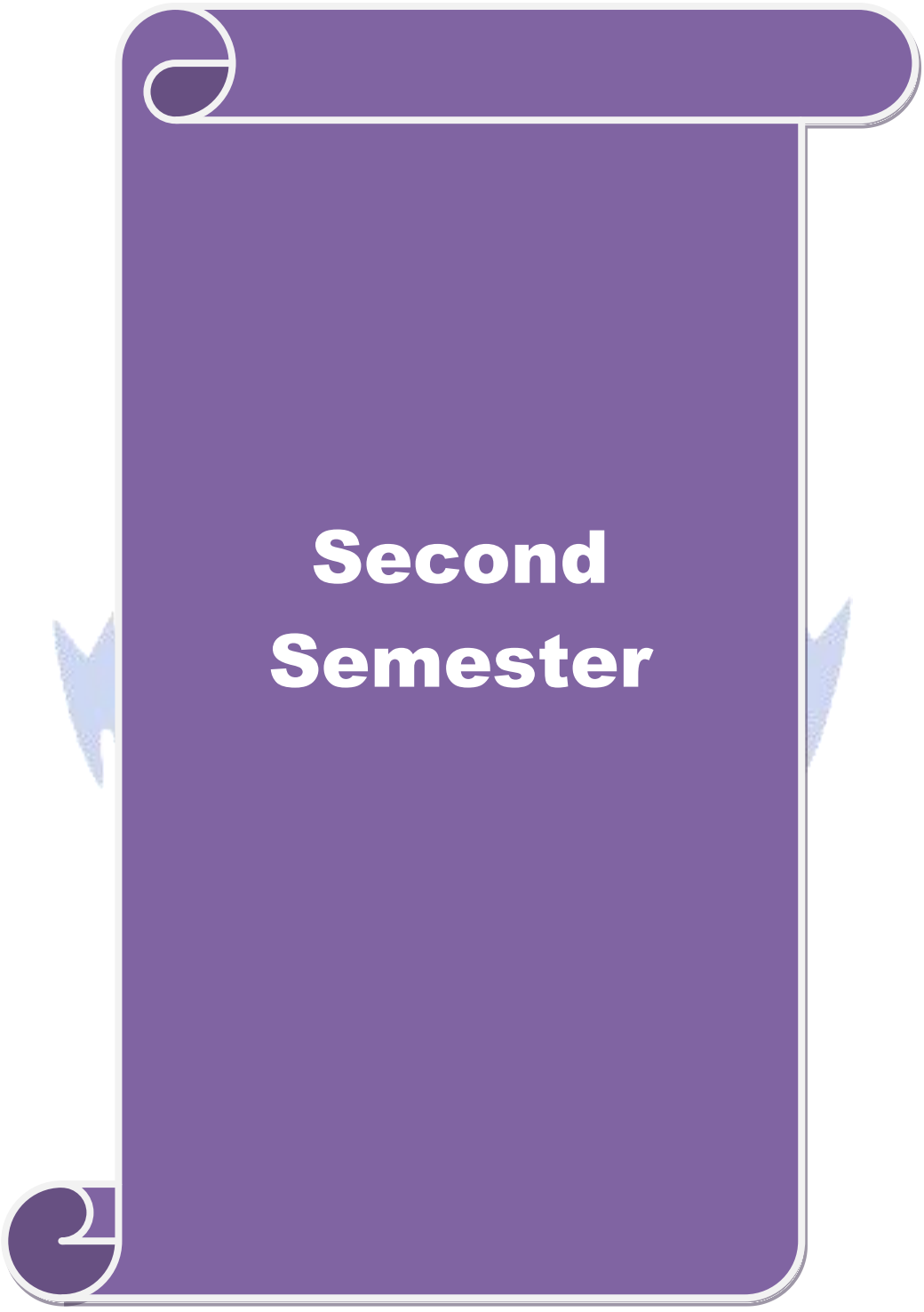
Course Designed By:
Dr. N.Vijayakumar, Asst. Prof, Dept. of Biochemistry & Biotechnology, Annamalai University, Chidambaram

NOTE: Question Paper Setter: 50% Problems and 50% theory should be asked from IV & V Units

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	S	S	S	L
CO2	S	L	S	S	S	L	S	S	M	M
CO3	S	S	S	S	M	M	S	S	L	S
CO4	M	M	M	L	S	S	L	S	S	L
CO5	S	M	S	S	M	S	S	M	L	S

*S-Strong; M-Medium; L-Low


Second
Semester

Course code 23A	PAPER - V IMMUNOLOGY AND IMMUNOTECHNOLOGY	L	T	P	C
Core		5			4
Pre-requisite	Should have a basic knowledge on Immunology	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To teach our students to have a concrete knowledge about immunology human system to study about the basis of the interaction as well as the genes involved in it.
2. To recapitulate the previous knowledge of immunology and to establish thorough understanding of various structure & function at cellular and molecular level.

Expected Course Outcomes (CO) :

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

1	Acquire knowledge on types and structure of immune systems and diversity of antibody	K2, K3
2	Elucidate cytokine and compliment based activation and regulation of immune mechanisms	K2, K3
3	Depict principles in diagnosis, HLA typing and Tumor immunology	K4, K5
4	Perceive knowledge on Immunodeficiency's	K1, K2. K3
5	To use the techniques, skills, and modern tools necessary for imbalances in various life processes, collect and analyze data, and interpret results	K3, K4, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	TYPES OF IMMUNITY, ANTIGENS AND ANTIBODIES	13 hours

History And Scope Of Immunology. Types Of Immunity: Passive, Active And Acquired Immunity. Humoral, Cell Mediated Immunity. Cells And Organs Of Immune Response And Their Functions. Antigens Types, Haptens, Epitopes And Factors Influencing Antigenicity. Antibodies Structure Types, Properties And Functions of Immunoglobulins

UNIT: 2	IMMUNE CELL TYPES	13 hours

Cells Of Immune System. T-Cells, B-Cells, Antigen Presenting Cells, Cell Mediated Subset Of T-Cells Helper And Suppressor Cells, Natural Killer Cells. Lymphoid Organs (Primary And Secondary) MHC Molecules, Antigen Presentation, B Cell And T Cell Activation, Cytokines Complement System. Structure, Components, Properties And Functions

UNIT: 3	IMMUNOTECHNIQUES	14 hours

Antigen Antibody Reactions: In Vitro Tests- Precipitation, Immune-Electrophoresis, Heamagglutination, Labeled Antibody (RIA ELISA And Immuno – Fluroscent Techniques) Hypersensitivity And Allergic Reactions Blood Cell Components, ABO Blood Grouping RH Typing. Application Of Immunological Techniques: Hybridoma Technology: Fusion Of Myeloma Cells With Lymphocytes, Production Of Monoclonal Antibodies And Their Applications. Human Monoclonals Catalytic Antibodies And Plantibodies

UNIT: 4	HYPERSENSITIVITY, IMMUNE DISORDERS AND TRANSPLANTATION	13 hours

Hyper Sensitivity Reactions, Auto Immuno Disorders, Deficiencies (Primary And Secondary) And Immuno Tolerance. Tumor Immunology: Tumor Antigens, Immune Responses And Therapy, Tissue And Organ Transplant.

UNIT: 5	VACCINES	12 hours

Immunity To Bacteria, Viruses And Parasites Vaccines And Immunization: Passive And Active Immunization Types Of Vaccines – Inactivated, Attenuated And Recombinant Vaccines – Peptide And DNA Vaccines, Synthetic Vaccines, Epitope Mapping.

UNIT: 6	CONTEMPORARY ISSUES	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	67 hours

Text Book(s)

1	Kuby Immunology. W. H. Freeman & Co. Fourth edition, 2000.
2	Immunology by Ivan Roitt, Jonathan Brostoff, and David Male. Mosby, London. 6th edition, 2001

Reference Books

1	Fundamental Immunology, Paul. 7th Edition, Wolters Kluwer, Lippincott Williams and Wilkins publication

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Fundamentals of Basic Immunology Specialization – Coursera https://www.coursera.org/specializations/immunology
2	Immunology – Swayam https://onlinecourses.swayam2.ac.in/cec19_bt14/preview

Course Designed By:
Dr. N.Vijayakumar, Asst. Prof, Dept. of Biochemistry & Biotechnology, Annamalai University, Chidambaram

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	S	M	S	S	M	S
CO2	S	S	M	L	S	S	S	L	S	L
CO3	M	M	S	S	M	S	M	M	S	S
CO4	M	S	S	S	S	L	L	M	L	L
CO5	S	M	S	M	M	S	M	S	S	M

*S-Strong; M-Medium; L-Low

Course code 23B	PAPER - VI GENETIC ENGINEERING	L	T	P	C
Core		4			4
Pre-requisite	Should have a studied Genetics in undergraduate	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To make learners understand the importance of gene manipulation with reference to different nuclear enzymes
2. To impart knowledge about source of vectors for their use in recombinant DNA technology and how effectively being employed as cloning vectors
3. To educate learners about methods of creating c-DNA libraries to assess for genetic disorders and its cure means of recombinant products/gene therapy

Expected Course Outcomes (CO) :

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

1	Recite key aspects of various enzymes in gene manipulation techniques to explore blotting techniques	K1
2	Construct plasmid vectors and illustrate them to comprehend more about its structure and functions	K2
3	Assess methods of transformation and analyses cloned genes for their markers	K4
4	Classify genomic C- DNA libraries and its significance in sequencing, mutagenesis and fingerprinting	K4
5	Employ various gene therapyusing different vectors and recombinant products	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	GENE MANIPULATION	13 hours

Enzymes used in manipulation: Polymerases and types; nucleases: endonucleases, exonucleases and restriction enzymes; ligases; topoisomerases, methylases; other modifying enzymes. Electrophorosis. Blotting techniques- Southern, Northern, Western, Dot and Slot blot

UNIT: 2	BIOLOGY OF CLONING VECTORS	12 hours

Biology and construction of plasmid vectors: pBR 322; pUC 18. Phages as vectors: Lambda phage; cosmids; phagemids. Expression vectors; shuttle vectors; artificial chromosomes: YAC, PAC, BAC, HAC.

