M.SC.,
INDUSTRIAL BIOTECHNOLOGY

MODEL SYLLABUS

AUGUST- 2022

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION,
CHENNAI – 600 005

LEARNING OUTCOMES – BASED CURRICULUM FRAME WORK GUIDELINES BASED REGULATIONS FOR POST GRADUATE PROGRAMME	
Programme:	**M.Sc. Industrial Biotechnology**
Programme Code	
Duration	**2 years [PG]**
Program Outcomes (PO)	
On successful completion of the **M.Sc., Industrial Biotechnology** program, the students are expected to	
PO1	Broad based knowledge in Industrial Biotechnology
PO2	Transforming meaningful applications for better healthcare, industries and economic development
PO3	Constant updation of knowledge
PO4	Empowering skills
PO5	Sole responsibility of contributing the public to lead better life through extension activities
PO6	Development of critical thinking and problem-solving skills
PO7	The provision of an inspiring, exciting and collaborative scientific environment
PO8	To inculcate the values of professionalism and dedication
PO9	Develop intelligent strategies and biochemical approaches in problem solving methods
PO10	To compete globally with confidence in all the sectors of life science

Program Specific Outcomes (PSO)	
On successful completion of the **M.Sc., Industrial Biotechnology** program, the students are expected to	
PSO1	Ability to understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind.
PSO2	Ability to contributeeffectively in the development of the ethical practices, societal contributions, and leading to responsible and competent professionals
PSO3	Acquiring the ability of leadership skills to manage projects in multidisciplinary environments
PSO4	Nurture problem solving skills, thinking, creativity through assignments, field work, seminar presentations and project work.
PSO5	Assist students in preparing (personal guidance, research papers, and books) for competitive exams e.g.,NET-JRF, SLET, etc.

M.Sc., INDUSTRIAL BIOTECHNOLOGY

Choice Based Credit System (CBCS)

Choice based credit system is a flexible system of learning. Credit defines the quantum of contents / syllabi prescribed for a course and determine the number of hours of instruction required.

The CBCS has unique features such as enhanced learning opportunities, ability to match students scholastic need and aspirations, inter institution transferability of students, part completion of an academic program in the institution of enrollment and part completion in specialized and recognized institution, improvement in educational quality and excellence, flexibility for working students to complete Programme over an extended time and standardization and comparability of educational programs across the country.

The Preamble of the syllabus

Master of Science (M.Sc.) in Biotechnology, the curricula, and course content were designed to meet the standards of UGC-CSIR (NET) and (SLET) examinations. The choice-based credit system of learning develops a strong base in the core subject and specializes in the disciplines of his / her liking and abilities and develops an in-depth understanding of various aspects of Biotechnology. The students develop experimental skills, design, and implementation of novel synthetic methods, and develop the aptitude for academic and professional skills, by acquiring basic concepts for structural elucidation with hyphenated techniques, and understanding the fundamental biological process and rationale of the computer. The project introduced in the curriculum will motivate the students to pursue research and entrepreneurial skill development**.**

Examination Pattern:
Time allotted: Theory – 03Hrs. & Practical – 04 hrs

Marks allotted for university examination:

	External Marks	Internal Marks	Total marks
Theory	75	25	100
Practical	75	25	100

Marks distribution for internals:

	Test	seminars	Assignment	Total marks
Theory	15	05	05	25

	Test	Record	Total marks
Practical	10	15	25

Pattern of question paper (theory):

The course of study and the scheme of Examination – Department of Biotechnology

	Study Components		*ins. hrs / week*	*Credit*	*Title of the Paper*	*Maximum Marks*		
	Course Title					*CIA*	*Uni. Exam*	*Total*
SEMESTER I								
	Core	Paper -1	5	4	A. Microbial biochemistry	25	75	100
	Core	Paper -2	5	4	B. Industrial microbiology	25	75	100
	Core	Paper -3	5	4	C. Genetic engineering	25	75	100
Internal Elective for same major students (Choose any one)								
	Core Elective	Elective – I	3	3	Statistics Bio informatics Nano biotechnology	25	75	100
	Practical -I		10	4	Environmental Biotechnology & Bioprocess technology Laboratory	25	75	100
	Value Added course	VAC-1	2	2	Cancer Biology ndustrial Hazard Management. letabolic Engineering	25	75	100
			30	**21**				
SEMESTER II						*CIA*	*Uni. Exam*	*Total*

	Core	Paper – 4	4	4	Fermentation Technology	25	75	100
	Core	Paper – 5	4	4	Downstream Process	25	75	100
	Core	Paper – 6	4	4	Enzyme engineering	25	75	100
	Core	Paper - 7	4	4	Immuno technology	25	75	100
Internal Elective for same major students (Choose any one)								
	Core Elective	Elective -II	2	2	Bio entrepreneurship Biopharmaceutical Technology Bio physics	25	75	100
	Practical -II		8	4	Tissue culture Agro Industrial and Immuno techniques & Food Toxicology and waste Management.	25	75	100
						25	75	100
			30	**26**				

Study Components		***ins. hrs / week***	***Credit***	***Title of the Paper***	***Maximum Marks***		
Course Title					***CIA***	***Uni. Exam***	***Total***
SEMESTER III							
Core	Paper -9	4	4	Animal and plant biotechnology	25	75	100
Core	Paper –10	4	4	Environmental biotechnology	25	75	100
Core	Paper – 11	4	4	Bio manufacturing principle and practise	25	75	100
Core	Paper -18	4	4	Molecular basis of disease I	25	75	100
Internal Elective for same major students (Choose any one)							
Core Elective	Elective -III	3	3	Microbiology B.Good manufacturing Practise and quality assurance. C. Applied and Industrial Microbiology	25	75	100
External Elective for other major students (Inter/multi-disciplinary papers) (Choose any one)							

Open Elective	Open Elective - II	2	2	Analytical Technique in Biotechnology Biochemical thermodynamics. Bioprocess Principle	25	75	100
Practical - III		9	4	Environmental Monitoring and quantitative analysis & Environmental Monitoring using remote sensing.	25	75	100
		30	**29**				
***MOOC Courses**			2				100
***USRR**			2				100
SEMESTER IV					***CIA***	***Uni. Exam***	***Total***
Core	Paper -13	4	4	A. Chemical reaction engineering	25	75	100
Core Elective	Elective -IV	3	3	Biofuel Bio polymer technology Medicinal Biotechnology	25	75	100
Core	**Project Compulsory**	**23**	8		100 (75 Project +25 viva)		100
		30	**15**				
		180	**91**		**725**	**2275**	**2900**

Extra credits for * MOOC course = 2
*** USSR Project = 2**

SEMESTER I

PAPER 1: Microbial Biochemistry.

Paper code: Subject: **Microbial Biochemistry.**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts of microbial diversity , introduction to bio molecules, microbial nutrition , cell membrane, bio energetic principles, major catabolic pathway.

Course Objectives

1)To learn the basic concept of Structural /physiological/biochemical difference between

2)basic microbial cell

3)To learn the concepts of bio molecules .

4)To develop knowledge on Microbial nutrition , types of culture medium

5)To understand the basic of cell membrane, bio energetic principles.

6)To develop a piece of knowledge in major catabolic pathways.

Course OutComes

1.After completing unit 1, the students will be able to identify the concept in basic microbial cell ,estimation of microbial biodiversity, diversity in some ecosystems.

1)After completing unit 2, the students will be able to know about the methods in structure of proteins , nucleoside , nucleotide , nucleic acids

2)After completing unit 3, the students will be know about the Microbial nutrition , different types of culture medium

3) After Completing unit 4, the students will be know about the cell membrane, types of transport within the cell

4) After completing unit 5, the students will be know about the cellular metabolism, role in microbial fermentation, the catabolic pathways.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Structural /physiological/biochemical difference between basic microbial cell type, biochemical / microscopic / molecular methods used to differentiate between archae, eubacteria and eukaryotes, estimation of microbial biodiversity, diversity in some ecosystems.	**18 hours**
Unit-II	Sugar- mono , di and polysaccharides with specific reference to glycogen , amylose and cellulose , glycosylation of other biomolecules - glyco proteins and glyco lipids; amino acis - structures and functional group properties , peptides and covalent structure of proteins , nucleoside , nucleotide , nucleic acids- structure a historical perspective leading up to proposition of DNA double helical structure .	**18 hours**
Unit-III	Microbial nutrition , different types of culture medium , C/N/P balance and making of culture medium	**18 hours**
Unit-IV	Outer membrane of Gram -ve bacteria and control of its synthesis (potential targets for drug design). different types of transport within the cell	
Unit-V	Cellular Metabolism Oxidation - reduction reaction , electron carrier and cellular metabolism , High energy compounds and their role in microbial fermentation , enzymes as a catalysts Catabolic Pathways Glycolysis , pentose phosphte pathway , citric acid cycle, oxidattve phosphorylation ; cellular metabolities and interconnectivity in biochemical pathway , respiration and electron pathway	**18hours**
	Total Teaching Hours	**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1)M.T. Madigan and J.M. Martinko (2006), Brock biology of microorganism , 11 th Ed, Pearson Prentice Hall.

2)Voet, D., & Voet , J. G. (2018) . Biochemistry (5 th ed. Hoboken, NJ: J. Wiley & sons.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	1	3	2	3	2	2	3
CO2	3	3	2	1	3	2	3	2	2	3
CO3	3	3	2	1	3	2	3	2	2	3
CO4	3	3	2	1	3	2	3	2	2	3
CO5	3	3	2	1	3	2	3	2	2	3

3 – Strong, 2– Medium, 1– Low

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	2	2	3	3
CO3	3	2	2	3	3
CO4	3	2	2	3	3
CO5	3	2	2	3	3
Weightage	15	14	10	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	3	3

3 – Strong, 2– Medium, 1– Low

SEMESTER I
PAPER 2: Industrial microbiology

Paper code: Subject: **Industrial microbiology**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts of characteristics of microbes , Isolation of microbes from nature and screening of biological activities, culture preservation and inoculum development, small scale liquid fermentation, small scale solid state fermentation, experimental design for improvement of fermentation.

Course Objectives

1. To learn the basic concept of Introduction to microbiology and microbes, cryopreservation
2. To learn the concepts of fermentation.
3. To develop knowledge on small scale process control.
4. To understand the basic of Experimental designs of fermentation.
5. To develop a piece of knowledge in Culture preservation

Course Out Comes

1)After completing unit 1, the students will be able to know the characteristics, structure and growth of microbes .

2)After completing unit 2, the students will be able to know about isolation and screening of microbes.

3)After completing unit 3, the students will know about the culture preservation and inoculum development.

4)After ccompleting unit 4, the students will know about the fermentation.

5)After completing unit 5, the students will know about the solid state fermentation, production of enzymes , small scale process control.

6)After completing unit 6, the students will know about the experimental design of fermentation.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Introduction to microbiology and microbes, morphology , structure and growth bacterial and other microbial growth curves	**18 hours**
Unit-II	Actinomycetes, bacteria, fungi, developing and semi automating , screening tests	**18 hours**
Unit-III	Culture preservation , cryopreservation , inoculum development	**18 hours**
Unit-IV	Introduction and scope, fermentation vessels , shaker , media / composition and gas Exchange, sampling and analysis	
Unit-V	Advantages / disadvantages of solid state fermentation, growth and production of enzymes, small scale process control.	**18 hours**
		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) M.T. Madigan and J.M.Martinko (2006), brock biology of microorganisms, 11 th Ed , pearson prentice - hall.

2) M. Wuilley , L. Sherwoolverton , L.M. Prescott , (2011) prescotts microbiology Mc Graw Hill, New York.

3) A.L. Demain and J. DAvaines (2004), Manual of industrial microbiology and biotechnology , 2 nd ED. ASM press

Web Sources

1) https://nptel.ac.in/courses/102103015

2) https://onlinecourses.swayam2.ac.in/cec22_bt18/preview

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I

PAPER 3: Genetic Engineering

Paper code: **Subject: Genetic Engineering**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts of genetic engineering in modern society, types of vector, types of PCR techniques, cDNA analysis and gene silencing.