UNIT: 3	BASIC RECOMBINANT DNA TECHNIQUES	09 hours

Construction of a recombinant molecule. Bacterial transformation: principle and methods; Physical methods of transformation. Analysis of cloned genes: direct and indirect methods.

Molecular Marker techniques: RFLP, RAPD, STS, SSR, ISSR, SCAR, SSCP and AFLP. Importance of molecular markers, molecular marker assisted selection, aided plant breeding. Selectable marker and reporter genes.

UNIT: 4	ADVANCED RECOMBINANT TECHNIQUES	12 hours

Genomic and cDNA libraries; PCR: principle and types; Site directed mutagenesis; DNA sequencing. Microarrays - cDNA and protein chips. DNA fingerprinting; SNPs; VNTRs and microsatellites.

UNIT: 5	APPLICATIONS OF GENE THERAPY	13 hours

Exvivo, Invivo, germ line and somatic gene therapy, Vectors in gene therapy. Viral gene delivery system- Adeno associated virus vector- Retero virus vector –HSV vector system; DNA forensics. Recombinant Products: blood products; vaccines; interferons; interleukins and therapeutic proteins. Molecular Pharming - Hirudin (Plant), Antibodies (Animal) and tissue plasminogen activator (Bacteria).

UNIT: 6	CONTEMPORARY ISSUES	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	65 hours

Text Book(s)

1	Genetic Engineering A Primer by Yamagami T, Auris Publishing, 2017
2	Molecular Biology and Genetic Engineering by N. Arumugam, A. Thangamani, L.M. Narayanan, Padmalatha Singh from Saras Publication, 2012

Reference Books

1	Principles of Genetics Gardner, Wiley India, 2006
2	Genetic Engineering, By Smita Rastogi from Oxford University Press, 2009

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://swayam.gov.in/nd1_noc19_bt15/preview
2	https://nptel.ac.in/courses/102/103/102103013/

Course Designed By:
Dr. G. Rajalakshmi, Head & Prof, Dept of Biotechnology, Hindusthan CAS, Coimbatore
Dr. S. G. Antony Godson, Asst.Prof, Dept of Biotechnology, Hindusthan CAS, Coimbatore

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	L	S	M	S	L
CO2	S	L	S	M	M	S	M	L	S	M
CO3	S	S	S	S	S	M	M	M	M	S
CO4	S	M	S	S	S	S	S	S	S	M
CO5	S	S	M	S	S	M	M	M	M	S

*S-Strong; M-Medium; L-Low

Course code 23C	PAPER - VII PLANT BIOTECHNOLOGY	L	T	P	C
Core		4			4
Pre-requisite	Should have a basic knowledge on Plant biology & biotechnology	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. Learn the fundamentals of plant totipotency nature, culturing plant cells and tissues, designing of culture environment
2. Acquire knowledge about molecular markers and their use in development of stress resistant crop plants.
3. Impart the basics of nanoparticle synthesis, characterization and application

Expected Course Outcomes (CO) :

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

1	Establish different types of plant cultures.	K3
2	Develop skill in raising transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement	K3
3	Apply the practical skills for entrepreneurial development.	K2, K3
4	Design and implement experimental procedures using relevant techniques	K4
5	Apply the concepts of Biotechnology in Environmental Management.	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	INTRODUCTION TO PLANT TISSUE CULTURE	13 hours

Tissues culture media - Composition and preparation; Plant Propagation - Conventional & Invitro techniques; Cell and tissue culture techniques for plants - Micro propagation, Callus culture, somatic embryogenesis, suspension culture, embryo culture, haploid culture, protoplast culture, protoplast fusion; Somaclonal variation; Artificial seeds; hardening.

UNIT: 2	TRANSFORMATION TECHNIQUES	14 hours

Genetic transformation techniques in plants: Gene transfer methods in plants – Direct DNA transfer methods, Agro bacterium mediated nuclear transformation. Ti and Ri plasmids, binary & co-integrated vector systems; genetic markers; reporter genes; genetic transformation techniques for overcoming biotic and abiotic stress. Green house and green home technology. Arid and semiarid technology.

UNIT: 3	APPLICATION OF TRANSFORMATION TECHNIQUES	12 hours

Role of genetic transformation techniques in production of Biodegradable Plastics, Therapeutic

proteins, antibodies, plant vaccines, herbal drugs, bioethanol and biodiesel. Phytoremediation; Proteomics and Plant biotechnology: Proteomics in plant breeding and genetics.

UNIT: 4	INTRODUCTION TO NANOTECHNOLOGY	13 hours
Phytochemical Extraction & purification and nano particle synthesis: secondary metabolic pathways. Synthesis process and application, Role of plants in nanoparticle synthesis and Characterization Techniques X-ray diffraction, Scanning Probe Microscopy, SEM, TEM, and application for analysis of nanomaterials, UV-VIS-NIR Spectrophotometers		
UNIT: 5	**NANOTECHNOLOGY IN AGRICULTURE**	**12 hours**
Nanotechnology in Agriculture. Nanotechnology applications in weed management - plant parasitic, nematode, insect management - Assessing the efficacy and bio- safety to non-target organisms. Biosensors for toxins, pest and pathogens- Aflatoxin, biosensor for moisture and pesticide content- organophosphorous pesticides- nutrient content in soil.		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**66 hours**

Text Book(s)

1	H. S. Chawla, 2017. Introduction to *Plant Biotechnology*, 3rd Edition. Oxford & Ibh Publishing
2	Ashutosh Shukla Siavash Iravani 2018, Green Synthesis, Characterization and Applications of Nanoparticles, 1st Edition, Elsevier

Reference Books

1	Abdin, M. Z., Kiran, U., Kamaluddin, M., Ali, A. (Eds.), 2017. Plant Biotechnology: Principles and Applications, Springer Publication
2	Neal Stewart, 2008. Plant Biotechnology and Genetics: Principles, Techniques, and Applications. John Wiley & Sons, Inc., Hoboken, New Jersey

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://swayam.gov.in/nd1_noc19_bt18/preview
2	https://swayam.gov.in/nd2_cec19_bt01/preview
3	https://nptel.ac.in/courses/102/103/102103016/

Course Designed By:
Dr. G. Rajalaskhmi, Head & Prof, Dept of Biotechnology, Hindusthan CAS, Coimbatore
Dr.P. Senthilkumar, Associate Prof, Dept of Biotechnology, Hindusthan CAS, Coimbatore

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	S	S	L	S
CO2	M	S	S	S	S	S	M	M	L	S
CO3	S	M	S	S	M	S	S	S	M	S
CO4	S	S	L	S	S	S	S	S	L	M
CO5	S	M	S	M	S	S	S	L	M	M

*S-Strong; M-Medium; L-Low

Course code 23D	PAPER - VIII ANIMAL BIOTECHNOLOGY	L	T	P	C
Core		4			4
Pre-requisite	Should have a basic knowledge on Animal biotechnology	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To take learners through a captivating journey of fundamentals, cell culture and characterization of animal tissue culture.
2. To orient learners about contaminations, understand significance of preservation of cell lines
3. To teach learners about innovative and novel work transgenic animal and invitro fertilizations

Expected Course Outcomes (CO) :

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

1	Remember fundamental techniques in animal tissue culture, and describe essential equipment employed, and types of media and methods	K1
2	Comprehend various features of primary cell culture, methods, and characterizations by discussing suitable examples	K2
3	Establish source and types of contamination and focus on methods of preservation to determine cytotoxicity	K3
4	Employ transgenic animal for various therapeutic purposes, as disease model and livestock improvement	K3
5	Analyze method invitro fertilizations to interpret embryonic stem cell culture to judge ethical issues pertaining to it.	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	ANIMAL TISSUE CULTURE AND MEDIA PREPARATION	13 hours

Introduction to Animal Tissue Culture: Background, Advantages, Limitations and applications. Culture Environment, Cell Adhesion, Cell Proliferation and Cell differentiation. Essential Equipment's required for animal tissue culture, Aseptic Technique and general safety. Media: Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Disadvantages of Serum supplemented media, Serum-Free Media, Advantages of Serum-Free media

UNIT: 2	CELL CULTURE TECHNIQUES	12 hours

Primary Culture: Isolation of Tissue, Steps involved in primary cell culture, Cell Lines, Nomenclature, Subculture and Propagation, Immortalization of cell lines, Cell line designations, Routine maintenance. Characterization of Cell Line: Need for characterization, Morphology, Chromosome Analysis, DNA, RNA and Protein Content, Enzyme Activity and Antigenic Markers. Transformation of animal cell.

UNIT: 3	CONTAMINATION, PRESERVATION AND TISSUE ENGINEERING	13 hours

Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination. Cryopreservation: Need of Cryopreservation. Apoptosis and its determination; Cytotoxicity assays. Application of animal cell culture; Vaccine production; Tissue engineering; Engineered cell culture as source of valuable products and therapeutic protein

production.