Course Objectives

1. To learn the basic concept of Impact of genetic engineering in modern society,

hybridization techniques

2. To learn the concepts of vectors ,protein purification,plant based vectors..

3. To develop knowledge on Principle of PCR,DNA sequencing ; RNA sequencing

4. To understand the basic of transformation , electroporation , transfection, construction of libraries

5. To develop a piece of knowledge in Gene silencing techniques

Course Out Comes

.After completing unit 1, the students will be able to know the general requirements for genetic engineering experiments , DNA ligase, radioactive probes, hybridization techniques

1. After completing unit 2, the students will be able to know about .Plasmids, bacteriophages,p Mal ; GST ; pET - based vector, protein purification ,Ti and Ri as vectors , yeast vectors, shuttle vectors

2. After completing unit 3, the students will be know about the PCR cloning of PCR products,chemical sequencing of DNA.

3. After Completing unit 4, the students will be know about the isolation of mRNA, c DNA and genome libraries, protein - protein interaction .

4. After completing unit 5, the students will be know about the si RNA technology ; Micro RNA,method of genetic manipulation in different model system,

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Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Impact of genetic engineering in modern society ; general requirements for performing a genetic engineering experiments ; restriction endonuclease and methylase ; DNA ligase , Klenow enzyme , T 4 DNA polymerase , poly nucleotide kinase , alkaline phosphatase ; cohesive and blunt end lingation , linkers , adaptors ; homo-polymer tailing ; labeling of DNA ; nick translation , random priming , radioactive and no - radioactive probes ,hybridization techniques ; northern , southern , south - western and far - western and colony hybridization , fluorescence in situ hybridization.	**18 hours**
Unit-II	Plasmids, bacteriophages, M13mp vectors ; PUC 19 and p Blue-script vectors , phagemids ; Lambda vector; Insertion and Replacement vectors ; cosmids; Artificial chromosomes vectors (YACs; BACs); principle for maximizing gene expression vectors , p Mal ; GST ; pET - based vector, protein purification , His- tag , GST - tag ; MBP - tag etc. Intein based vectors ; inclusion bodies , methodologies to reduce formation of inclusion bodies ; mammalian expression and replicating vectors , Baulovirus and pichia vectors system , plant based vectors , Ti and Ri as vectors , yeast vectors, shuttle vectors	**18 hours**
Unit-III	Principle of PCR : primer design , fidelity of thermostable enzyme , DNA polymerases ; types of PCR - multiplex , nested , reverse transcription PCR , real time PCR , touchdown PCR Hot star PCR , colony PCR , asymmetric PCR , cloning of PCR products ; TA cloning vectors ; proof reading enzymes , PCR based site specific mutagenesis; PCR in molecular diagnostics ; viral and bacterial detection, sequencing methods, enzymatic DNA sequencing ; chemical sequencing of DNA ; automated DNA sequencing ; RNA sequencing , chemical synthesis of oligonucleotides, mutation detection : SSCP, DGGE , RFLP	**18 hours**

Unit-IV	Insertion of foreign DNA into host cells, transformation , electroporation , transfection , construction of libraries , isolation of mRNA and total RNA ; reverse transcriptase and c DNA synthesis , c DNA and genome libraries ; construction of micro-arrays - genomic array c DNA array and oligo arrays ; study of protein - DNA interaction ; electrophoretic mobility shift assay ; DNA ase foot printing ; methyl interference assay , chromatin immunoprecipitation ; protein - protein interaction using yeast two - hybrid system ; phage display.	**18 hours**
Unit-V	Gene silencing techniques ; introduction to si RNA technology ; Micro RNA ; construction of siRNA vectors, principle and application of gene silencing ; gene knockout and gene therapy , creation of transgenic plant ; debate over GM crops ; introduction to method of genetic manipulation in different model system e.g. fruit flies (Drosophila), worms (C. elegans), frogs (Xenopus), fish (Zebra fish) and chick. Transgenics - gene replacement ; gene targeting ; creation of transgenic and knock out mice , disease model ; introduction to genome editing by CRISPR - CAS with specific emphasis on Chinese and American clinical traits ; cloning genome targets into CRISPR /Cas9 plasmid, electroporation of Cas9 plasmid into cells ; purification of DNA from Cas9 treated cells and evaluation of Cas9 gene editing in-vitro synthesis of single guide RNA (sgRNA), using Cas9/sgRNA complexes to test for activity on DNA substrate ; evaluate Cas 9 activities by T 7E1 assay and DNA sequence analysis ; Application of CRISPR /cas9 technology. Application gene therapy/gene editing - antiviral strategies , cancer immunotherapy , hematologic disorder ; liver - targeted gene editing, neuromusclar disorder , ocular disorder etc ., examples of Chinese and American clinical trials .	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Old , R.W. , Primrose, S.B., &Twyman, R.M. (2001).Principles of gene Manipulation and Genomics, 7th Edition: Oxford : Blackwell Scientific Publications.

2. F Green , M.R., & Sambrook, J. (2018). Molecular cloning : a Laboratory Manual. Cold

spring Harbor, NY : Cold spring Harbor Laboratory Press.

3. Brown , T.A. (2006). Genomes (3rd ed.). New york ; Garland Science Pub .

4. Selected papers from Scientific Journals, particularly Nature & science .

5. Technical Literature from Stratagene, Promega , Novagen, New England Biolabs

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	2	2	3	3	2	3	3	2	2
CO3	2	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	3
CO2	2	3	3	3	3
CO3	2	3	3	3	3
CO4	2	3	3	3	3
CO5	2	3	3	3	3
Weightage	10	15	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	2	3	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I

CORE ELECTIVE PAPER 1 : Statistics

Paper code: Subject: **Statistics**

Hours/Week: 5Credits: 3

Aim: To enable the students to understand the basic concepts of biological data base, standard deviation, probability, statistical hypothesis , statistical significance , and

experimental designs.

Course Objectives

1. To learn the basic concept of types of biological database, frequency distribution, bar graphs.
2. To learn the concepts of Arthematic Mean, median, mode , range , Coefficient of Variation.
3. To develop knowledge on Principle of probability and distribution.
4. To understand the basic of hypothesis testing.
5. To develop a piece of knowledge in parametric and non parameteric test, sampling.

Course Out Comes

1. After completing unit 1, the students will be able to know about the graphical representation, biological data, frequency distribution.

2. After completing unit 2, the students will be able to know aboutproperties of Arthmetic Mean , medium , mode , range , Properties of Variance and Standard Deviation , Coefficient of Variation ,

3. After completing unit 3, the students will be know about the laws of probability, properties of binomial distribution, Poisson distribution and normal distribution .

4. After Completing unit 4, the students will be know about the calculation of covariance and correlation, correlation coefficient from un grouped data person's Rank Correlation Coefficient , general concepts of regression.

5. After completing unit 5, the students will be know about the Null and alternative hypothesis , error hypothesis testing , confidence interval, the significance and interpretation of results, sampling, distribution of mean and standard error, large sample tests Parametric and Non parametric test.

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Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Types of biological data (ordinal scale , nominal scale, continuous and discrete data), frequency distribution and graphical representation (bar graph, histogram , box plot and frequency polygon), cumulative frequency distribution , populations, samples, simple random , stratified and systematic sampling	**18 hours**
Unit-II	Measures of location, properties of Arthmetic Mean, medium , mode, range , Properties of Variance and Standard Deviation , Coefficient of Variation , Grouped Data, Graphic Methods , Obtaining Descriptive Statistics on Computer , case study.	**18 hours**
Unit-III	Introduction to probability and laws of probability , random events , events - exhaustive , mutually exclusive and equally likely (with simple exercise), definition and properties of binomial distribution , Poisson distribution and normal distribution .	**18 hours**
Unit-IV	Correlation , covariance, calculation of covariance and correlation , correlation coefficient from un grouped data person's Rank Correlation Coefficient , scatter and dot diagram , general concepts of regression, Fitting Regression lines , regression coefficient, properties of Regression coefficients , standard error of estimates.	**18 hours**
Unit-V	Making assumption, Null and alternative hypothesis , error hypothesis testing , confidence interval , one - tailed and two -tailed testing decision making. Steps in testing statistical significance , selection and computation of test of significance and interpretation of results, sampling, distribution of mean and standard error, large sample tests (test for an assumed mean and equality of two population means with known S.D.), z- test; small sample test (t-Test for an assumed mean and equality of means of two population when sample observation are independent); Parametric and Non parametric test (Mann - Whitney test); paired and unpaired t- test ;chi square test.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) Jaype Brothers, (2011), Methods in bio-statistics for medical students and Research workers (English) , 7th Edition
2) Norman T.J. Bailey , (1995), statistical Methods in biology , 3rd Edition , Cambridge University press.
3) P.N. Arora and P.K. Malhan , (2006), Bio-statics , 2nd Edition , Himalaya publishing House
4) Jerold Zar , Bio statistical Analysis , 4th Edition , Pearson Education .
5) Bio-statistics : A Foundation for analysis in the Health Science , 7 th Edition , Wiley.

Web Sources

https://archive.nptel.ac.in/courses/102/106/102106051/
https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-bt01/

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	2	2	3	3	2	3	3	2	2
CO3	2	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low – 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3
CO2	3	3	3	2	3
CO3	3	3	3	2	3
CO4	3	3	3	2	3
CO5	3	3	3	2	3
Weightage	15	15	15	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	3	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I
CORE ELECTIVE 2: Bioinformatics

Paper code: **Subject: Bioinformatics**

Hours/Week:5 Credits: 3

Aim: To enable the students to understand the basic concepts of primary and secondary database, visualizing structural information, sequence alignment, phylogenetic analysis, structural biology, classification of 3D structure, and drug design.

Course Objectives

1) To learn the basic concept of primary & secondary database, Sequence file formats.
2) To learn the concepts of sequence alignment, Multiple Sequence Alignments.
3) To develop knowledge on tree building and tree evaluation, DNA bar coding
4) To understand the Basic concepts in molecular modeling different types of computer representation of molecules
5) To develop a piece of knowledge 3 D structure prediction (sequence similarity/ identity of proteins of known structure .

Course Out Comes

1) After completing unit 1, the students will be able to know about Proteins Data Bank (PDb),
2) Molecular Modelling Database (MMDb), structure file formats, Database of structure viewers.
3) After completing unit 2, the students will be able to know about Evolutionary basis of sequence alignment ,Multiple Sequence Alignments, Motifs and patterns
4) After completing unit 3, the students will be know about Alignments, Comparison and application of Unweighted Pair Group Method with Arithmetic Mean, DNA bar coding,
5) Applications and limitations of bar coding.
6) After Completing unit 4, the students will be know about the Basic concepts in molecular modeling different types of computer representation of molecules,
7) Ramachandran map, anatomy of proteins.
8) After completing unit 5, the students will be know about the DNA & RNA secondary and tertiary structure, Chemical database, Structure based drug design, Structure Activity Relationship.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Introduction , primary &secondary database , Sequence file formats, Introduction to structure , Proteins Data Bank (PDb), Molecular Modelling Database (MMDb), structure file formats, Visualizing structural information , Database of structure viewers , collection of sequence , sequence annotation , sequence description .	**15 hours**
Unit-II	Evolutionary basis of sequence alignment , Optimal alignment methods, Substitution scores & gap penalties , statistical significant of alignments , Database similarly searching ., FASTA, BLAST, Low complexity regions , Repetitive elements , Multiple Sequence Alignments : Progressive alignments methods, Motifs and patterns , Clustral, Muscle, Scoring matrices , Distance matrices .	**18 hours**
Unit-III	Alignments , tree building and tree evaluation , Comparison and application of Unweighted Pair Group Method with Arithmetic Mean (UPGAMA), Neighbouring Joining (NJ), Maximum Parsimony (MP) , Maximum Like hood (ML) methods , Bootstrapping , Jacknife , software for Phylogenetic analysis . DNA bar coding : Methods tools and database for bar coding across all species , Applications and limitations of bar coding , Consortium for Bar coding of Life (CBOL) recommendation , Bar coding of Life Database (BOLD)	**18 hours**
Unit-IV	3-D structure visualization and simulation , Basic concepts in molecular modeling different types of computer representation of molecules ; External coordinated and Internal Coordinates, Molecular Mechanisms, Force field etc. Secondary structure elucidation using Peptide bond, phi, psi and chi torsion angles, Ramachandran map, anatomy of proteins - Hierarchical organization of protein structure - like CATH (Class, architecture , topology , homology), SXOP (structural classification of proteins), FSSP (families of structurally similar proteins)	**18 hours**
Unit-V	DNA & RNA secondary and tertiary structure , t- RNA tertiary structure ; protein secondary structure prediction : Algorithms viz Chou Fasman , GOR method Tertiary structure prediction : Fundamentals of the ,methods for 3 D structure prediction (sequence similarity/ identity of proteins of known structure , fundamentals of the	**21 hours**

	method for 3D structure prediction (sequence similarity / identity of target proteins of known structure , fundamental principle of protein folding etc) Homology/ comparative modeling , fold recognition , threading approaches and lab initio structure prediction methods; CASP (Critical Assesment of protein Structure Prediction); Computational design of promoters , proteins enzymes. Chemical database like NCI/PUBCHEM ; Fundamentals of Receptors - ligands interactions; Structure based drug design : Identification and Analysis of Binding sites and viral screening ; ligand based drug design : Structure Activity Relationship - QSARs & Pharmacophore ; In silco prediction of drug activity and ADMET .	
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) A.D.Baxevanis and B.F.F .Outlette (Eds). (2002), Bio-informatics : a Practical Guide to the Analysis of Gene and Proteins , John Wiley and Sons .
2) D.W. Mount (2001), Bio-informatics : Sequence and Genome Analysis , Cold Spring Harbour Laboratory Press.
3) Jones &Peuzer , (2004) ; Introduction to Bio-informtics Algorithms , Anc Books, India.
4) Dov Stekel , (2003); Microarray Bio-informatics ; Cambridge University Press.
5) Web - resource and suggested reviews/ research papers

Web Sources

1) https://archive.nptel.ac.in/courses/102/106/102106090/
2) https://www.slideshare.net/nmicaelo/structure-based-drug-design?from_search=0

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	2	2	3	3	2	3	3	2	2
CO3	2	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	3	3	3	2
CO3	3	3	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	2
Weightage	15	15	15	15	10
Weighted percentage (rounded of) Course Contribution to POs	3	3	3	3	2

Strong - 3, Medium – 2, Low - 1

SEMESTER I

CORE ELECTIVE 3: Nano Biotechnology

Paper code: **Subject: Nano Biotechnology**

Hours/Week: 5Credits: 3

Aim: To enable the students to understand the basic concepts of Nano architecture,Methods using solid precursors,Nano-structured materials,drug Delivery, Nanotechnology for Cancer Diagnostics and Treatment.

Course Objectives

1) To learn the basic concept of Strategies for Nano architecture,Sol. Gel methods.
2) To learn the concepts of Nanofluidics,Carbon Nanotubes.
3) To develop knowledge on drug Delivery, Protein targeting.
4) To understand the Basic concepts in Small Molecule-Protein Interactions.
5) To develop a piece of knowledge Micro-array and Genome Chips, Tumor-targeted Drug Delivery Systems.

Course Out Comes

1) After completing unit 1, the students will be able to know about Nano architecture,Sol. Gel methods
2) After completing unit 2, the students will be able to know about Nanofluidics,Carbon Nanotubes.
3) After completing unit 3, the students will be know about drug Delivery, Protein targeting.
4) After Completing unit 4, the students will be know about Basic concepts in Small Molecule-Protein Interactions
5) After completing unit 5, the students will be know about Micro-array and Genome Chips, Tumor-targeted Drug Delivery Systems, chemical database

.Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Introduction to nanotechnology: characteristic scale for quantum phenomena, nano particles, nano-clusters, nano composite, nano tubes, nano wires emergence of bio nanotechnology. Characterization of nano particles- UV-Vis spectroscopy, electron Microscopy- HRTEM,SEM, AFM, EDS, XRD.	**18 hours**
Unit-II	Microbial nanotechnology –Microbial synthesis of nano drugs-metal nano particles and drug delivery vehicles- Nanoshels – Tectodentrimers Nano particle drug systems– diagnostic applications of nanotechnology.	**18 hours**
Unit-III	Preparation of nano materials by physical, chemical and Green methods: Polymeric scaffolds collagen, elastin's: Muco polysaccharides, Proteoglycans, cellulose and derivate; dextran's ; alginates; Pectin's; Chitin. Nanoparticles – types, functions-Silver, Gold and Titanium. Physical and chemical properties of nanoparticles.	**18 hours**
Unit-IV	Preparation of nano materials by physical, chemical and Green methods: Polymeric scaffolds collagen, elastin's: Muco polysaccharides, Proteoglycans,cellulose and derivate; dextran's ; alginates; Pectin's; Chitin. Nanoparticles – types, functions-Silver, Gold and Titanium. Physical and chemical properties of nanoparticles.	**18 hours**
Unit-V	Nanoscale applications in biology and medicine: nanotechnology for biology and medicine – micro and nano-fluides- scanning probe microscopy in biology and medicine- self –assembly of biological molecules .drug delivery – protein mediated and nanoparticle mediated. Hybrid conjugates of gold nano particles – DNA oligomers - use of DNA molecules in nanomechanics and computing	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) A.D.Baxevanis and B.F.F .Outlette (Eds). (2002), Bio-informatics : a Practical Guide to the Analysis of Gene and Proteins , John Wiley and Sons .

2) D.W. Mount (2001), Bio-informatics : Sequence and Genome Analysis , Cold Spring Harbour Laboratory Press.

3) Jones &Peuzer , (2004) ; Introduction to Bio-informtics Algorithms , Anc Books, India.

4) Dov Stekel , (2003); Microarray Bio-informatics ; Cambridge University Press.

Web Sources

1) https://archive.nptel.ac.in/courses/102/107/102107058/#

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

Practical I (4 CREDIT)

Environmental Biotechnology

1. Sub cellular fractionation.

1. Titration of amino acids and determination of pKa.
2. Model building using space filling / ball and stick models.
3. Identification of amino acids, sugars and lipids by TLC and/ or color reactions.
4. Isolation and quantification of Nucleic acids.
5. Quantization of proteins, sugars and cholesterol by different methods.
6. Determination of iodine, saponification and acid no. of lipid/ oil samples.
7. Separation of proteins by gel filtration and ion exchange chromatography.
8. Microscopy: Bright field, phase contrast and fluorescence microscopy.
9. Microtomy and Histochemical techniques.

10. Peptide mapping.
18. Separation techniques (HPLC , GLC ,FPLC)

Bio process technology

1. Bacterial transformation
2. Study of mutation by Ames test.
3. Isolation of plasmids .
4. Isolation of genomic DNA and Southern blotting.
5. Isolation of RNA & Northern blotting.
6. Isolation of poly A RNA.
7. Preparation of probes.
8. Demonstration of transcription and translation.
9. Chemical modification of protein.
10. Enzyme: purification and kinetic analysis.

SEMESTER I
VALUE ADDED COURSE
PAPER 1: CANCER BIOLOGY

Paper code: **Subject: Cancer Biology**

Hours/Week:5 **Credits: 2**

Aim: To enable the students to understand the basic concepts of cell cycle, Cancer screening,Chemical carcinogenesis, Signal targets and cancer.

Course Objectives

1) To learn the basic concept of, detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.
2) To learn the concepts of Chemical carcinogenesis
3) To develop knowledge on identification of oncogenes
4) To understand the Basic concepts in heterogeneity of metastatic phenotype
5) To develop a piece of knowledge Gene therapy.

Course Out Comes

1) After completing unit 1, the students will be able to know about rregulation of cell cycle, mutations different forms of cancers
2) .After completing unit 2, the students will be able to know about Theory of carcinogenesis, Chemical , metabolism , principles of physical carcinogenesis.
3) .After completing unit 3, the students will be know about Oncogenes, identification , detection of oncogenes. Oncogenes activity. Growth factors related to transformation. Telomerases
4) . After Completing unit 4, the students will be know about Basic concepts Clinical significance of invasion, heterogeneity of metastatic phenotype, metastatic cascade.
5) After completing unit 5, the students will be know about chemotherapy, radiation therapy, detection of cancers, the Internal Assessment: Assignments, Seminars and Guest lecturers

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	**FUNDAMENTALS OF CANCER BIOLOGY** : Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.	**18 hours**
Unit-II	**PRINCIPLES OF CARCINOGENESIS** : Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.	**18 hours**
Unit-III	**PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER** : Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto oncogene activity. Growth factors related to transformation. Telomerases.	**18 hours**
Unit-IV	**PRINCIPLES OF CANCER METASTASIS** : Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion	**18 hours**
Unit-V	**NEW MOLECULES FOR CANCER THERAPY** : Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) DeVita VT Jr, Lawrence TS, Rosenberg SA. 2015. Cancer: Principles & Practice of Oncology: Primer of the Molecular Biology of Cancer. Ed.

2) Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007

3) McDonald, F etal., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004.

Web Sources

1) https://nptel.ac.in/courses/102106025
2) https://www.slideshare.net/guest2f1d32/biologia-del-cance

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low – 1

SEMESTER I

VALUE ADDED COURSE

PAPER 2: INDUSTRIAL HAZARD MANAGEMENT

Paper code:
Subject: **INDUSTRIAL HAZARD MANAGEMENT**

Hours/Week:5Credits: 2

Aim: To enable the students to understand the basic concepts of Industrial Hazard Management .

Course Objectives

1.To learn the basic concept of identify and causes of various Hazards

2.To learn the concepts of Enable the students to compare the hazards of chemicals with the permissible levels.

3.To develop knowledge on Acquire knowledge about types of hazards arising out of physical, chemical and biological agents.

4.To understand the Basic concepts in Demonstrate various techniques involved in Hazard waste Management.

5.To develop a piece of knowledge Recognize the issues related to environment and safety.

Course Outcomes

1. After completing unit 1, the students will be able to know about Physical hazard.
2..After completing unit 2, the students will be able to know about Chemical hazard.

3.After completing unit 3, the students will be know about Biological and Ergonomical hazards.
4. After Completing unit 4, the students will be know about Basic concepts in Hazardous Waste Management.
5. After completing unit 5, the students will be know about Safety Management.

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Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs-vibration, types, effects, instruments, surveying procedure, permissible exposure limit.	**18 hours**
Unit-II	Recognition of chemical hazards-dust, fumes, mist, vapor, fog, gases, types, concentration, Exposure vs. dose, TLV-Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapor monitors, dust sample collection devices, personal sampling	**18 hours**
Unit-III	Classification of Biohazardous agents–examples, bacterial agents, rickettsial and chlamydial agents,viral agents, fungal, parasitic agents, infectious diseases-Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets.Work Related Musculoskeltal Disorders–carpal tunnel syndrome CTS-Tendon paindisorders of the neck-back injuries	**18 hours**
Unit-IV	Waste generation, control and sustainable reuse of Biodegradable waste after segregation, Transportation of waste and identified areas with blocks marked out for separate categories. Identifying target application of processed waste and costs involved - Documentation procedures and understanding standard permissible waste limits as per statutory regulations. Storage and identification of processed waste. Evaluation of time and scope of reuse. Tabulation and documentation. Laboratory tests for potability of such reprocessed material. Health hazards-toxic and radioactive wastes-incineration and vitrification-hazards due to bio-process-dilution-standards and restrictions–recycling and reuse	**18 hours**
Unit-V	Organising for safety, Health and Enviornment, Organisation : Structure, Function and responsibilities, Safety Committee : Structure and function,The competent person in relation to safety legislation - duties and responsibilities, Competence Building Technique (CBT), Concept for training, Employee participation in safety - Colour coding and its awareness, Types of fire and its control, SOPs for machinery and process, Packing and storage, Emergency preparedness procedures, Training towards risk elimination, Role of Trade union in safety, health and environment. Safety promotion and safety awards, safety, competitions, audio visual publication.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS

1) S.P.Mahajan, "Pollution control in process industries", 1 stEdition, Tata McGraw Hill Publishing Company, New Delhi, 1993.

2) Krishnan N.V. "Safety Management in Industry", 1 stEdition, Jaico Publishing House, Bombay, 1997.

REFERENCE BOOKS

B.D. Singh, "Biotechnology", Kalyani Publishers, 1st Edition,2003.