UNIT: 4	TRANSGENIC ANIMALS AND CLONING	13 hours

Transgenic Animals: Production Methodology-Embryonic Stem Cell method, Microinjection method; Applications of transgenic animals-in therapeutic protein production; livestock improvement; Transgenic animals as disease models. Gene targeting, silencing and knockout technologies. Animal cloning

UNIT: 5	IN VITRO FERTILIZATION AND STEM CELL CULTURE	12 hours

In vitro Fertilization and Embryo Transfer: Composition of IVF media, Steps involved in IVF, Fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA. Stem cell culture, embryonic stem cell and their applications. Ethical issues in animal biotechnology

UNIT: 6	CONTEMPORARY ISSUES	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	65 hours

Text Book(s)

1	Animal Biotechnology by N. Arumugam, V. Kumaresan from Saras Publication, 2019
2	Textbook of Animal Biotechnology by B. Singh, S.K. Gautam from The Energy and Resources Institute, TERI (1 December 2013)

Reference Books

1	Animal Biotechnology by Ashish Verma Anchal Singh,2nd Edition,© Academic Press 2020
2	Animal Biotechnology by P.K. Gupta from Rastogi publications, 2020

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://swayam.gov.in/nd1_noc20_me04/preview/
2	https://nptel.ac.in/courses/102/104/102104059/

Course Designed By:
Dr. G. Rajalakshmi, Head & Prof, Dept of Biotechnology, Hindusthan CAS, Coimbatore
Dr. S. G. Antony Godson, Asst. Prof, Dept of Biotechnology, Hindusthan CAS, Coimbatore

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	S	S	L	L
CO2	M	S	S	S	S	M	S	L	S	S
CO3	S	M	S	S	M	S	M	S	S	M
CO4	S	S	S	S	S	M	S	M	S	M
CO5	S	M	S	M	S	L	M	S	M	M

*S-Strong; M-Medium; L-Low

Third Semester

Course code 33A	PAPER - IX BIOPROCESS TECHNOLOGY	L	T	P	C
Core		4			4
Pre-requisite	This course gives an overview of the Bioprocess raw material to product. This also explicates the connection between microbial growth, product formation, mass transfer and environment	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Acquire knowledge on historical perspectives of Bioprocess Engineering.
2. Understand the basics of fermentation techniques and to enable them to learn about the Design of Bioreactor.
3. Know about the principle involved in transport mechanisms and techniques involved upstream and downstream Bio-processing

Expected Course Outcomes (CO) :

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

1	Recognize the basic principles of Bioprocess technology and historical perspectives of fermentation.	K1
2	Understand the different designs of Bioreactors	K2
3	Apply their scientific and technological knowledge of BPT	K3
4	Analyze the various types of processing techniques	K4
5	Evaluate and assessing the process involved in production	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	INTRODUCTION TO BIOPROCESS ENGINEERING	11 hours

Fermentation a Historical perspective. Biotechnology and bioprocess engineering, Bioprocess regulatory constraints, Basic of Biology - Microbiology of industrial fermentation, an engineering perspectives - cell construction, cell nutrients. Alteration in cellular information.

UNIT: 2	BIOREACTOR - DESIGNS	13 hours

Introduction to fermentation process. Sterilization. Thermal death kinetics. Design of continuous sterilization process, Fibrous filters. Bioreactor design, parts and their functions, Alternative vessel designs - CSTR, Tower, Airlift, Loop jet, Bubble Column, Packed bed. Immobilized cells.

UNIT: 3	INSTRUMENTATION CONTROLS	13 hours

Different types of instrumentation, common measurement and control systems, Additional sensors, Feedback control, PID control, Computers in Bioprocess control systems, Biosensors in bioprocess monitoring and control.

UNIT: 4	UPSTREAM AND DOWNSTREAM PROCESSING	14 hours

Upstream processing**,** Removal of microbial cells, cell disruption – enzymatic, chemical and physical methods; purification of fermentation products - precipitation methods, membrane process, centrifugation – Ultracentrifugation; Chromatography -Ion exchange and gel permeation chromatography, HPLC; crystallization, drying, lyophilisation, packaging and quality assurance

UNIT: 5	**APPLICATIONS OF BIOPROCESS TECHNOLOGY IN INDUSTRY**	**13 hours**
Stochiometry of microbial growth and product formation, Process Involved in production, harvest, recovery and uses – Antibiotics & Vitamins, Baker's yeast, Single Cell Protein. Formulation of Biofertilizer - *Rhizobium Pseudomonas* and Biopesticides (*Bacillus thuringiensis*)		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**66 hours**

Text Book(s)	
1	The encyclopedia of Bioprocess Technology*:* Fundamentals and Applications, by Flickinger, Michael C.A Wiley-Interscience Publication
2	Bio-Process Technology an Introduction to Fermentors, October 2017, Publisher: Rajan Singh
3	Advanced Biotechnology, By R C Dubey, 2014
Reference Books	
1	Principles of Fermentation Technology by Peter. F. Stanbury, Allan Whitaker, Stephen. J. Hall. Published by Elsevier Science Ltd., Edition: 3
2	Cruger and Cruger. A Biotechnology: A Textbook of Industrial Microbiology Science Tech. Incorporated. 2nd Edition, 1984
3	Prescott and Dunns, Industrial Microbiology. CBS Publishers & Distributors PVT. Limited. 4th Edition. 1982
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://online-learning.tudelft.nl/courses/industrial-biotechnology/
2	Principles of Downstream techniques in Bioprocess - NPTEL
3	https://www.classcentral.com/course/swayam-principles-of-downstream-techniques-in-bioprocess-3967
4	https://swayam.gov.in/nd1_noc19_bt20/preview

Course Designed By:
Dr. S. Jayashree, Associate Professor, Dept of Biotechnology, Nehru Arts & Science, Coimbatore

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	M	M	L	S	S	S	M	S
CO2	S	M	M	M	L	S	S	M	S	M
CO3	S	S	M	L	M	S	S	S	M	S
CO4	M	M	L	M	L	S	S	M	L	M
CO5	S	M	M	M	M	M	S	M	M	S

*S-Strong; M-Medium; L-Low

Course code 33B	PAPER - X PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
Core		4			4
Pre-requisite	Should have a basic knowledge on pharmacology	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To enable the students to learn about various drugs, its effects, drug metabolism, drug receptors, drug tolerance, dependence and resistance with therapeutic monitoring of drugs
2. To offers the students comprehensive information and insights in pharmaceutical biotechnology and the development of biopharmaceuticals in pharmaceutical industry

Expected Course Outcomes (CO) :

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

1	Understand the Knowledge of the drugs and its principles	K1. K2
2	Recollecting the concept, classification production and application of pharmaceutical substances	K2
3	Imparting a comprehension of basic skills necessary for employing biotechnology principles	K2, K3
4	The knowledge gained in this course would be used to understand and evaluate the different pharmaceutical parameters of the current and future biotechnology related products on the market	K2,K5
5	Understanding in both scientific knowledge of designing and mechanism of action of drugs	K2,K3, K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	FUNDAMENTAL PRINCIPLES OF PHARMACOLOGY	12 hours

History of pharmaceutical industry, Drugs discovery, Development phases and Drug-Manufacturing Process. Drugs and Cosmetics ACT and regulatory aspects. Definition: Generics and its advantages. Biogenerics and Biosimilars. Protein-based biopharmaceuticals

UNIT: 2	CONTEMPORARY APPROACHES TO DRUG DISCOVERY	14 hours

Introduction to pharmaceuticals of animal, plant and microbial origin. Hemotopoietic growth factors and coagulation factors. Interferons and cytokines for anti-infective and cancer therapy. Insulin and growth hormones. Vaccine: genetically improved vaccines, synthetic peptide based vaccines, nucleic acid vaccines.

UNIT: 3	PHARMACOLOGY, TOXICOLOGY AND THERAPEUTICS	12 hours

Recombinant thrombolytic agents: tissue type plasminogen activator, first and second generation of thrombolytic agents. Xenotransplantation in pharmaceutical biotechnology. Estimation of

toxicity: LD50 and ED50. Pre-clinical and clinical trails

UNIT: 4	FUNDAMENTALS OF DRUG EVALUATION AND PHARMACOGENOMICS	14 hours

Introduction to pharmacopoeia, good microbiological techniques and good laboratory practice (GLP). Basic principles of quality control (QA) and quality assurance (QC), Guidelines for QA and QC: raw materials, sterilization, media, stock cultures and products, Validation study and toxicity testing. Role of culture collection centre, public health laboratories and regulatory agencies Concept of biotech process validation, Cell lines culture process validation and characterization.

UNIT: 5	PROTEIN AND NUCLEIC ACID FORMULATION DEVELOPMENT	10 hours

Issues of DNA vaccines and plasmid DNA vaccines. Analytical methods in protein formulation: concentration, size, purity, surface charge, identity, structure/sequence, shape, activity. Introduction to drug designing and Search of database. Biosafety guidelines; Risk and risk assessment- Biosafety levels, laboratory biosecurity concepts Introduction to drug design- Pre-clinical and clinical trials. Basics of bioethics principles, international codes and guidelines in India. Ethics in post-genomic era.

UNIT: 6	CONTEMPORARY ISSUES	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	66 hours

Text Book(s)

1	Goodman & Gilman's The Pharmacological Basis of Therapeutics,11th edition, Mc Graw- Hill Medical Publishing Division New York, 2006
2	Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes into drugs, 1st Edition, Wiley Liss, 2003

Reference Books

1	Pharmaceutical Biotechnology Fundamentals and Applications 5th Edition 2019 by Crommelin DJA, Springer

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Drug Discovery – Coursera https://www.coursera.org/learn/drug-discovery
2	Drug Delivery: Principles and Engineering – SWAYAM https://onlinecourses.nptel.ac.in/noc19_bt23/preview

Course Designed By:
Mr. T. Purushothaman, Head, Asst Prof, Dept of Biotechnology, SNMV CAS, Coimbatore

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	S	M	L	S	S	S	S
CO2	M	M	S	S	S	L	S	M	M	S
CO3	S	S	M	S	L	M	M	M	S	L
CO4	S	M	S	M	M	L	S	L	M	L
CO5	S	M	M	S	M	M	M	S	M	S

*S-Strong; M-Medium; L-Low

Course code 33C	PAPER - X GENOMICS & PROTEOMICS	L	T	P	C
Core		4			4
Pre-requisite	Should have a basic knowledge on Genomics	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To understand the various aspects of diversity and complexity of eukaryotic genomes, evolutionary perspective of genomic content, techniques commonly employed in studies of genomics and transcriptomics and applications derived from the knowledge provided by this science.
2. To explain how the field of genomics led to the development of proteomics
3. To investigate how proteins affect and are affected by cell processes or the external environment

Expected Course Outcomes (CO) :

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

1	Student will be able to describe the development of Omics technologies, with emphasis on modern genomics and proteomics	K1
2	Student will have an awareness and understanding of modern molecular biology concepts and techniques including genomics, transcriptomics, proteomics, and bioinformatics, to translate theoretical knowledge gained from the programme into practical experience via intensive laboratory research that will be particularly applicable to industry	K2, K3
3	Will be able to describe advanced genomics and proteomics technologies and the ways in which their data are stored	K2, K3
4	Student will be able to discuss how biological systems information relating to genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells.	K3,K5
5	Use scientific terminology to manage bibliography and IT resources related to biochemistry, molecular biology or biomedicine and present the results scientifically.	K3, K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	GENOMICS	12 hours

Genome mapping, Genome sequence assembly: Base calling and assembly programs, Genome annotation: Gene ontology, Automated genome annotation. Comparative genomics: Whole genome alignment, Finding a minimal genome, Lateral gene transfer. Sequence based approaches: EST, Microarray and SAGE. Comparison of SAGE and DNA Microarrays.

UNIT: 2	PROTEOMICS	14 hours

Technology of protein expression analysis: Mass spectrometry protein identification, protein identification through database searching, Differential in-gel electrophoresis and Protein Microarrays. Post translational modification: Prediction of disulphide bridges and Identification of posttranslational modifications in proteomics analysis. Protein sorting.

UNIT: 3	PROTEIN-PROTEIN INTERACTIONS	13 hours
Experimental determination of protein-protein interaction, Prediction of protein-protein interactions: predicting interactions based on phylogenetic information and prediction interactions using hybrid methods.		
UNIT: 4	**APPLICATIONS OF PROTEOMICS**	**13 hours**
Medical proteomics-disease diagnosis: Biomarkers, Biomarker discovery using 2DGE and mass spectrometry and Biomarker discovery and pattern profiling using protein chips. Pharmaceutical proteomics-drug development: Proteomics and target validation, Proteomics in the development of lead compounds and Proteomics and clinical development.		
UNIT: 5	**DATA ANALYTICS**	**13 hours**
Introduction– Data Analytics – Data Analysis vs. Data Analytics – Big Data Analytics –Data Formats – Data Characteristics – Big Data Platforms – Applications - Data Analytics Use case: Data Analytics – Health care – Marketing		
UNIT: 6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**67 hours**

Text Book(s)

1	Brenden C, and Tooze J. (1999). Introduction to protein structure, 2nd ed. New York: Garland publishing.
2	Hagen J.B. (2000).The origin of bioinformatics. Nat. Rev. Genetics. 1: 231-236

Reference Books

1	Goodman N. (2002). Biological data becomes computer literature: New Advances in Bioinofrmatics. Curr. Opin. Biotechnol. 13: 68-71
2	V. Bhuvaneswari, “Data Analytics with R Step by Step”, Scitech Publication, ISBN –978-81-929131-2-4, Edition 2016

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Proteomics and Genomics – NPTEL https://nptel.ac.in/courses/102/103/102103017/
2	Introduction to Proteogenomics – SWAYAM https://onlinecourses.nptel.ac.in/noc19_bt26/preview

Course Designed By:
Mr. T. Purushothaman, Head, Asst. Prof, Dept. of Biotechnology, SNMV CAS, Coimbatore
Dr. K. Ramalashmi, Asst. Prof, Dept. of Biotechnology, SNMV CAS, Coimbatore

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	S	M	L	S	M	M	M	S
CO2	M	S	M	M	M	M	S	S	S	L
CO3	L	S	S	M	M	S	M	S	S	M
CO4	M	S	M	S	M	M	S	S	M	S
CO5	S	M	M	L	L	M	L	S	M	L

*S-Strong; M-Medium; L-Low

Course code 33D	PAPER - XII BIO-ENTREPRENEURSHIP	L	T	P	C
Core		4			4
Pre-requisite	Should have a basic knowledge on startups in biotechnology	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To enable the students to understand the sources of innovation opportunities and development of the skills to identify and analyze these opportunities for bioentrepreneurship and innovation.
2. To develop personal skills set for creativity, innovation and entrepreneurship and specific concepts and tools for combining and managing creativity in organization

Expected Course Outcomes (CO) :

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

1	Students will know the legal and financial conditions for starting a business venture	K2
2	Will be able to explain the importance of marketing and management in small businesses venture and can interpret their own business plan	K1, K2
3	Able to identify the elements of success of bioentrepreneurial scheme and projects	K3
4	Can able to specify the basic performance indicators of various entrepreneurial activities	K4, K5
5	Student will be able to analyse the business environment in order to identify business opportunities	K4, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	BASICS OF BIOENTREPRENEURSHIP	13 hours

Introduction to bioentrepreneurship – Biotechnology in a global scale, Scope in Bioentrepreneurship, Importance of entrepreneurship. Meaning of entrepreneur, function of an entrepreneur, types of entrepreneur, and advantages of being entrepreneur. Innovation – types, out of box thinking, opportunities for Bioentrepreneurship. Entreprenuership development programs of public and private agencies (MSME, DBT, BIRAC, Startup and Make in India). Patent landscape, IP protection and commercialization strategies.

UNIT: 2	MANAGEMENT, ACCOUNTING AND FINANCE	14 hours

Management principles of Henry Fayol. Business plan preparation: business feasibility analysis by SWOT, socio-economic costs benefit analysis, Sources of financial assistance – making a business proposal, approaching loan from bank and other financial institutions, budget planning and cash flow management, basics in accounting practices - balance sheet, P&L account, double entry book keeping, and estimation of income, expenditure and Income tax. Collaborations and partnerships, information technology for business administration and expansion.

UNIT: 3	KNOWLEDGE CENTRE AND R & D	13 hours

Knowledge centers - Universities, innovation centre, research institutions and business incubators. R&D - technology development and upgradation, assessment of technology development, managing technology transfer, industry visits to successful bio-enterprises, regulations for transfer of foreign technologies, quality control, technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GCP & GMP)

UNIT: 4	**MEDIUM & SMALL SCALE INDUSTRY**	**12 hours**

Definition, characteristics, need and rationale, objectives, scope and advantages of small scale industries. Types of bioindustries – Pharma, Agri and Industry. Biofertilizers production - Azospirillium, Azolla, Cyanobacteria and its applications. Biopecticides production - Bacterial, fungal, viral and plant insecticides. Sericulture. Apiculture. Dairy farming. Single Cell Protein-Production and applications. Vermicomposting and its applications. Mushroom cultivation and its application. Ancillary and tiny industries

UNIT: 5	**MARKETING AND HUMAN RESOURCE DEVELOPMENT**	**13 hours**

Assessment of market demand for potential product(s) of interest, Market conditions, segments, prediction of market changes, identifying needs of customers including gaps in the market. Branding issues, developing distribution channels – franchising policies, promotion, advertising, branding and market linkages. Marketing of agro products. Recruitment and selection process, leadership skills, managerial skills, organization structure, training, team building and teamwork.

UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**

Expert lectures, online seminars - webinars

	Total Lecture hours	**67 hours**

Text Book(s)

1	Principles of Management", PC Tripati, PN Reddy,–Tata Mc Graw Hill
2	Dynamics of Entrepreneurial Development & Management" Vasant Desai Himalaya Publishing House

Reference Books

1	Management Fundamentals ", Robert Lusier – Concepts, Application, Skill Development" Thomson
2	Entrepreneurship Development" S S Khanka , S Chand & Co

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Entrepreneurship – SWAYAM https://onlinecourses.swayam2.ac.in/cec19_mg39/preview

Course Designed By:
Dr. K. Ramalashmi, Asst. Prof, Dept. of Biotechnology, SNMV CAS, Coimbatore

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	M	S	S	M	S	L
CO2	M	S	M	S	S	S	M	L	M	L
CO3	L	S	S	M	M	S	S	M	L	S
CO4	S	S	L	M	S	S	M	S	M	M
CO5	M	M	S	S	S	M	M	S	S	M

*S-Strong; M-Medium; L-Low

Elective Course

Course code 1EA	GROUP A PAPER -I OCCUPATIONAL HEALTH & INDUSTRIAL SAFETY	L	T	P	C
Elective		4			4
Pre-requisite	Should have a basic knowledge on industrial safety	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To identify, and evaluate hazardous conditions and practices, and implement effective hazard control strategies in such areas as accident prevention, safety management, occupational health, industrial hygiene, loss/risk control management, ergonomics, emergency planning and response, and environmental health and safety.
2. To become an effective communicators and ethical leaders within the occupational safety and health profession.
3. To contribute for the development and maintenance of a healthy and safe work environment

Expected Course Outcomes (CO) :

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

1	Identify hazards in the home or workplace that pose a danger or threat to their safety or health	K1
2	Discuss the role of health and safety in the workplace pertaining to the responsibilities of workers	K2
3	Identify the decisions required to maintain protection of the environment	K2, K3
4	An ability to understand ethical and professional responsibilities and the impact of technical and/or scientific safety and health solutions in global	K4
5	An ability to function effectively on teams that establish goals	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	SAFETY MANAGEMENT	12 hours

Parameters of safety - Factors affecting the conditions of occupational and Industrial safety - Concept of safety organization and Management - Safety Regulations. Definition and Role of Ergonomics in Designing Work-Place

UNIT: 2	OCCUPATIONAL PHYSIOLOGY	11 hours

Work Environment - Effects of Light, Ventilation, Vibration, Noise etc - The Work Physiology and their Relevance to Safety - Performance Evaluation of Man - Environment systems.

UNIT: 3	OCCUPATIONAL HEALTH AND TOXICOLOGY	12 hours

Occupational Health and Safety – Occupational Health and Hazards – Physical, Chemical and Biological hazards. Occupational Diseases and their Prevention and Control. Health Protection Measures for Workers. Principles of Arthropod Control.