WEB SOURCES

1) slideshare id=249824553&doc=biohazard-210721180535
2) https://www.slideshare.net/rajeevkashyap/waste-management-1832384
3) https://csumb.edu/risk/health-and-safety/chemical-and-laboratory-safety/biohazard-control-program-including-biohazardous-waste/

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	2	3	3	3
CO2	3	3	2	3	2	3	3	3	2	2
CO3	3	3	2	3	2	3	3	2	2	2
CO4	3	3	2	2	2	3	3	3	2	3
CO5	3	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	3	3	3	2
CO3	3	3	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	2
Weightage	15	15	15	15	10
Weighted percentage (rounded of) Course Contribution to POs	3	3	3	3	2

Strong - 3, Medium – 2, Low - 1

SEMESTER I
VALUE ADDED COURSE
PAPER 3: METABOLIC ENGINEERING

Paper code: Subject: **METABOLIC ENGINEERING**

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts of To provide a quantitative basis, based on thermodynamics, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level. To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner.

Course Objectives

1.To learn the basic concept of quantitative basis

2.To learn the concepts of metabolic networks in single cells and at the organ level

3.To develop knowledge on organisms to produce valuable substances on an industrial scale

4.To understand the Basic concepts in thermodynamics,

5.To develop a piece of knowledge in enzyme kinetics,

Course Out Comes

1) After completing unit 1, the students will be able to know about To learn stoichiometry and energetics of metabolism
2) After completing unit 2, the students will be able to know about To apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields
3) After completing unit 3, the students will be know about To integrate modern biology with engineering principles
4) After Completing unit 4, the students will be know about Basic concepts in to design a system, component, or process to meet desired needs.
5) After completing unit 5, the students will be know about metabolic network

.

Units	Course Contents	Teaching hours
Unit I	**INTRODUCTION TO EXAMPLES OF PATHWAY MANIPULATION - QUALITATIVE TREATMENT** Enhancement of Product Yield and Productivity, Extension of substrate Range, Extension of Product spectrum and Novel products, Improvement of Cellular properties, Xenobiotic degradation.	**18 hours**
Unit-II	**MATERIAL BALANCES AND DATA CONSISTENCY** Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems-identification of gross measurement errors. Introduction to MATLAB®	**18 hours**
Unit-III	**METABOLIC FLUX ANALYSIS** Theory, over determined systems, underdetermined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis.	**18 hours**
Unit-IV	**METABOLIC CONTROL ANALYSIS** Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations	**18 hours**
Unit-V	**ANALYSIS OF METABOLIC NETWORKS** Control of flux distribution at a single branch point, Grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplifications, consistency tests and experimental validation.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) A.D. Baxevanis and B.F.F .Outlette (Eds). (2002), Bio-informatics : a Practical Guide to the Analysis of Gene and Proteins , John Wiley and Sons .
2) D.W. Mount (2001), Bio-informatics : Sequence and Genome Analysis , Cold Spring Harbour Laboratory Press.
3) Jones &Peuzer , (2004) ; Introduction to Bio-informtics Algorithms , Anc Books, India.
4) Dov Stekel , (2003); Microarray Bio-informatics ; Cambridge University Press.

Web Sources:

1) https://www.slideshare.net/guillermogaribay1447/stoichiometry-of-cellular-reactions

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II

PAPER 1: Fermentation technology.

Paper code: **Subject: Fermentation technology.**

Hours/Week:5 Credits: 4

Aim: To enable the students to understand the basic concepts of basic reaction theory, general reaction kinetics for biological system.Types of sterilization, types of fermentation, bioreactor configuration, bioprocess scale up.

Course Objectives

1.To learn the basic concept of reaction Basic homologous reaction theory, general reaction kinetic for biological system.

2.To learn the concepts of Types of sterilization,Various types of fermentation, Overview of bio synthetic mechanism ; Metabolic stoichiometry.

3.To develop knowledge on bioreactor configurations practical consideration for bioreactor construction

4.To understand the Heat and mass transfer issues in bioreactors,Various approaches to scale up including regime analysis and scale down.

1. To develop a piece of knowledge Bulk organs,Biomass,Organic acids.

Course Out Comes

1) After completing unit 1, the students will be able to know about Basic reaction theory, calculation of reaction rates,cell growth kinetics , production kinetics , kinetics of cell death, Concept of maintenance and calculation of maintenance coefficient.
2) After completing unit 2, the students will be able to know about Types of sterilization,
3) Various types of fermentation. Overview of bio synthetic mechanism
4) After completing unit 3, the students will be know about monitoring and control of bioreactors, ideal reactor operations, batch operation of a mixed reactor .
5) After Completing unit 4, the students will be know about the Heat and mass transfer issues in bioreactors, Scale up method by currently used rule,Various approaches to scale up including regime analysis and scale down.
6) After completing unit 5, the students will be know about the Commercial Product Processing..

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Homologous reaction Basic reaction theory, calculation of reaction rates , general reaction kinetics for biological system , yields in cell culture , cell growth kinetics , production kinetics , kinetics of cell death ; Continuous stirred tank reactor as a tool for calculating kinetics parameters for growth and production formation ; Concept of maintenance and calculation of maintenance coefficient.	**18 Hours**
Unit-II	Types of sterilization , thermal death kinetics of microorganisms; Heat sterilization of liquid medium in batch and continuous mode ; Air sterilization ; Inoculum development ; Various types of fermentation , submerged and solid state fermentation , aerobic and anaerobic fermentation ; Overview of bio synthetic mechanism ; Metabolic stoichiometry.	**18 Hours**
Unit-III	Bioreactor configurations practical consideration for bioreactor construction, monitoring and control of bioreactors, ideal reactor operations, batch operation of a mixed reactor	**18 Hours**
Unit-IV	Heat and mass transfer issues in bioreactors, Estimation of KLa , Scale up with constant parameter like oxygen transfer rate , mixing, shear stress,f low regime, Reactor volume , etc. Scale up method by currently used rules -of - thumb viz. Constant P/V, kLa, Various approaches to scale up including regime analysis and scale down ; Analysis of alternate bioreactor configuration including cell -cycle , air lift and immobilized - cell bioreactors, Problems on scale - up method	**18 Hours**
Unit-V	Bulk organs (ethanol), Biomass (Bakers yeast), Organic acids (Citric acid), Amino acids (L- Lysine), Microbial Transformation (steroids), Antibiotics (Penicillin), Extra Cellular Polysaccharides (Xantham Gum) , Nucleotide (5- GMP), vitamins (B18) ,Pigments (Shikonim) Production of cell biomass and some primary metabolites , e. g. ethanol , acetone - butanol, citric acid , dextran and amino acids ; Microbial production of industrial enzymes - glucose isomerase , cellulase & lipases.	**18 Hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) M.L.Schuler, F. Kargi & M. DeLisa , (2017), Bio-process Engineering -
2) Basic Concepts , 3rd Ed., Prentice Hall.
3) Pauline M. Doran, (2018), Bio-process Engineering Principles, 2 ndEdition Academic Pres.
4) C.Ratledge &B. Kristiansen, (2008). Basic Biotechnology, 3rd Ed., Cambridge University Press.
5) Peter F. Stanbury, Stephen J. Hall & A. Whitaker, (2007), Principles of fermentation Technology , Elsevier India Pvt Ltd.

Web Sources

1) https://archive.nptel.ac.in/courses/102/106/102106086/

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II

PAPER 2: Down stream Process.

Paper code: Subject: **Down stream Process.**

Hours/Week: 5

Credits: 4

Aim: To enable the students to understand the basic concepts of screening and design purification, low resolution protein purification method, protein purification and characterization,and also about animal based products.

Course Objectives

1) To learn the basic concept of Overview of down - stream processing,ion - exchange chromatography.
2) To learn the concepts of Aqueous two phase partitioning system, Chromatography.
3) To develop knowledge on Protein Purification and characterization.
4) To understand the proteins based therapeutic products.
5) To develop a piece of knowledge on animal based products.

Course Out Comes

1) After completing unit 1, the students will be able to know about deign space for bio-pharmaceutical process, Media selection in ion - exchange chromatography in single micro-plate.
2) After completing unit 2, the students will be able to know about Aqueous two phase partitioning system, purification refolding of protein by affinity precipitation.
3) After completing unit 3, the students will be know about initial recovery of protein, protein characterization ..
4) After Completing unit 4, the students will be know about the .general principleof impurities potentially present in proteins based therapeutic products.
5) After completing unit 5, the students will be know about the Tissue Plasminogen activator, insulin, erythropoietin.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Overview of down - stream processing ; Establishment of deign space for bio-pharmaceutical process, High - through out process development , Media selection in ion - exchange chromatography in single micro-plate , high - throughput screening of dye - ligand for chromatography.	**18 hours**
Unit-II	.Aqueous two phase partitioning system , A platform for isolation of process related impurities from therapeutics proteins , Simultaneous purification refolding of protein by affinity precipitation and macro (Affinity ligand)- facilitate three- phase partitioning bacterial cytoplasm and periplasm , immunoglobulin purification by caprylic acid ; Filtration , Chromatography (comparison),rationale of choosing between quality and cost of different products .	**18 hours**
Unit-III	Introduction , initial recovery of proteins , removal of whole cells and cell debris , concentrations and primary purification , protein inactivation and stabilization , protein characterization	**18 hours**
Unit-IV	Some general principle , range and medical significance of impurities potentially present in proteins based therapeutic products , labeling and packing of finished products	
Unit-V	General DSP, Case studies of : monoclonal antibodies ; Tissue Plasminogen activator, insulin, erythropoietin. . General DSP, Case studies of : shikonin , Protein extract from Seed material and green tissues.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Nikolaos . E . Labrous (2014), Protein Downstream Processing : Design Development and

application of high and low Resolution Methods in Molecular Biology ,

Spinger protocols, Human Press.

2.Gary Walsh , (2002), Proteins : Biochemistry and Biotechnology , 2 nd Editions , Wiley Blackwell

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II

PAPER 3: Enzyme Engineering

Paper code: Subject: **Enzyme Engineering**

Hours/Week:5 Credits: 4

Aim: To enable the students to understand the basic concepts of enzymes, nomenclature and classification of enzymes, types of specificity, mechanism of catalysis, enzyme kinetics, immobilization of enzyme, industrial application of enzymes, industrial enzymes.

Course Objectives

1) To learn the basic concept of Nomenclature and classification , Properties , structure of enzymes
2) To learn the concepts of Koshland "Induced fit " hypothesis,Mechanism of catalysis, Metal - activated enzyme and metalloenzyme
3) To develop knowledge on Kinetics of enzymes,Specific activity of enzymes
4) Inhibition of enzymes activity, Regulation of enzymes activity .
5) To understand the Concept, Methods of immobilization , kinetics of immobilized enzymes.
6) To develop a piece of knowledge on Industrial enzymes.

Course Out Comes

1) After completing unit 1, the students will be able to know about Properties of enzymes ,
2) structure of enzymes , active site of enzymes , factors influencing enzyme activity , enzyme assays
3) After completing unit 2, the students will be able to know about Mechanism of catalysis,
4) Mechanism of reaction catalyzed by enzymes without co factor , Metal - activated enzyme and metalloenzyme
5) After completing unit 3, the students will be know about Kinetics of enzymes - catalyzed reaction, Methods for investigation kinetics of enzymes - catalyzed reaction.
6) .After Completing unit 4, the students will be know about the Effect of immobilization on enzymes , Use of immobilized enzymes.
7) After completing unit 5, the students will be know about the traditional (non-Recombinant source of industrial enzymes , Impact of genetic engineering on enzyme production.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	What are enzymes , Brief history of enzymes , Nomenclature and classification of enzymes , Properties of enzymes , structure of enzymes , active site of enzymes , factors influencing enzyme activity , enzyme assays	**18 hours**
Unit-II	. Types of specificity , Koshland "Induced fit " hypothesis , Strain or transition - state stabilization hypothesis; Mechanism of catalysis, Mechanism of reaction catalyzed by enzymes without co factor , Metal - activated enzyme and metalloenzyme, coenzyme in enzymes catalyzed reactions.	**18 hours**
Unit-III	Kinetics of enzymes - catalyzed reaction, Methods for investigation kinetics of enzymes - catalyzed reaction , Interpretation of Km, Vmax , Turnover number and Kcat , Specific activity of enzymes , Enzyme units , Inhibition of enzymes activity, Regulation of enzymes activity	**18 hours**
Unit-IV	Concept, Methods of immobilization , kinetics of immobilized enzymes , Effect of immobilization on enzymes , Use of immobilized enzymes , Bioreactor using immobilized enzymes	
Unit-V	Industrial enzymes : Sales value of industrial enzymes , traditional (non- Recombinant source of industrial enzymes , Impact of genetic engineering on enzyme production, Engineered enzymes, Extremophiles, hyperthermophiles, Enzymes from hyperthermophiles, Enzymes from additional extremophiles, Enzymes in organic solvents Protease and Carbohydrates , Proteolytic enzymes : Carbohydrates , Lingnocellulose degrading enzymes , Pectin and Pectin enzymes	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) T.Palmer and P.L. Bonner , (2007), Enzymes : Biochemistry, Biotechnology and Clinical Chemistry, Woodhead publishing limited .
2) N.C /Price and L. Stevens , (2002), Fundamentals of Enzymology , Oxford university Press.
3) Wolfgag, Aehle , (2004), Enzyme in Industry ; Production and appliction (Ed) Wiley - VCH Verlag GmbH & Co.KGaA.
4) Branden and RTooze , (1999), Introduction to proteins structure , Garland Publishing Group
5) Gary Walsh, (2014), Proteins : Biochemistry and Biotechnology , John Wiley & Sons Ltd.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II

PAPER 4: Immuno technology

Paper code: **Subject: Immuno technology**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts on lymphocyte maturation and cell mediated immune response, Immunoglobulins, Antigen antibody interaction, vaccinology, clinical immunology, Monoclonal antibodies.