UNIT: 4	**REGULATION FOR HEALTH SAFETY AND ENVIRONMENT**	**13 hours**
Health Education Medical First-Aid and Management of Medical Emergencies Industrial Safety management Techniques - Industrial Safety Standards. Accidents-Definition, Frequency Rate, Prevention and Control. Work Study - Method of Study and Measurement. Measurement of Skills. Safety - Cost of Expenses.		
UNIT: 5	**SAFETY MANAGEMENT IN INDUSTRIES AND AIRPORT**	**12 hours**
Principles of Functions in Safety Management Case Study - Visit to an Industry - Preparation of report on safety measures followed in Airport/Industry.		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**62 hours**

Text Book(s)

1	Environmental Strategies–Hand Book, Kolluru R. V, (1994) Mc Graw Hill Inc., New York
2	A B C of Industrial Safety, Walsh, W and Russell, L, (1984) Pitma Publishing United Kingdom (1984)

Reference Books

1	Environmental and Industrial Safety, (1989) Hommadi, A. H (1989). I.B.B Publication, New Delhi (1989)

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Industrial Safety Engineering – SWAYAM https://onlinecourses.nptel.ac.in/noc20_mg43/preview

Course Designed By:
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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	M	S	M	S	S
CO2	M	M	M	S	S	S	S	S	S	L
CO3	S	S	S	M	L	S	M	M	S	S
CO4	S	S	M	S	S	L	M	L	S	M
CO5	M	S	M	L	L	S	S	S	M	L

*S-Strong; M-Medium; L-Low

Course code 2EA	GROUP A Paper -II BIOETHICS, BIOSAFETY AND IPR	L	T	P	C
Elective		4			4
Pre-requisite	Should have a basic knowledge on Biosafety & IPR	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. The course has been designed to sensitize students about the importance of Personnel Protective Equipment (PPE), general biosafety rules and different biosafety levels.
2. The course further aims to make students aware about the ethical issues involving biological material.
3. The course further includes the different forms Intellectual Property, which a researcher could utilize to protect its intellectual output

Expected Course Outcomes (CO) :

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

1	Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life	K1, K2
2	Recognize importance of biosafety practices and guidelines in research	K2
3	Follow good laboratory procedures and practices	K3
4	Comprehend benefits of GM technology and related issues	K4, K5
5	Understand the social and ethical issues related to plant, animal and modern biotechnology	K3, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	BIOETHICS	12 hours

Introduction to ethics/bioethics – framework for ethical decision making; biotechnology and ethics –benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare

UNIT: 2	BIOTECHNOLOGY AND ETHICS	11 hours

Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research-GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project

UNIT: 3	BIOSAFETY	12 hours

Introduction to biosafety – biosafety issues in biotechnology – risk assessment and risk Management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations – types of biosafety containment

UNIT: 4	INTRODUCTION TO INTELLECTUAL PROPERTY AND INTELLECTUAL PROPERTY RIGHTS	13 hours
Introduction to intellectual property and intellectual property rights – types: patents, copy rights, Trade marks, design rights, geographical indications – importance of IPR - world intellectual Property rights organization (WIPO)		
UNIT: 5	**NATURE OF PATENT**	**12 hours**
What can and what cannot be patented? – Patenting life – legal protection of biotechnological Inventions – Patenting in India: Indian patent act.		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**62 hours**

Text Book(s)

1	Principles of cloning, Jose Cibelli, Robert P. lanza, Keith H. S . Campbell, Michael D.West, Academic Press, 2002

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Intellectual Property Rights and Competition Law – NPTEL https://nptel.ac.in/courses/110/105/110105139/
2	Bioethics – NPTEL https://nptel.ac.in/courses/109/106/109106092/

Course Designed By:
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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	S	S	M	M
CO2	M	S	S	L	S	M	M	S	S	S
CO3	S	M	M	M	M	S	L	L	M	S
CO4	M	S	L	S	S	S	M	S	S	M
CO5	S	M	S	M	M	S	M	M	M	L

*S-Strong; M-Medium; L-Low

Course code 3EA	GROUP A PAPER - III BIOTECHNIQUES	L	T	P	C
Elective		**4**			**4**
Pre-requisite	Should have studied bioinstrumentation	**Syllabus Version**	**2020-2021**		

Course Objectives:

The main objectives of this course are to:

1. It offers the immunological techniques in disease identification
2. It deals with various advanced techniques , instruments for the disease prediction

Expected Course Outcomes (CO) :

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

1	To know the immunological methods in disease prediction	K2,K3
2	It explains the role of biophysical methods in compound identification	K2
3	It helps to identify the role of isotopes in instrumentation	K2
4	To gain knowledge on the microscopy techniques	K4,K1
5	To determine the role of tracers in disease detection	K5,K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	HISTOCHEMICAL AND IMMUNOTECHNIQUES	12 hours

Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH

UNIT: 2	BIOPHYSICAL METHODS	13 hours

Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

UNIT: 3	RADIOLABELING TECHNIQUES	12 hours

Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

UNIT: 4	MICROSCOPIC TECHNIQUES	13 hours

Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

UNIT: 5	ELECTROPHYSIOLOGICAL METHODS	12 hours

Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**64 hours**

Text Book(s)

1	Biotechniques Theory & Practice Rana SVS

Reference Books

1	Modern Biotechniques and Biotechnology H.B, Neelima Gupta edition :1 2015

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Bioanalytical Techniques and Bioinformatics – NPTEL https://nptel.ac.in/courses/102/103/102103044/

Course Designed By:
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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	S	M	M	M	M
CO2	M	M	M	L	L	M	S	S	L	S
CO3	S	S	M	L	L	S	M	L	L	L
CO4	S	S	S	M	M	M	S	S	S	L
CO5	M	S	M	S	S	S	M	S	M	S

*S-Strong; M-Medium; L-Low

Course code 4EA	GROUP A PAPER - IV CONSERVATION BIOLOGY	L	T	P	C
Elective		4			4
Pre-requisite	Should have a basic knowledge on biodiversity conservation & environmental biology	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To know the principles of evolution, and wildlife and conservation biology and how they are used to manage wildlife and solve environmental problems.
2. To use contemporary tools and techniques for studying wildlife, habitat, and ecosystem processes.
3. To be familiar with a variety of laws and regulations that influence how natural resources are used and protected.

Expected Course Outcomes (CO) :

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

1	Analyzing and evaluating the importance of biological processes on conservation of biodiversity	K1, K2
2	Critical reading and understanding of scientific results in conservation biology	K2, K3
3	Planning management of biodiversity and biological resources in the light of ecological and evolutionary dynamics.	K4
4	Discuss appropriate ecological, mathematical, and statistical concepts and methods to interpret, understand and communicate wildlife ecology and conservation data.	K4, K5
5	Advanced understanding of biodiversity and conservation biology that is highly valuable both for scientific and management purposes	K3,K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	BIODIVERSITY; SPECIES CONCEPTS; ANIMAL DIVERSITY	12 hours

What is Biodiversity- Components of Biodiversity (Ecosystem, Genetic and Species diversity) - Assigning values to biodiversity - Species concepts - **Animal diversity**: (Distribution, inventory, species richness) - Biodiversity Hotspots (Western Ghats, Indo-Burma region).

UNIT: 2	LOSS OF ANIMAL DIVERSITY, STATUS OF SPECIES	12 hours

Extinctions: Past rates of Extinctions - Concepts of Island biogeography and extinction rates on Islands - Human induced, Modern and local extinctions - Population reduction-threats to wildlife (examples)- Habitat loss, degradation and fragmentation. Threats to animal diversity in India - **Status of species**: Rare, endemic and threatened species - Measuring status of species in the wild - IUCN Red list (Assessments and methodologies) - Status of Indian animals.

UNIT: 3	CONSERVATION BIOLOGY AND TOOLS IN ANIMAL CONSERVATION	13 hours
What is conservation biology? - *In situ* and *Ex situ* conservation of Indian animals (Case studies) - Population management -Project Tiger and Elephant - Captive breeding programme- peoples participation in conservation - Successes and failures of conservation actions in India (Case study) - **Tools in Conservation**: Interpretation of various data on wildlife - GIS - remote sensing - Landscape model – PVA and CAMP processes.		
UNIT: 4	**ANIMAL LAWS AND POLICIES IN INDIA; ECONOMICS OF BIODIVERSITY CONSERVATION**	**13 hours**
Wildlife (Protection) Act of India (1972) - Protected Area network - forest policy - Prevention of cruelty to Animal Act - Convention on Biological diversity, International Trade in endangered species - Zoo policy- Laws and their applications in Zoological parks, wildlife sanctuaries and biosphere reserves - Economics of biodiversity conservation. Wildlife (Protection) Act of India (1972) - Protected Area network - forest policy - Prevention of cruelty to Animal Act - Convention on Biological diversity, International Trade in endangered species - Zoo policy- Laws and their applications in Zoological parks, wildlife sanctuaries and biosphere reserves - Economics of biodiversity conservation.		
UNIT: 5	**CONSERVATION EDUCATION AND AWARENESS**	**12 hours**
Wildlife / Animal magazines, Journals- How to write popular and Scientific articles - Magazine and Journal information - Wildlife, nature, environment games (examples) – Role of NGO's and Government organizations in wildlife conservation - Wildlife celebration days in India - Biotechnology in conservation.		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**64 hours**

Text Book(s)

1	R. B. Primack 1993. Essentials of Conservation Biology, Sinauer Associates, USA
2	B. Groom bridge 1992. Global Biodiversity. Status of the Earth's Living Resources. Chapman and Hall, London

Reference Books

1	M. L. Reaka - Kudla, D. E. Wilson and E. O. Wilson 1997. Biodiversity II: Understanding and Protecting our Biological Resources. Joseph Henry Press, Washington, DC
2	T. W. Clark, R. P. Reading and A.L. Clarke 1994. Endangered Species Recovery: Finding the Lessons, Improving the process. Island Press, Washington, DC

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Wildlife Conservation – NPTEL https://nptel.ac.in/courses/102/104/102104068/
2	Wildlife Conservation – SWAYAM https://onlinecourses.nptel.ac.in/noc20_bt39/preview

Course Designed By:
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Chidambaram

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	M	S	S	S	S	S	M	M
CO2	S	S	M	L	S	M	M	M	L	L
CO3	M	S	S	S	S	S	S	S	L	L
CO4	S	L	M	S	M	M	L	S	M	M
CO5	S	S	M	M	S	M	S	M	L	L

*S-Strong; M-Medium; L-Low

Course code 1EB	GROUP B PAPER - I PLANT SYSTEM PHYSIOLOGY	L	T	P	C
Elective		4			4
Pre-requisite	Should have a basic knowledge on plant system mechanism	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To understand organisms, however, it is necessary to understand the functions of their cells and biological molecules.
2. This course provides an introduction to basic principles of plant function, primarily covering physical processes in plants, metabolism,
3. To understand secondary products, cell physiology, and introducing principles of growth and development of the plants.