Course Objectives

1) To learn the basic concept of innate and acquired immunity, haptens, major histo compatibility.
2) To learn the concepts of Immunoglobulins, cell signaling, B cell maturation.
3) To develop knowledge on antigen antibody interaction, vaccinology..
4) To understand the Concept of clinical immunology.
5) To develop a piece of knowledge on Enzyme engineering .

Course Out Comes

1) After completing unit 1, the students will be able to know about Important organs and cells of immune responses, Role of MHC in infectious disease and disease susceptibility , HLA typing .
2) After completing unit 2, the students will be able to know about Immunoglobulins - basic structure , classes & sub classes of immunoglobulins. cell signaling.
3) After completing unit 3, the students will be know about immunological techniques, CMI techniques, Hybridoma and monoclonal antibodies.
4) After Completing unit 4, the students will be know about the Active and passive immunization, proteins based vaccines ,vaccine technology - role and properties of adjuvants Recombinant DNA and proteins based vaccines
5) After completing unit 5, the students will be know about the autoimmunity; types of autoimmune disease ,cancer immunotherapy,immunodeficiency.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	**LYMPHOCYTE MATURATION AND CELL - MEDIATED IMMUNE RESPONSE** Components of innate and acquire immunity ; Important organs and cells of immune responses, complement and inflammatory responses; pathogen recognition receptors (PRP) and pathogens associated molecular pattern (PAMP); innate immune response ; mucosal immunity ; antigens - imunogens , haptens ; Major histo-compatibility complex (MHC) genes, Role of MHC in infectious disease and disease susceptibility , HLA typing	**18 hours**
Unit-II	.**IMMUNOGLOBULINS** - basic structure , classes & sub classes of immunoglobulins , antigenic determinants ; multigene organization of immunoglobulins gene ; B - cell receptor ; Immunoglobulin super family; Principle of cell signaling ; basis of self & non - self discrimination kinetics of immune response , memory ; B cell maturation , activation and differentiation ; generation of antibody diversity ; T- cell maturation , activation and differentiation ; and T- Cell receptors ; functional T cell subset ; cell - mediated immune response , ADCC; cytokines - properties , receptors and therapeutics uses ; antigens processing and presentation - endogenous antigens , exogenous antigens, non - peptide bacterial antigens and super- antigens ; cell - cell co-operation.	**18 hours**
Unit-III	**ANTIGEN - ANTIBODY INTERACTIONS** Precipitation , agglutination and complement mediated immune reactions; advanced immunological techniques - RIA , ELISA , Western blotting , T- cells epitope prediction and ELISPOT assay, immunofluroscence, flow cytometry and immuno electron microscopy ; surface plasmon resonance , biosensor assay for assessing ligand - receptor interaction , CMI techniques - lympho proliferation assay, mixed lymphocytes reaction , cell cytotoxicity assay , apoptosis, micro arrays, transgenic mice , gene knock outs, Hybridoma and monoclonal antibodies , Applications of monoclonal antibodies ; HLA - tetramer complex, Application of HLA - tetramer complex in analyzing antigen / Peptide - specific T cell response using flow cytometer.	**18 hours**

Unit-IV	**VACCINOLOGY** Active and passive immunization ; live killed , attenuated , subuint vaccines ; vaccine technology - role and properties of adjuvants, Recombinant DNA and proteins based vaccines , reverse vaccinology ; peptide vaccine , conjugate vaccine ; antibody genes and antibody engineering ; chieric , hybrid monoclonal antibodies , catalytic antibodies and generation of immunoglobulin gene libraries ; idiotic vaccines and marker vaccines , viral - like particles (VLPS), dendritic cell based vaccines, vaccines against cancer, T cell based vaccine; edible vaccine and therapeutic vaccine , Success stories in vaccinology e.g. Hepatitis , Polio, Small pox , DPT.	
Unit-V	**CLINICAL IMMUNOLOGY** Immunity to infection : bacteria , viral, fungal and parasitic infections (Tuberculosis , HIV / AIDS , Schistosomiasis, Kala Azar, Chikungunya Dengue); hypersensitivity reactions - Type I-IV ; autoimmunity; types of autoimmune disease ; mechanism and role of CD 4+ T cells; MHC and TCR in autoimmunity; transplantation - immunological basis of graft rejection ; clinical transplantation and immuno suppressive therapy ; tumor immunology - tumour antigens; immune response to tumour and tumour evasion of the immune system, cancer immunotherapy ; immunodeficiency - primary immunodeficiency , acquired or secondary immuno deficiencies , anaphylactis shock ; immuno deficiencies , acquired or secondary immunodeficiencies , anaphylatics shock; immuno senescence: a challenge for an aging population ; Immune exhaustion in the setting of chronic infections and malignancies ; chronic Inflammation (Inflammating) and immune activation ; mucosal immunity and Gut Associated Lymphoid Tissue (GALT) in various gastrointestinal (GI) infections ; complement deficiencies and human health ; role of regulatory B cells (Bregs) in human disease Monoclonal antibodies and their therapeutic role in reversing T cell Functionality , Fab , F (ab) 2 Fragments; single - chain variable fragments (scFv), A tri functionality antibody ; Bi specific T -cell engagers (BiTEs) as artificial bi specific monoclonal antibodies for the use as anti cancer drug .	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1) Kindit , T. J., Goldsby , R.A., Osborne , B.A., &Kubly , J . (2006). Kuby Immunology . Newyork : W.H. Freeman .
2) Brostoff , J., Seaddin , J.K. Male , D., & Roitt, I. M. (2002). Clinical Immunology. London : Gower Medicinal Pub
3) Murphy, K., Travers, P., Walport , M . & Janeway , C . (2018). Janeway ‘s Immuno biology. New york : Garland science .
4) Paul . W.E. (1993). Fundamental Immunology . New york : Raven Press.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	2	3	3	3
CO2	3	3	2	3	2	3	3	3	2	2
CO3	3	3	2	3	2	3	3	2	2	2
CO4	3	3	2	2	2	3	3	3	2	3
CO5	3	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II
CORE ELECTIVE: Bio entrepreneurship

Paper code: **Subject: Bio entrepreneurship**

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts on innovation and entrepreneurship in bio business;Bio markets; finance and accounting; technology management.

Course Objectives

1) To learn the basic concept of Introduction and scope in Bio-entrepreneurship,Strategy and operation of bio- sector firms,Factors shaping opportunities for innovation and entrepreneurship in bio - sector.\
2) To learn the concepts of Pricing strategy,Challenges in marketing in bio business, Basic contract principles
3) To develop knowledge on Business plan preparation, Information technology.
4) To understand the Concept Quality control & transfer of foreign technologies
5) To develop a piece of knowledge on technology management.

Course Out Comes

6) After completing unit 1, the students will be able to know about opportunities for innovation and entrepreneurship in bio - sector , and the business implication of entrepreneurship development progrmmes off public and private agenices.
7) After completing unit 2, the students will be able to know about Challenges in marketing in bio business, Basic contract principles , different types of agreements and disputes resolution skills
8) After completing unit 3, the students will be know about Business plan preparation, financial managements issues, Collaboration & partnership , Information technology.
9) After Completing unit 4, the students will be know about the Quality control & transfer of foreign technologies, Understanding of regulatory compliance
10)
11) 5 . After completing unit 5, the students will be Business Sectors and forms
12)

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	**INNOVATION AND ENTERPRENEURSHIP IN BIO BUSINESS** Introduction and scope in Bio- entrepreneurship, Types of bio - industries and competitive dynamics between the sub - industries of the bio- sector (e.g pharmaceuticals vs Industrial biotech), Strategy and operation of bio- sector firms : Factors shaping opportunities for innovation and entrepreneurship in bio - sector , and the business implication of those opportunities , Alternative faced by emerging bio-firms and the revelent tools for startegic decisions, Entrepreneurship development progrmmes off public and private agenices (MSME, DBT, BRIAC , Make In India), strategic dimension of patenting & commercialization strategies.	**18 hours**
Unit-II	**.BIOMARKETS : BUSINESS STRATEGT AND MARKETING** Negotiating the road from lab to the market (strategies and process of negotiation with finance-rs , government and regulatory authorities), Pricing strategy , Challenges in marketing in bio business (market condition & segments ; developing distribution channels , the nature analysis and managements of customer needs), Basic contract principles , different types of agreements and contract terms typically found in joint venture and development agreements , Disputes resolution skills	**18 hours**
Unit-III	**FINANCE AND ACCOUNTING** Business plan preparation including statutory and legal requirements , Business feasibility study, financial managements issues of procurement of capital and managements of costs, Collaboration & partnership , Information technology. **TECHNOLOGY MANAGEMENT** Technology - assessment , development &upgradation , Managing technology transfer , Quality control & transfer of foreign technologies , Knowledge centers and Technology transfer agencies , Understanding of regulatory compliance and procedure (CDSCO, NBA, GCP, GLA, GMP).	**18 hours**

Unit-IV	**Business Sectors and forms** Meaning and classifications - primary, secondary and tertiary sectors - Business Organisation – Forms of business organization, Sole Proprietorship, Partnership firms, Joint stock companies, Co-operative Society – their features, relative merits, demerits & suitability – Concept of Social Enterprise and Social Entrepreneurship, Social Entrepreneurs, Sustainability issues in Social Entrepreneurship – Entrepreneurial failure, issues, reasons and revamps.	
Unit-V	.**Entrepreneurship Development and Government** : Role of Government in promoting Entrepreneurship, MSME policy in India – District Industries Centres (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship Development Board (NEDB) – Recent initiatives by the Central and State Governments to boost startups and entrepreneurship in India , Startup India, Skill India, MSDE and NSDC– Financial Support System for entrepreneurship development	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Adams, D.J., &Sparrow , J.C. (2008). Enterprise for life scientists : Developing Innovation and Entrepreneurship in the Bioscience , Bloxham : Scion .

2. Shimaski , C. D (2014). Biotechnology Entrepreneurship: Starting , Managing , and Leading Biotech companies . Amsterdam : Elsevier . Academic Press is an imprint of Elsevier .

3. Onetti, A., &Zucchella , A. Business Modeling for life Science and Biotech Companies : Creating Value and Competitive Advantages with the Miles tone Bridge . Routeldge

4. Jordan , J. F. (2014). Innovation , Commercialization , and Start - Ups in Life science London : CRC Press.

5. Desai, V. (2009) . The Dynamics of Entrepreneurial Development and Management.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II

PAPER 6: Bio pharmaceutical Technology

Paper code: Subject: **Bio pharmaceutical Technology**

Hours/Week 5

Credits: 2

Aim: To enable the students to understand the basic concepts on development of drugs, Pharmacokinetics., dry and wet granulation,and also about biopharamaceuticals.

Course Objectives

1. To learn the basic concept of therapeutic agents.

2 . To learn the concepts of drug metabolism

3 To develop knowledge on capsule preparation

4.To understand the categories of therapeutics

5. To develop a piece of knowledge on Pharmacokinetics.

Course Out Comes

6. After completing unit 1, the students will be able to know about the Pharmaceutical industry & development of drugs

7. After completing unit 2, the students will be able to know about Mechanism of drug action, principles of drug metabolism.

8. After completing unit 3, the students will be know about Manufacture of drugs.

9. After Completing unit 4, the students will be know about the Compressed tablets; dry and wet granulation; slugging

10 . After completing unit 5, the students will be Various categories of therapeutics

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	**INTRODUCTION** : Pharmaceutical industry & development of drugs ; types of therapeutic agents and their uses; economics and regulatory aspects	**18 hours**
Unit-II	**DRUG ACTION, METABOLISM AND PHARMACOKINETICS** Mechanism of drug action; physico-chemical principles of drug metabolism; radioactivity; pharmacokinetics .	**18 hours**
Unit-III	**MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS** Types of reaction process and special requirements for bulk drug manufacture	**18 hours**
Unit-IV	. **PRINCIPLES OF DRUG MANUFACTURE :** Compressed tablets; dry and wet granulation; slugging or direct compression; tablet presses; coating of tablets; capsule preparation; oval liquids – vegetable drugs – topical applications; preservation of drugs; analytical methods and other tests used in drug manufacture; packing techniques; quality management; GMP.	
Unit-V	**BIOPHARMACEUTICALS :** Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, antibiotics, hormones and biologicals.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars 15	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Adams, D.J., &Sparrow , J.C. (2008). Enterprise for life scientists : Developing Innovation

and Entrepreneurship in the Bioscience , Bloxham : Scion .

2. Shimaski , C. D (2014). Biotechnology Entrepreneurship: Starting , Managing ,

and Leading Biotech companies . Amsterdam : Elsevier . Academic Press is an imprint of Elsevier .

3. Onetti, A., &Zucchella , A. Business Modeling for life Science and Biotech Companies :

Creating Value and Competitive Advantages with the Miles tone Bridge . Routeldge

4. Jordan , J. F. (2014). Innovation , Commercialization , and Start - Ups in Life science London : CRC Press.

5. Desai, V. (2009) . The Dynamics of Entrepreneurial Development and Management.

Web Sources

https://nptel.ac.in/courses/104106106

http://www.nitttrc.edu.in/nptel/courses/video/102106070/lec39.pdf

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II
PAPER 6: BIO PHYSICS

Paper code: Subject: **BIO PHYSICS**

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts on Atomic & Molecular structure, Physico-chemical Foundations,Physical Foundations of Biophysics, Bio molecules as molecular alphabets of life, Molecular Structure Of Biological Systems, Energetics & Dynamics Of Biological Systems.

Course Objectives

1. To learn the basic concept of Structure of atom.

2 . To learn the concepts of Physico-chemical and,Physical Foundations of Biophysics

3 . To develop knowledge on Bio molecules as molecular alphabets of life,

4.To understand the categories of dynamics of biological system.

5.To develop a piece of knowledge on Molecular Structure Of Biological Systems

Course Out Comes

1.After completing unit 1, the students will be able to know about the Structure of atom,

Secondary bonding,Bonds within molecules.

2.After completing unit 2, the students will be able to know about Biophysics of Water, Acid & Bases,Redox potential.

3.After completing unit 3, the students will be know about Thermodynamics of Biological system,Bioenergetics,

4.After Completing unit 4, the students will be know about the Nucleic acids, Amino acids & Proteins,Carbohydrates

5.. After completing unit 5, the students will be Concepts in thermodynamics

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	**Atomic & Molecular structure** : Structure of atom-Models & theories, Periodic table, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; molecular orbital theories, polar & non polar molecules; inductive effect; Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipoleinduced dipole interactions; London dispersion forces. Bonds within molecules-Ionic, covalent, Hydrogen, Electrostatic, Disulphide & peptide bonds, Van-der Waals forces Bond lengths & Bond energies , Bond angles, Structural isomerism; optical isomerism & optical activity	**18 hours**
Unit-II	**.Physico-chemical Foundations Biophysics of Water**: Physicochemical properties of water, Molecular structure, Nature of hydrophobic interactions, Water Structure. Small-Molecule Solutes: Hydrophiles, Hydrophobes, Large Hydrophobic Solutes and Surfaces, Aqueous Environment of the Cell, State of water in bio- structures & its significance, Protein Hydration-Non-specific Effects, The Hydration Shell. Acid & Bases: Acid-Base theories, Mole concept, Molarity, Molality & Normality, Ampholyte, concept of pH,measurements of pH , Henderson–Hasselbatch equation , Titration curve & pK values,	**18 hours**

	Buffers & Stability of their pH , numerical problems. Redox potential : Oxidation –Reduction, examples of redox potential in biological system.	
Unit-III	**Physical Foundations of Biophysics Thermodynamics of Biological system**: First and second laws of thermodynamics, activation energy. Biological systems as open, non-equilibrium systems,Concept of free energy, unavailable energy and entropy, heat content of food, bomb calorimetry, Enthalpy, Negative entropy as applicable to biological systems. thermodynamics of passive and active transport, glycolytic oscillations, biological clocks. Bioenergetics: Concept of energy coupling in biological processors, Energy requirements in cell metabolism, structure and role of mitochondria, high energy phosphate bond, energy currency of cell, Biological oxidation, Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis. Thermodynamic analysis of TCA cycle and oxidative phosphorylation.	**18 hours**
Unit-IV	. **Biomolecules as molecular alphabets of life Nucleic acids**: Purine and Pyrimidine bases, nucleosides, nucleotides, basic differences in structure and function of RNA and DNA Amino acids & Proteins: Amino acid general structure & types, peptide bond,Structure of Proteins - primary, secondary, tertiany and quarternary , Carbohydrates : Structure and function of mono, di ,oligo and polysaccharides, Structure of D-glucose & D-fructose; formation of glucosides & the cyclic structure of Dglucose; Structure and conformation of diasacharides and polysaccharides- cellulose, amylopectin & glycogen,Chitin. Lipids : Defination:Types of lipids; Triglycerides , fatty acids, Fats & oils ,Phospholopids, Glycolipids; lipoproteins, Structure, Function and Localization Vitamins & hormones: Structure, classification & function	
Unit-V	**ENERGETICS & DYNAMICS OF BIOLOGICAL SYSTEMS** Concepts in thermodynamics – force and motion – entropy and stability – analyses of fluxes – diffusion potential – basic properties of fluids and biomaterials – laminar and turbulent flows **MOLECULAR STRUCTURE OF BIOLOGICAL SYSTEMS** Intramolecular bonds – covalent – ionic and hydrogen bonds – biological structures -general features – water structure – hydration – interfacial phenomena and membranes – self assembly and molecular structure of membranes	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

6. Adams, D.J., &Sparrow , J.C. (2008). Enterprise for life scientists : Developing Innovation and Entrepreneurship in the Bioscience , Bloxham : Scion .

7. Shimaski , C. D (2014). Biotechnology Entrepreneurship: Starting , Managing , and Leading Biotech companies . Amsterdam : Elsevier . Academic Press is an imprint of Elsevier .

8. Onetti, A., &Zucchella , A. Business Modeling for life Science and Biotech Companies :

Creating Value and Competitive Advantages with the Miles tone Bridge . Routeldge

9. Jordan , J. F. (2014). Innovation , Commercialization , and Start - Ups in Life science London : CRC Press.

10. Desai, V. (2009) . The Dynamics of Entrepreneurial Development and Management.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

PRACTICALS –II (4 credit)

TISSUE CULTURE, AGRO-INDUSTRIAL AND IMMUNO TECHNIQUES

1. Micropropagation of ex-plant
2. Isolation of DNA from plant cells
3. Giemsa banding and Karyotyping of chromosomes by lymphocyte culture
4. Animal cell culture – MTT assay and COMET assay
5. Determination of doubling time of bacteria by plotting growth curve
6. Determination of specific growth rate of bacteria
7. Screening of microbes for antibiotic production
8. Isolation of bacteriophage
9. Hemagglutination
10. Blood film preparation and identification of cells

FOOD TOXICOLOGY AND WASTE MANAGEMENT

1. Detection of microbes from spoiled meat, egg and fish
2. Isolation and identification of Salmonella, E. coli, Listeria, Proteus, Shigella and Vibrio
3. spp.
4. Isolation and identification of Staphylococcus aureus using Baird parker agar.
5. To determine the LD50 value of common microbial toxin i.e. aflatoxin, enterotoxin
6. To study the antibiotic sensitivity pattern and MIC for different food pathogen
7. To isolate and determine the food spoilage psychrotrophs from frozen food
8. Biochemical characterization of purified bacterial strains for identification
9. Microbial analysis from the chemically preserve food material
10. Detection of microbial toxin from infected food/spoiled food
11. Estimation of pesticides in food brewages
12. Heavy metal analysis in contaminated food material
13. Study the biodegradation of waste discharged from food industry

SEMESTER II

OPEN ELECTIVE : Bio information and Bio instrumentation

Paper code: Subject: Bio information and Bio instrumentation

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts on to **enable the students to understand the use of databases available, analysing biomolecules and apply the information for understanding biological system**

Course Objectives

1. To learn the basic concept of to provide the information to understand the principles of analyzing biological data.

2 . To learn the concepts of testing hypotheses 16

3 . To develop knowledge on building models using computer science paradigms

4.To understand the categories of basic instrumentations in biology

5.To develop a piece of knowledge on Structural analysis of Biomolecules

Course Out Comes

1. After completing unit 1, the students will be able to know about the Introduction to biological databases -

2..After completing unit 2, the students will be able to know about Protein structure prediction

3.After completing unit 3, the students will be know about Bio instrumentations, Separation of Bio molecules:

4.After Completing unit 4, the students will be know about the Structural analysis of Bio molecules

5. . After completing unit 5, the students will be Concepts Cell analysis

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Bioinformatics - Definition, History, Web servers, computer systems, languages, - machine, high level and assembly. Internet basics – internet connection, web browsing and URL. Introduction to biological databases - Sequence databases, structural databases, specialized databases, sequence retrieval system from net - SRS, Entrez	**18 hours**
Unit-II	Protein structure prediction –Similarity and database structure tools, FASTA, BLAST - Sequence and similarity – sequence alignment – local, global pairwise and multiple sequence, Introduction to phylogenetic trees	**18 hours**
Unit-III	Bioinstrumentations: Separation of Biomolecules: Centrifugation-Preparative, Analytical and Density gradient centrifugation. Chromatographic Techniques-Theory andapplication of Paper Chromatography, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography. Electrophoretic Techniques: Theory and Application of PAGE, SDS PAGE.	**18 hours**
Unit-IV	Structural analysis of Biomolecules: UV, IR, NMR, LASER Raman Spectroscopy, Mass Spectroscopy, Fluorescence Spectroscopy.	
Unit-V	Cell analysis: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Confocal Microscopy.	**18 hours**
Unit-VI	Biostatistics: Definition, Types of biological data, Representation of biological data. Measurement of central tendency; Measurement of dispersion; Data analysis – Student's t-test, Chi-square test, F-test, ANOVA, Correlation and Regression, Probability	**05 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS

1.Introduction to bioinformatics by T.A Atwood

2.Introduction to computers by Alexis Leon and Mathews Leon

3.Genomics: The Science and Technology Behind the Human Genome Project (2000). Edited by C.Cantor and C.L.Smith, Wiley -Interscience, New York

4.Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata McGraw Hill

5.Biophysical chemistry – Upadhyay., Upadhyay and Nath

6.Practical Biochemistry – Principles and techniques -Wilson. K and Walker. J,

7.Biostatistics Basic Concepts And Methodology For The Health Sciences –Wayne W. Daniel, Chod L. Cross

8.Biostatistics: Basics and Advanced – Manju Pandey

REFERENCE BOOKS

1. Genome Mapping – A Practical Approach (1997) by P.H. Dear, Oxford University Press, Oxford.

2. Reviews and Articles from Journals such as Nature, Science, PNAS (USA), NucleicAcids Research, Trends Series & Current Opinion Series.

3. Protein Research: New Frontiers in Functional Genomics (1997). Edited by M.R. Wilkins, K.L. Williams, R.D.Appel and D.F. Hochstrasser, Springer – Verlag, NewYork2-D Proteome Analysis Protocols (1998). Edited by A.L. Link, Humana Press, Totowa, NJ.