Expected Course Outcomes (CO) :

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

1	Impart an insight into the photosynthesis, respiration and photorespiration	K1, K2
2	Understand the mechanism of various metabolic processes in plants	K2
3	Acquire basic knowledge about growth and development in plants	K3
4	Take students to higher levels of learning about the secondary metabolites	K4
5	Understand the mechanism of various stress physiology in plants	K2, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	PHOTOSYNTHESIS, RESPIRATION AND PHOTORESPIRATION	12 hours

Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO_2 fixation-C_3, C_4 and CAM pathways.

Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photo respiratory pathway

UNIT: 2	PLANT HORMONES & SENSORY PHOTOBIOLOGY	12 hours

Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Structure, function and mechanisms of action of Phytochromes, Cryptochromes and Phototropins; Stomatal movement; Photoperiodism and biological clocks.

UNIT: 3	SOLUTE TRANSPORT AND PHOTO ASSIMILATE TRANSLOCATION	13 hours

Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photo assimilates.

UNIT: 4	SECONDARY METABOLITES	12 hours
Biosynthesis of Terpenes, phenols and nitrogenous compounds and their roles.		
UNIT: 5	**STRESS PHYSIOLOGY**	**12 hours**
Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**62 hours**

Text Book(s)

1	Frank. B. Salisbury and Cleon Wross. Plant Physiology CBS publishers and distributors, New delhi
2	Malcolm S. Wilklins. Advanced Plant Physiology
3	Roy, G. Noggle and George J. Friltz., Introductory Plant physiology

Reference Books

1	Devlin and Barker, 1973 Photosynthesis. Reinhold affiliated east west press Pvt, Ltd, New Delhi
2	Introduction to Plant Physiology, 4th Edition William G Hopkins

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Plant Physiology – SWAYAM https://onlinecourses.swayam2.ac.in/cec19_bt09/preview
2	Plant Physiology and Metabolism – UGC MOOCS http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_ug.php/55

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	S	M	S	L	S	M
CO2	M	S	S	S	S	M	L	S	M	M
CO3	S	M	L	S	M	S	S	M	L	S
CO4	M	S	S	M	M	M	L	M	M	M
CO5	M	L	S	S	S	M	M	S	M	M

*S-Strong; M-Medium; L-Low

Course code 2EB	GROUP B PAPER - II ANIMAL SYSTEM PHYSIOLOGY	L	T	P	C
Elective		4			4
Pre-requisite	Should have a basic knowledge on animal physiology & animal behaviour	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To provide students with a basic understanding of the fundamental processes and mechanisms that serves and controls the various functions of the body.
2. The major areas of study include excitable tissues, muscle, blood, the cardiovascular system and neurophysiology primary literature to develop the ability to think critically about issues in animal physiology and write about those in an effective manner.
3. A comprehensive knowledge of functional physiological pathways common to all animals

Expected Course Outcomes (CO) :

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

1	Have an enhanced knowledge and appreciation of mammalian physiology	K1,K2
2	Understand the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems	K2
3	Understand how these separate systems interact to yield integrated physiological responses to challenges such as exercise, fasting and ascent to high altitude	K2,K3
4	Will be able to recognize and identify principal tissue structures.	K2,K5
5	Will be able to perform, analyse and report on experiments and observations in physiology	K2,K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	BLOOD AND CIRCULATION	12 hours

Blood corpuscles, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. **Cardiovascular System:** Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure

UNIT: 2	RESPIRATORY SYSTEM	11 hours

Anatomy and structure transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

UNIT: 3	NERVOUS SYSTEM	12 hours

Neurons, action potential, gross Neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. **Sense organs:** Vision, hearing and tactile response.

UNIT: 4	EXCRETORY SYSTEM	13 hours
Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.		
UNIT: 5	**DIGESTIVE SYSTEM, ENDOCRINOLOGY AND REPRODUCTION**	**13 hours**
Digestion, absorption, energy balance, BMR. Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation.		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**63 hours**

Reference Books

1	Ganong, H, Review of Medial Physiology, 1989. 14th edition, Appleton &Lange publisher, New York
2	Physiology: A regulatory system approach, Fleur, and Strand, (1978). Macmillan Publishing Company, New York; Collier Macmillan Publishers, London
3	Animal Physiology, EcKert, R (5th edition), 2002. W.H.Freeman
4	Barrington, E.J.W. (1975): An Introduction to General & Comparative Endocrinology 2nd ed., Clarendon press, Oxford
5	Medical Physiology (4th Edition) Guyton Arthur C., Hall John E., W. B. Saunders

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Animal Physiology – SWAYAM https://onlinecourses.nptel.ac.in/noc20_bt42/preview

Course Designed By:
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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	S	M	L	S	S	L
CO2	S	L	S	S	S	S	S	S	S	M
CO3	M	S	M	M	M	L	L	S	M	S
CO4	S	S	M	S	M	S	S	M	M	L
CO5	M	M	S	M	M	L	S	L	S	S

*S-Strong; M-Medium; L-Low

Course code 3EB	GROUP B PAPER - III DEVELOPMENTAL BIOLOGY	L	T	P	C
Elective		4			4
Pre-requisite	Should have a basic knowledge on cell biology	Syllabus Version	2020-2021		

Course Objectives:

The main objectives of this course are to:

1. To Know the broad phylogenetic relationships of animal phyla and some of the traits used to support our current understanding of these evolutionary relationships
2. To be familiar with the events that leads up to and comprises the process of fertilization.
3. To understand the difference between specification and determination

Expected Course Outcomes (CO) :

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

1	Describe the main anatomical changes that occur during development	K2
2	Identify the cellular behaviors that lead to morphological change during development	K1, K2
3	Describe the main signaling pathways that play important roles in development	K3, K4
4	Understand how errors in development lead to congenital defects and spontaneous abortion	K4, K5
5	Describe the main signaling pathways that play important roles in programmed cell death	K2, K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	BASIC CONCEPTS OF DEVELOPMENT	12 hours

Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

UNIT: 2	GAMETOGENESIS, FERTILIZATION AND EARLY DEVELOPMENT	13 hours

Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

UNIT: 3	MORPHOGENESIS AND ORGANOGENESIS IN ANIMALS	12 hours
Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans;* eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination.		
UNIT: 4	**MORPHOGENESIS AND ORGANOGENESIS IN PLANTS**	**13 hours**
Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum.*		
UNIT: 5	**APOPTOSIS**	**12 hours**
Programmed cell death, aging and senescence.		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**64 hours**

Reference Books

1	Essential developmental biology – Jonathan Michael Wyndham slack, Wiley-Blackwell, 2006
2	Current topics in developmental biology – Geral P. Schatten, Academic press, 2006
	The origin of animal body plans: a study in evolutionary developmental biology – Wallace Arthur, Cambridge university press, 2000

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Introduction to Developmental Biology – SWAYAM https://onlinecourses.nptel.ac.in/noc20_bt35/preview

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	S	M	M	S	S	M	L
CO2	S	M	L	S	S	S	L	S	S	S
CO3	M	M	M	M	M	M	S	L	M	M
CO4	S	S	M	S	S	S	M	M	S	L
CO5	M	S	L	S	M	M	L	S	M	S

*S-Strong; M-Medium; L-Low

Course code 4EB	GROUP B PAPER - IV EVOLUTION AND BEHAVIOUR	L	T	P	C
Elective		**4**			**4**
Pre-requisite	Should have basic knowledge on Evolution & environmental biology	**Syllabus Version**	**2020-2021**		

Course Objectives:

The main objectives of this course are to:

1. To provide comprehensive overview of Concept of Evolution
2. To impart descriptive knowledge regarding Origin and Evolution of Man
3. To develop comprehensive knowledge regarding various Sources of Variations and their role in evolution.

Expected Course Outcomes (CO) :

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

1	The students will be able to learn most of the essential aspects of Evolutionary Biology in detail which will help them in acquiring better understanding regarding the subject.	K1
2	Able to recognise when behaviour poses difficulties for accepted wisdom and theory.	K1, K2
3	Able to understand and communicate problems and their solutions to both an intelligent public and a community of informed scientists.	K2, 3
4	Able to think strategically on how to formulate and test adaptive hypotheses.	K3
5	Students will be able to apply evolutionary concepts and findings to real-world questions.	K4, K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

UNIT: 1	EMERGENCE OF EVOLUTIONARY THOUGHTS	12 hours

Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis.