4. Proteins and Proteomics. 2002. R.J. Simpson. Cold Spring Harbor Lab. Press. New York.

5. Instrumental methods of chemical analysis – P.K. Sharma

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II

OPEN ELECTIVE: TEACHING TECHNIQUES IN SCIENCE

Paper code: **Subject: TEACHING TECHNIQUES IN SCIENCE**

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts on to Teaching Learning Process

Methods of Teaching Science Pedagogy Micro-teaching skills in Science , Teaching of Science

Course Objectives

1. To learn the basic concept of to provide the information to understand the Teaching Learning Process

2. To learn the concepts of Methods of Teaching Science

3. To develop knowledge on building models Pedagogy

4. To understand the categories of Micro-teaching skills in Science

5. To develop a piece of knowledge on Teaching of Science

Course Out Comes

6.After completing unit 1, the students will be able to know about the. Bloom‟s Taxonomy of Learning objectives in Science.

7.After completing unit 2, the students will be able to know about Pedagogy: Meaning,

concept

8.After completing unit 3, the students will be know about Methods of Teaching in Science

9.After Completing unit 4, the students will be know about the Steps and Cycle. Skills of Micro-teaching

10 . After completing unit 5, the students will be Unit Planning

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Teaching: Meaning, Scope, Importance. Learning: Meaning, Scope, Importance. Teaching Learning Process.Bloom‟s Taxonomy of Learning objectives in Science.	**18 hours**
Unit-II	Pedagogy: Meaning, concept. Different pedagogy of teaching Science: Seminar, Conference, Symposium and Workshop	**18 hours**
Unit-III	Methods of Teaching in Science: Lecture-cum-Discussion Method, Laboratory Method, Observation Method, Project Method and Problem Solving Method.	**18 hours**
Unit-IV	Micro-teaching: Meaning, Importance, Steps and Cycle. Skills of Micro-teaching: Set Induction, Explaining, Stimulus variation, reinforcement and Closure.	
Unit-V	Formulation of Instructional Objectives. Unit Planning: Meaning and Steps. Lesson Planning: Meaning and Steps. Improvised of teaching aids in general science. Evaluation: Definition and Objectives. Types of Evaluation: Formative and Summative. Achievement test: Development and Construction.	**18 hours**

Total Teaching hours	90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS

1.Kumar, K.L. (1996). Educational technology. New Delhi: New Age International Publishers.

2.Srivastava, A.P. (1987). Teaching and learning in 21st century. New Delhi: Indian Books Centre. Vedanayagam, E.G. (1989).Teaching technology for college teachers. New York: Sterling Publishers.

3.Sharma, S.R. (2003). Effective classroom teaching modern methods, tools & techniques. Jaipur: Mangal Deep.

4.Neel A, GlasGow, Cathy & Hicks. What successful teachers do. Chennai: Tamil Nadu Book House. □

5.Sampath, K., Panneerselvam, A. &Santhanam, S. (1984). Introduction to educational technology. II revised Edition. New Delhi: Sterling Publishers. □

6.Witch, W.A. &Schulles, C.F. (1973). Instructional technology: Its nature and use New York: Harpu& Row. □ Maheshkumar. (2004). Modern teaching of information technology. New Delhi: Anmol Publishers. □

7.Jaganath, Mohanty. (2003). Modern trends in educational technology. Hyderabad: Neelkamal. □

8.Rameshvarma, et al. (2005). Modern trends in teaching technology. New Delhi: Anmol Publishers. □

9.Janardan, P. et al. (2003). Advanced educational technology. New Delhi: Kanishka. □

10.Siidiqui. (2005).Challenges of educational technology. Coimbatore: Global Books Syndicate

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	2	3	3	3
CO2	3	3	2	3	2	3	3	3	2	2

CO3	3	3	2	3	2	3	3	2	2	2
CO4	3	3	2	2	2	3	3	3	2	3
CO5	3	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III

PAPER 1: Animal and Plant Biotechnology

17

Paper code: **Subject: Animal and Plant Biotechnology**

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts on culture media , subculture and cell lines, cloning and hybridoma technology, cell separation, and quantitation, cell characterization and differentiation and application of animal biotechnology and related problems.

Course Objectives

1. To learn the basic concept of .Media and supplements,cell lines and its maintenance

2 . To learn the concepts of somatic cell fusion,organ culture, tumor genesis.

3 To develop knowledge on antibody based techniques,Quantitation.

4.To understand the basic concept on Differentiation , and cell morphology, cell matrix interaction

5.To develop a piece of knowledge on Artificial animal , breeding,diagnosis of diseases and disorders, gene therapy , forensic application .

Course Out Comes

1.After completing unit 1, the students will be able to know about Media and supplements , serum , serum free media , natural media,Gas phase for tissue culture .

2.After completing unit 2, the students will be able to know about Cross contamination, cell lines and its maintenance , subculture , growth cycle and split ratio.

3.After completing unit 3, the students will be know about Vectors and cloning, somatic cell fusion , HAT selection , selection of Hybrid clones, organ culture, tumor genesis.

4.After Completing unit 4, the students will be know about the antibody based techniques, cell counting , cell weight , cell proliferation .

5. After completing unit 5, the students will be cell morphology, Karyotyping , chromosome banding, cell interaction

diagnosis of diseases.

Matching Table (Put Yes / No in the appropriate box)

17

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes

2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	**CULTURE MEDIA FOR ANIMAL CELL CULTURE** Introduction and history : Media and supplements , serum , serum free media , natural media , feeder layer on substrate , Gas phase for tissue culture , source of tissue , Primary culture , Stages of commitments and differentiation , proliferation and malignancy **SUBCULTURE AND CELL LINES** Cross contamination , terminology, naming and choosing cell lines and its maintenance Criteria for subculture , growth cycle and split ratio, Propagation in suspension and attached culture.	**18 hours**
Unit-II	**CLONING AND HYBRIDOMA TECHNOLOGY** Vectors and cloning, somatic cell fusion , hybridoma, HAT selection, Medium suspension fusion , selection of Hybrid clones, organ culture, tumor genesis.	**18 hours**
Unit-III	. **CELL SEPARATION AND QUANTITATION** Separation techniques based on density , size, sedimentation velocity , antibody based techniques - immuno panning magnetic sorting , fluorescence activated cell sorting ; Quantitation - cell counting , cell weight, DNA content, protein , rate of synthesis, measurements of cell proliferation .	**18 hours**
Unit-IV	**CELL CHARACTERIZATION AND DIFFERENTIATION** Authentication , record keeping , provenance , parameters of Characterization , lineage and tissue markers, cell morphology, Karyotyping , chromosome banding ; Differentiation - commitments , terminal differentiation ; Lineage selection ,proliferation and differentiation , commitment and lineage, markers of differentiation , induction of differentiation , cell interaction - homotypic and heterotypic , cell matrix interaction	**18 hours**

Unit-V	.**APPLICATION OF ANIMAL BIOTECHNOLOGY AND RELATEDD PROBLEMS** Artificial animal breeding , cloning and transgenic animals , medicines , vaccines , diagnosis of diseases and disorders, gene therapy , forensic application .	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Freshney , I., (2010), cultures of Animal Cells, John Wiley and Sons Inc.

2. Cibelli, J., Robert P. , Keith L.H.S ., Campbell H., and West M.D. (Editors), (2002) Principles of Cloning, St. Diego academic press.

3. J.Hammond et.al., Plant Biotechnology , Springer Verlag .

4. R.J Henry , Practical Application of Plant Molecular Biology ,Champman and Hall

5. Brun T.A. (2006) . Gene cloning and DNA Analysis . An Introduction , Oxford , Black well Pub.

6. Primrose S.B. and Twyman R.M . (2006). Principles of Gene Manipulation and Genomics , Maldem M.A. Blackwell Pub.

7. Gordon T, (2005), Reference Techniques in Farm Animals . Oxford . CAB International .

8. Porter R., Totowa N.J. (2007N), Animal Cell Biotechnology : Methods and Protocols, Human press.

Web Sources

https://www.biotechbug.in/2022/07/mcqs-on-cell-culture-technologies-nptel.html?m=1

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III

PAPER 2: Environmental Biotechnology

Paper code: **Subject: Environmental Biotechnology**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts on nitrogen fixation, bio fertilizer, PGPR, environmental problems and monitoring, environmental problem and monitoring.

Course Objectives

1. To learn the basic concept of .Physiology and biochemistry of nitrogen fixing organisms,

and regulation of gene expression

2. To learn the concepts of Phosphate Solubilizing Microorganisms,Ecto - Endo - Mycorrhizae

3. . To develop knowledge on mechanism in plant growth promotion , factors affecting rhizosphere

colonization

4. To understand the basic concept on Pollution and its classification,Global environmental problems.

5.To develop a piece of knowledge on Principles of biological treatments,Bioreactor design.

Course Out Comes

1. After completing unit 1, the students will be able to know Physiology and biochemistry of nitrogen fixing organisms,genetics and regulation of gene expression.

2. .After completing unit 2, the students will be able to know about the Phosphate Solubilizing Microorganisms,phosphate mineralizers

3. After completing unit 3, the students will be know about phosphate mineralizers.

. 4. After Completing unit 4, the students will be know about the Environmental monitoring and audit ; Environmental and and policies in India .

5.After completing unit 5, the students will be know about Principles of biological treatments ;

Biological treatments, the Bio-remediation principles and processes strategies and techniques of bio remediation in situ and ex situ of hydrocarbons.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	**BIOLOGICAL NIITROGEN FIXATION** Physiology and biochemistry of nitrogen fixing organisms, genetics and regulation of gene expression , signaling factors and molecular interaction in establishing rhizobia legume symbiosis.	**18 hours**
Unit-II	**BIOFERTILIZERS** Phosphate Solubilizing Microorganisms, inorganic phosphate solubilization and its mechanisms, phosphate mineralizers - phytate and organic phosphate hydrolyzing bacteria , Ecto - Endo – Mycorrhizae **PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR)** PGPR in improving plant growth , mechanism in plant growth promotion , factors affecting rhizosphere colonization	**18 hours**
Unit-III	**ENVIRONMENTAL PROBLEMS AND MONITORING** Pollution and its classification ; Effluent standards - examination of waste water , characteristics , municipal and industrial waste water , characteristics , municipal and industrial waste water ;Global environmental problems , global warming , acid rain , ozone depletion ; Sampling and analysis , Environmental monitoring and audit ; Environmental and and policies in India .	**18 hours**
Unit-IV	**BIOTREATMENTS , KINETICS AND REACTOR DESIGN** Principles of biological treatments ; Biological treatments - composting , suspended growth system, attached growth system ; Bioreactor design - activated sludge process, trickling filters , fluidized bed and packed bed reactor, rotating biological contractors , oxidation ponds and ditches , lagoons anaerobic reactors.	**18 hours**
Unit-V	**BIOREEDIATION AND BIODEGRADATION** Bio-remediation principles and processes, Bio absorption , bio-accumulation , bio-conversion , bio-transformation , bio-leaching , bio-degradation , detoxification , activation , accumulation and co-metabolism ; Strategies and techniques of bio remediation in situ and ex situ of hydrocarbons , pesticides and dyes ; G Mos in bio remediation and bio degradation , Microbial enhanced oil recovery.	**05 hours**

Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Atlas R.M. and Bertha , R (2009). Microbial Ecology , 4th Ed , Pearson Education .

2. Maier, R.M., Peppler I.I. and Gertha C.P. Environmental Microbiology , 2nd ED, Academic Press.

3. Olum E.P and Barrett G.W (2005). Fundamental of Ecology , 5th ed , Cenegage learning .

4. Wiley J.M., Sherwood , L.M. and Woolverton C.J. Prescott , Harley and Klein (20050, Microbiology , 7th Edition Mc Graw Hill.

5 . Garrity , G.M, Brenner , D.J Kreig M.R. and Statey J.T . (2005), Bergey's Manual of Systematic Bacteriology , 2nd ed , Vol II spinger .

6.Lawrence K.W, Volodymyr Ivanow , Joo- Hwa Tay Yung - Tse Hung , (2010); Environmental Biotechnology , Vol 10 , handbook of Environmental Engineering , Springier .

7.Hans - Joachim Jordening , Josef Winter , (2005), Environmental Biotechnology : Concepts and Application, Wiley - Vch.