UNIT: 2	ORIGIN OF CELLS AND UNICELLULAR EVOLUTION	13 hours

Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT: 3	PALEONTOLOGY AND EVOLUTIONARY HISTORY	12 hours
The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of plants and animals; stages in primate evolution including Homo.		
UNIT: 4	**BRAIN BEHAVIOR AND EVOLUTION**	**13 hours**
Approaches and methods in study of behavior; proximate and ultimate causation; altruism and evolution-group selection, kin selection, reciprocal altruism; neural basis of learning, memory, cognition, sleep and arousal; biological clocks.		
UNIT: 5	**BEHAVIOR**	**13 hours**
Development of behavior; social communication; social dominance; use of space and territoriality; mating systems, parental investment and reproductive success; parental care; aggressive behavior; habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioral changes		
UNIT: 6	**CONTEMPORARY ISSUES**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**65 hours**

Text Book(s)

Reference Books

1	Carter. G.S. Animal Evolution, 1951, Sedgwick and Jackson, London, England.
2	Sobrig and Sobrig : Population biology and evolution ,1981 Addition Wiley
3	Stahl. V: vertebrate history: problems in evolution 1985, Mc GRAW-Hill, New Delhi
4	Mayer. S: Systematic and origin of species ,1942, University press, Colombia

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Evolutionary Biology – SWAYAM https://onlinecourses.swayam2.ac.in/cec20_bt06/preview

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	L	S	M	S	S	S	M
CO2	S	M	M	S	M	S	S	L	M	S
CO3	M	M	S	S	S	L	M	L	L	M
CO4	M	S	S	S	L	S	S	M	S	S
CO5	M	S	M	M	S	M	S	L	M	M

*S-Strong; M-Medium; L-Low

Course code 23P	PRACTICAL I - LAB IN BIOCHEMISTRY AND ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
Practical		**5**			**4**
Pre-requisite	Should have practical exposure in biochemistry	**Syllabus Version**	**2020-2021**		

Course Objectives:

The main objectives of this course are to:

1. To get hands on experience and to learn the principles behind biochemistry and environmental biotechnology.
2. To give hands on experience for assaying the compound both qualitatively and quantitatively and also to determine the concentration of unknown compound.
3. To train the students on microbiological media preparation, isolation of microbes and staining techniques from various environmental samples.

Expected Course Outcomes (CO) :

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

1	Extending the hands on experience on standard solution preparation, Demonstrating the separation of various compounds using chromatographic techniques.	K1, K6
2	Developing and applying the skills gained through the biochemistry techniques for research as well as for in the various fields of applied science	K2, K4
3	Examining and to analyze the results behind the biotechnological techniques for the development of new techniques in future	K4, K5
4	Applying the practical knowledge to learn about the waste water treatment from the various environmental samples.	K5, K3
5	The students will investigate the different strategies and also resolve the problems encounter to remove heavy metal and hydrocarbons from the polluted samples.	K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

BIOCHEMISTRY

1. Estimation of reducing sugars by Nelson - Somogyi method
2. Estimation of total carbohydrates by Anthrone method
3. Estimation of acid value, saponification value, Iodine number of fat
4. Estimation of total free amino acids
5. Protein estimation by Absorbance at 280nm, Lowry's method and Bradford method.
6. Separation of LDH isozymes from serum by SDS-PAGE.
7. Paper Chromatography - separation of pigments
8. Thin Layer Chromatography - separation of amino acids
9. Ion Exchange Chromatography
10. Gel permeation Chromatography
11. Extraction and purification of peroxidase from soy bean seeds
12. Assay of amylase activity and determination of enzyme kinetic parameters - Km, Vmax and Kcat
13. Estimation of ascorbic acid and riboflavin
14. Estimation of calcium and iron

ENVIRONMENTAL BIOTECHNOLOGY

15. Sampling techniques: Waste water analysis for physio - chemical characteristics such as pH, conductivity, TDS, DO, BOD, COD, CO_2, alkalinity, nutrients, chlorides, hardness, settle ability of solids
16. Isolation of microorganisms (Bacteria and Fungi) from polluted environment
17. Microbial degradation of hydrocarbons
18. Removal of Heavy metals from industrial effluent

REFERENCE

1. Principles of Instrumental Analysis by D. A. Skoog, F. J. Holler and T.A. Nieman, Published by Saunders. 1998. Edition: 5
2. Laboratory Manual of Biochemistry by J. Jayaraman, Published by Willy Eastern. 1981. Edition: 2.
3. Protein Methods by Daniel M. Bollag *et al*. Published by Wiley-Liss, Inc. 1996. Edition: 2.
4. Biochemical Methods by S. Sadasivam and A. Manickam, Published by Reprint New age international (P) Ltd. 1996. Edition: 2.
5. An Introduction to practical Biochemistry by David T Plummer, Published by Tata Mcgraw hill Publication. 1971. Reprinted 2004. Edition: 3.
6. Environmental Biotechnology by C. F. Forster and D.A., John Wase, Published by Ellis Horwood Ltd. 1987.
7. Advances in Waste Water Treatment Technologies (Volumes I and II) by K. Trivedy, Published by Global Science publications.1998.
8. Biocatalysis and Biodegradation: Microbial transformation of organic compounds by Lawrence P. Wacekett, C. Douglas Hershberger Published by ASM Publications. 2000.
9. A Manual of Environmental Microbiology by Christon J. Hurst Published by ASM Publications. 2001. Edition: 2

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	L	M	S
CO2	M	S	S	L	S	S	M	S	L	S
CO3	S	M	S	M	L	M	L	M	S	L
CO4	M	S	S	S	S	S	S	S	L	S
CO5	M	S	M	M	S	M	M	L	S	L

*S-Strong; M-Medium; L-Low

Course code 23Q	PRACTICAL II - MICROBIOLOGY AND MICROBIAL BIOTECHNOLOGY	L	T	P	C
Practical		4			4
Pre-requisite	Should have a basic practical exposure in microbiology	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. The major objective of the course is to impart hands-on training in basic microbiological and microbial biotechnology techniques.
2. Students will be trained in basic bacterial culturing and identification methods, as well as working in biosafety cabinet. Student will become familiar with sterilization techniques when handling bacteria and fungi.
3. Student will be trained to isolate industrially important microorganisms, strain improvement by mutation, fermentation techniques and be taught to present the results both, qualitatively and quantitatively

Expected Course Outcomes (CO) :

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

1	Student is able to use different sterilization procedures and learn handling of micropipette	K1, K2
2	Students will develop understanding about isolation and enumeration of microorganisms from various samples	K2, K3
3	Microbial identification and characterization using a number of approaches will be well understood.	K4, K5
4	Student is able to determine the thermal death point and thermal death time of microorganisms	K4, K6
5	Student will apply practical knowledge for lab scale production of biofertilizer and biopesticide	K4, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

MICROBIOLOGY

1. Microscopy- care and use of microscope
2. Sterilization
3. Sample collection - clinical and Environmental samples
4. Culture media preparation
5. Pure culture techniques
6. Staining of Bacteria: simple, negative, differential, microchemical staining
7. Staining of fungi - Lacto phenol cotton blue
8. Isolation, purification and biochemical identification of bacteria
9. Antibiotic sensitivity test
10. Maintenance and storage of bacterial strains

MICROBIAL BIOTECHNOLOGY

11. Screening and Isolation of Industrially important microorganisms and strain improvement by mutation.
12. Growth curve - measure of bacterial population by turbidimetry and studying the effect of temperature, pH, carbon and nitrogen source in the media.
13. Determination of thermal death point and thermal death time of microorganisms
14. Lab scale fermentation of antibiotics
15. Production of alcohol
16. Production of citric acid from *Aspergillus niger*
17. Production of extracellular lipase from *Bacillus* spp.
18. Immobilization of bacteria
19. Immobilization of enzymes
20. Lab scale production of Biofertilizer and Biopesticide

REFERENCE

1. Manual of Microbiology Tools and Techniques by Kanika Sharma, Published by Ane Books, 2007. Edition: 4.
2. Laboratory Manual on Biotechnology- Prof. P.M. Swamy, Published by Rastogi Publications.
3. Microbial Technology: Fermentation technology - Henry J. Peppler, D. Perlman, Published by Academic Press, 1979. Edition: 2.
4. Microbiology: A laboratory Manual by James G. Cappuccino, & Natalie Sherman, Published by Benjamin/Cummings, 1996. Edition: 7.
5. Experiments in Microbiology, Plant pathology and Biotechnology by K.R. Aneja, Published by New age International Publishers, 2003. Edition: 4.
6. Manual of industrial Microbiology and Biotechnology by Davis J.E. and Demain
7. A.L. Published by ASM publications, 1999. Edition: 2.

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	M	S	M	M
CO2	S	M	M	L	S	M	S	L	L	S
CO3	M	S	M	L	M	S	M	L	M	L
CO4	S	S	S	M	S	M	L	S	M	S
CO5	S	M	S	S	M	M	S	M	M	L

*S-Strong; M-Medium; L-Low

Course code 43P	PRACTICAL - III IMMUNOLOGY, ANIMAL BIOTECHNOLOGY AND PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
Practical		5			4
Pre-requisite	Should have basic practical knowledge on immunology	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. The course gives a broad overview of basic pharmacology
2. Extensive research carried out in industrial setup towards drug discovery and development

Expected Course Outcomes (CO) :

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

1	To learn the cell culture techniques of using body fluids	K1,K2
2	To understand the role of sterilization of media	K2,K4
3	To find the antibodies to fight against infection	K5,K6
4	Analyze the toxicity of drugs and antioxidant	K4,K6
5	To evaluate role of antibodies and the immune blotting and its need	K5,K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

IMMUNOLOGY

1. Demonstration of animal handling for experimental purposes, cervical dislocation, dissection of mice, cardiac puncture, blood sample preparation and its handling
2. Immunization and generation of antiserum in animals against antigen
3. Separation of IgG using affinity chromatography
4. Blood grouping and counting of blood cells
5. Antigen-Antibody Interactions: Radial Immunodiffusion, Ouchterlony double diffusion Precipitin ring test
6. Immunoelectrophoresis and rocket immunoelectrophoresis.
7. Antibody Titre by ELISA
8. SDS-PAGE and Immunoblotting
9. Separation of mononuclear cells from Human peripheral blood

ANIMAL BIOTECHNOLOGY

10. Sterilization techniques
11. Preparation of culture media and sera
12. Preparation of primary cell culture
13. Trypsinizing and subculturing cells from a monolayer
14. Passaging cells in suspension culture
15. Determining cell umber and viability with a hemocytometer and Trypan blue staining
16. Preservation of cells

PHARMACEUTICAL BIOTECHNOLOGY

17. Various modes of administration of drugs: Intravenous, Intramuscular, Intraperitoneal, Intradermal
18. Acute toxicity testing of drugs
19. Determination of analgesic and anti-inflammatory activity of a compound
20. Spectrophotometric determination of Allantoin and Griseofulvin
21. Microbial analysis of Pharamaceuticals (syrups)
22. Qualitative and Quantitative analysis of phytochemicals (any four)
23. Determination of antioxidant activity
    a) DPPH, b) SOD, c) H_2O_2
24. Determination of iron chelating activity of plant extract

REFERENCE

1. Animal Cell Culture: A Practical Approach- R. Ian Freshney, Published by IRL Press, 1986.
2. Practical Immunology - Leslie Hudson, F.C. Hay, Published by Blackwell Scientific Publications, 1981, Edition: 2.
3. Animal Cell Culture: A Practical Approach- John R. W. Masters Contributor John R. W. Master, Published by Oxford University Press, 2000, Edition: 3.
4. Practical Immunology- Leslie Hudson, Frank C. Hay, Published by Blackwell (Oxford), 1976. Pharmaceutical Microbiology by W. B. Hugo & A. D. Russell Published by Blackwell scientific Publications.2009, Edition: 6.
5. Analytical Microbiology by Frederick Kavanagh Volume I & II. Published by Academic Press New York.
6. Quality control in the Pharmaceutical Industry by Murray S. Cooper Volume.II. Published by Academic Press New York.
7. Manual of Clinical Laboratory and Immunology by Noel R. Rose, Published by ASM Publications, 2002, Edition: 6
8. Quality control in the Pharmaceutical Industry by Murray S. Cooper Volume.II. Published by Academic Press New York.
9. Manual of Clinical Laboratory and Immunology by Noel R. Rose, Published by ASM Publications, 2002, Edition: 6

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	L	S	S	S	M	M	L
CO2	S	M	M	S	M	M	L	L	S	M
CO3	M	M	S	S	S	S	M	S	M	L
CO4	M	M	S	S	L	S	S	M	S	L
CO5	M	S	M	M	S	M	M	S	S	S

*S-Strong; M-Medium; L-Low

Course code 43Q	PRACTICAL - IV PLANT BIOTECHNOLOGY AND RECOMBINANT DNA TECHNOLOGY	L	T	P	C
Practical		5			4
Pre-requisite	Should have a basic practical knowledge on plant tissue culture	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. Aims the students to get aware of tissue culture techniques
2. Offers the students to have hands on experience in tissue culture.
3. To gain knowledge in transformation techniques

Expected Course Outcomes (CO) :

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

1	To gain knowledge on the media preparation and techniques	KX
2	To isolate the DNA and RNA from plant	K3,K4
3	To learn the transformation techniques in genetic engineering	K2,K3
4	To quantify the nucleic acid by blotting techniques	K4,K5
5	To study the role of markers in transgenic plant identification	K5,K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

PLANT BIOTECHNOLOGY

1. Composition and preparation of media and sterilization
2. *In vitro* Seed Germination
3. Micropropagation - Nodal and apical meristems.
4. Callus induction , regeneration and Acclimatization
5. Somatic Embryogenesis and Synthetic Seeds
6. Suspension cultures and somatic embryogenesis
7. Anther culture
8. Embryo culture
9. Protoplast Isolation and Viability Testing
10. Isolation of plant genomic DNA
11. Qualitative and quantitative analysis of plant genomic DNA
12. Isolation of plasmid DNA from *Agrobacterium* spp.
13. *Agrobacterium* mediated transformation
14. RNA Isolation from plants and separation in denaturing gel

RECOMBINANT DNA TECHNOLOGY

15. Isolation of genomic DNA from bacteria and animal tissue. Purification and Quantification.
16. Agarose gel electrophoresis
17. Isolation of plasmid DNA from bacteria
18. Restriction digestion and ligation of Lambda phage DNA and gel analysis
19. Transformation of plasmid DNA in *E. coli*, expression and selection

20. Polymerase chain reaction
21. Southern Hybridization using non-radioactive detection
22. Northern Blotting
23. RAPD

REFERENCE

1. Plant Tissue Culture Concepts and Laboratory Exercise - Robert Nicholas Trigiano, Dennis John Gray, Published by CRC Press, 1999 Edition: 2.
2. Introduction to Plant Tissue Culture - M. K. Razdan, Published by Science Publishers, 2003, Edition: 2.
3. An Introduction to Practical Biotechnology - S. Harisha, Published by Firewall Media, 2006.
4. Novo's Handbook of Practical Biotechnology - C. O. L. Boyce, Boyce, Published by Novo Industri A/S, 1986.
5. Genetic Engineering Principles and Practice, Sandhya Mitra, Published by Macmillan India, 1996.
6. Molecular Cloning: A Laboratory Manual - Joseph Sambrook, E. F. Fritsch, Tom Maniatis, Chris Nolan Published by Cold Spring Harbor Laboratory, 1989 Edition: 2.
7. Molecular Cloning: A Laboratory Manual - Joseph Sambrook, David William Russell, Published by CSHL Press, 2001, Edition: 3.
8. Manual on Plant Biotechnology and Recombinant DNA Technology Dr.A.G. Rajalakshmi. Published by LAP LAMBERT Academic Publishing, 2017 Edition: 1.

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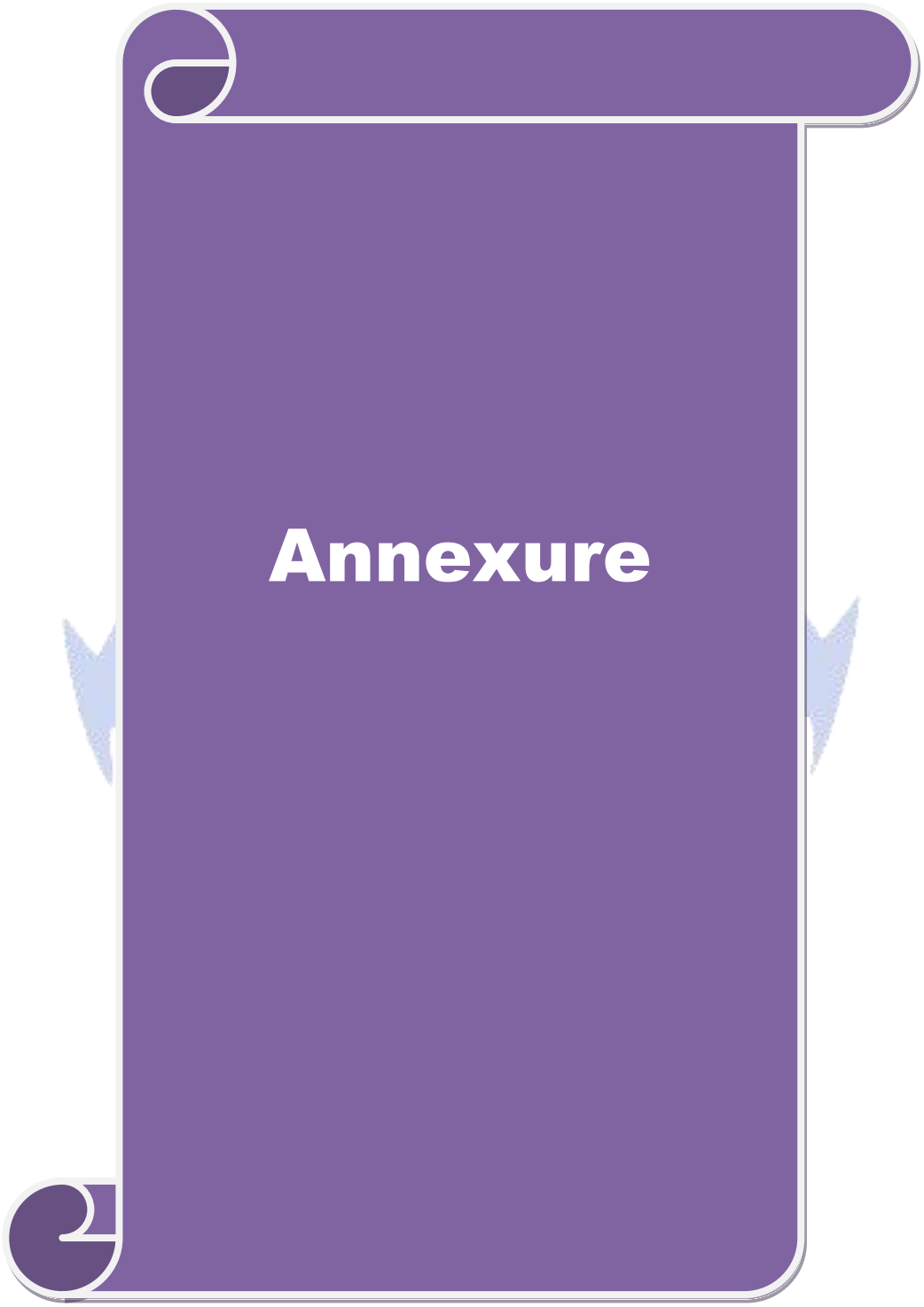
Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	L	S	M	L	S	M	L
CO2	S	M	S	M	M	S	M	M	S	M
CO3	M	M	S	S	S	M	S	S	M	L
CO4	S	M	S	S	M	M	M	L	S	M
CO5	M	S	M	M	S	M	S	S	M	S

*S-Strong; M-Medium; L-Low


Annexure

M. Sc. BIOTECHNOLOGY

(AFFILIATED COLLEGES)

Syllabus

(With effect from 2020-2021)

Program Code :

DEPARTMENT OF BIOTECHNOLOGY
Bharathiar University
(A State University, Accredited with "A" Grade by NAAC and
13th Rank among Indian Universities by MHRD-NIRF)
Coimbatore 641 046, INDIA