8.Christon Hurst , Ronald L.C. Guy R.K., Miachel J.M, Linda D.S, (2002) Manual of Environmental

Microbiology , 2nd edition , ASM press.

Web Sources

https://nptel.ac.in/courses/103107086
https://nptel.ac.in/courses/102105058

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10

CO1	3	3	2	2	2	3	2	3	3	3
CO2	3	3	2	3	2	3	3	3	2	2
CO3	3	3	2	3	2	3	3	2	2	2
CO4	3	3	2	2	2	3	3	3	2	3
CO5	3	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

MESTER III

PAPER 3: Bio Manufacturing Principle and Practise

Paper code: **Subject: Bio Manufacturing Principle and Practise**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts on overview and design of bio manufacturing , quality system, principles and practice of GMP, Bio remediation and Bio degradation and principles of microbial diversity.

Course Objectives

1. To learn the basic concept of principles of bio manufacturing, Chromatography. ,

2. To learn the concepts of Introduction, practical implementation, and structure of quality system

3. To develop knowledge on Principle and Practise of GMP.

4. To understand the basic concept on Bio remediation and bio degradation.

5. To develop a piece of knowledge on principle of microbial diversity.

Course Out Comes

1.After completing unit 1, the students will be able to know .about the life cycle of manufacturing , raw material consideration , compliance and quality in bio-manufacturing,(PAT),Standard manufacturing operating procedure of biotechnology, Therapeutic proteins ,monoclonal antibodies , human vaccines .

2.After completing unit 2, the students will be able to know about the Introduction to quality system, Structure of quality manual

3. After completing unit 3, the students will be know about Principles of human resource managements,Pharmaceutical water.

4.After Completing unit 4, the students will be know about Information , national bodies and pharmaceutical associates

5.After completing unit 5, the students will be know about the concept of pharmaceutical water.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	17 **Course Contents**	**Teaching hours**

Unit I	**BIOMANUFACTURING PRINCIPLES** Overview and design of bio-manufacturing , quality by design approach , technical consideration , phases and scale up : life cycle of manufacturing , raw material consideration , compliance and quality in bio-manufacturing , lean bio-manufacturing ; Process analytical technology (PAT) during bio-manufacturing : background and need tools for data acquisitions (software in fermenters , flow filtration , chromatography , analysis and design process analyzers, process control tools and continuous improvement and knowledge managements ; Standard manufacturing operating procedure of biotechnology , including upstream and down stream processing of proteins , and quality control of proteins production , and final fill and finish of product; Case studies to be include at least ; Therapeutic proteins , monoclonal antibodies , human vaccines .	**18 hours**
Unit-II	**QUALITY SYSTEM** Introduction to quality system, main elements of a quality system : Essential of quality system ; Practical implementation of a quality system ; Structure of quality manual , correlation between GMP requirements (WHO) and ISO 9001: 2000.	**18 hours**
Unit-III	**PRICIPLES AND PRACTICE OF GMP** Personnel : Principles of human resource managements , duties of senior managements , organizational structures, qualification and profiles requirements , workplace and job descriptions , health monitoring and occupational health safety, training , function owners subject to public law ; Premises : official requirements , material & personnel flow and layout , air cleanliness class and grades , constructions elements , barrier system , isolators and safety cabinets, building services , heating ventilation air conditioning (HVAC) , Process gases , qualification of premises and HVAC system , pharma monitoring of HVAC system , particle monitoring ; Facilities and Equipment : Facility planning , material , hygienic design in solid handling , system controllers and process control system, technical documents , calibration , maintenance , cleaning of facilities , containment (personnel protection) in solid handling ;	**18 hours**

Unit-IV	**GMP IN REGULATION** Information , national bodies and pharmaceutical associates ; Pharmacopoeia; EU directives and guidelines, USA : CFR and FDA guidelines , ICH - guidelines , PIC/S guidelines , GMP of other regions , WHO guidelines .	
Unit-V	**Pharmaceutical water** : Water quality, generation of pharmaceutical water , distribution and storage of pharmaceutical water , qualification of water supplies , operation of water supplies , pure steam system ; Qualification: Official requirements , Preparation of qualification (IQ) , operational qualification (OQ) , Performance qualification (PQ), special cases of qualification ; Process Validation : Official requirements , Validations -a key elements of quality managements , validation planning and procedure , validation documentation , process validation and product life cycle; cleaning validation : Official requirements , how to validate cleaning procedure , cleaning validation master plan , establishing scope of validation , acceptance criteria and limit calculation , sampling procedures, analytical procedure , documentation , maintenance of validated status , cleaning validation documentation ;.Production : Sanitation , personal hygiene , Production Hygiene , sanitation Programme, environmental monitoring , GMP in production hygiene , sanitation programme, environmental monitoring , GMP in production process, weigh - in , identification , in -process control prevention of cross -contamination , empty chapter, reworking , warehouse and logistics; Sterile Production and Packaging : Introduction , Air lock concepts , manufacture of terminally sterilized products , sterilization process, aseptic processing , freeze - drying , testing for sterility ,testing for endotoxins, testing for leakage and for particles , microbiological monitoring , packaging process, qualification of a servo - controlled blister packaging line , blow- fill - seal -technology(BFS technology); Documentation : Official Requirements , GMP - compliant documentation , batch documentation , standard operating procedures (SOPs) , site master files , electronic batch recording and batch release , CAPA , document managements systems	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III) 18	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Introduction to Bio-manufacturing by Northeast Bio-manufacturing Center and Collaboration , 2018.

2. Introduction to Bio-manufacturing by , Mark WIitcher . In Encyclopedia of Industrial Biotechnology

3. Good Manufacturing Practice for Pharmaceuticals (e- resource) : A plan for total Quality Control . Sidney Willing and James Stoker.

4. Biotechnology Operations : Principles and Practices ,by John .M. Centanni, Michael J.Roy ; CRC press

5. Learn Bio-manufacturing , 1 st Ed ., by Nigel Smart; Wood-head Publishing

6. GMP Manual ; Publisher Maas & Peither A America , Inc GMP Publishing .

Web Sources

https://nptel.ac.in/courses/102105058

https://nptel.ac.in/courses/102106022

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	2	3	2	3	2	2	3	3	2	2
CO3	2	3	2	3	2	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	2	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III
PAPER 4: MOLECULAR BASIS OF DISEASE-I

Paper code: Subject: **MOLECULAR BASIS OF DISEASE-I**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts on Introduction to Human diseases, Introduction to infection,Viral Disease,:Bacterial diseases,Protozoan/Helminthic diseases,Fungal diseases.

Course Objectives

1. To learn the basic concept of Mode of transmission of infectious diseases-
2. To learn the concepts of Introduction to different pathogens
3. To develop knowledge on Introduction to virology
4. To understand the basic concept on Host-bacterial pathogen interaction,
5. To develop a piece of knowledge on Host-pathogen interaction

Course Out Comes

1.After completing unit 1, the students will be able to know about the Human diseases

2..After completing unit 2, the students will be able to know about virus induced cell transformation

3.After completing unit 3, the students will be know about Introduction to virology- general properties, Classification of viruses

4..After Completing unit 4, the students will be know about Host-bacterial pathogen interaction

5.After completing unit 5, the students will be know about Host-pathogen interaction, Fungal diseases

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Causative agents-bacteria, fungi, viruses, parasites (helminthes and protozoan's). Mode of transmission of infectious diseases- Air-borne, food and water-borne, sexually transmitted, zoonotic. Special insight on hospital born infections and opportunistic infectious diseases.	**18 hours**
Unit-II	. Introduction to different pathogens, recognition and entry processes of different pathogens (bacteria, Viruses, fungus) into animal host cells, host cell alteration by pathogens, virus induced cell transformation.	**18 hours**
Unit-III	Introduction to virology- general properties, Classification of viruses (DNA/RNA virus, single and double stranded virus), virus-host interactions- viral infections, Biology and pathophysiology of major viral diseases- HIV, Japanese encephalitis, influenza, viral hepatitis	**18 hours**

Unit-IV	Host-bacterial pathogen interaction, biology and pathophysiology of tuberculosis, typhoid and cholera	
Unit-V	Host-pathogen interaction, biology and pathophysiology of malaria and filarial, Entamoeba histolytica, Giardia	**18 hours**
Unit-VI	Host-pathogen interaction, biology and pathophysiology of cryptococcosis, candidiasis	**05 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Jawetz, Melnick & Adelberg's Medical Microbiology (26/E), Author: Geo. F. Brooks, Karen C.
Carroll, Janet S. Butel, Stephen A. Morse. Publisher: McGraw Hill Education. ISBN-10: 0071790314,
ISBN-13: 978-0071790314
2.Prescott, Harley and Klein's Microbiology: Wiley JL, Sherwood LM and Woolverton CJ. 7 th Edn. Tata McGraw Hill
3.Textbook of Microbiology by Ananthanarayanan and Panicker, Seventh edition, Orient Longman.
4.Topley and Wilson`s, Microbiology and Microbial infections. Volume 1 to 4. Wiley Publications. 10 th edition

Web Sources

https://nptel.ac.in/courses/102103039

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	2	3	3	3
CO2	3	3	2	3	2	3	3	3	2	2
CO3	3	3	2	3	2	3	3	2	2	2
CO4	3	3	2	2	2	3	3	3	2	3
CO5	3	3	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III
ELECTIVE PAPER 1: MICROBIOLOGY

Paper code: **Subject: MICROBIOLOGY**

Hours/Week: 5Credits: 3

Aim: To enable the students to understand the basic concepts on classification of microbes. The paper also throws light on multifarious habitats of microbes and provides information about all the microbial cellular functions and various metabolic pathways in microbes.

Course Objectives

1. To learn the basic concept of classification of microbes

2. To learn the concepts of Microbial techniques

3.To develop knowledge on Strain improvement methods

4.To understand the basic concept on Microbial ecology

5.To develop a piece of knowledge on Microbial taxonomy and physiology of growth

Course Out Comes

1.After completing unit 1, the students will be able to know classification and molecular systematic
2.After completing unit 2, the students will be able to know classification and structure of viruses
3.After completing unit 3, the students will be know about Microbial techniques, Culture techniques:
4.After completing unit 4, the students will be know about Strain improvement methods
5.After completing unit 5, the students will be know about Microbial ecology, different culture techniques

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	**Classification and molecular systematic**: Classical, numerical, polyphasic and molecular (G+C analysis, DNA-DNA hybridization, 18S rRNA sequencing and construction of phylogenetic tree) techniques. Archae: Earliest life forms – halophiles, methanogens, hyper-thermophiles, thermoplasma. Bacteria and Actinomycetes: Classification and Characteristics.	**18 hours**
Unit-II	**Viruses**: Classification and structure of viruses, positive, negative and double stranded; Bacterial, plant, animal and tumour viruses; replication – lytic and lysogenic. Fungi: Classification (Alexopoulose); salient features of each class – habitat, cell and thallus organization; nutrition and reproduction. Algae: Classification (Smith); salient features of each class – habitat, cell and thallus organization; pigmentation, nutrition and reproduction.	**18 hours**
Unit-III	**Microbial techniques and Culture techniques**: Isolation of microbes from various sources, serial dilution technique, pure culture techniques , Anaerobic culture methods (chemical and physical) and culture préservation techniques. Microbial culture collection centres. Staining techniques – Gram, endospore, negative, flagellar and methylene blue staining. Biochemical characterization (IMVIC test). Microbiological media: Types and composition of media. Sterilisation techniques: Moist heat; dry heat, pasteurization, Richards‟ rapid method – HTST (high temperature/short time) treatments; filter sterilization, gas (ethylene oxide), chemical sterilization, radiation.	**18 hours**
Unit-IV	**Strain improvement methods:** Non recombinant methods – mutation and protoplast fusion; Recombinant method – recombinant cell culture process – guidelines for choosing host, vector systems, plasmid stability in recombinant cell culture, limits to over expression.	
Unit-V	**Microbial ecology**: Soil, aquatic and aerobiology; Influence of environment on microbial physiology – Physical factors – radiations, temperature, Ph and pressure; chemical factors. Antimicrobial compounds – principles and mechanism of action, Antibiotic resistance. Different culture techniques, media, pure culture technique, isolation of preservation. Biochemical, serological classification; DNA/RNA based classification.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1.Microbiology, Pelczar, M.J., Jr., Chan, E.C.S., Krieg, N. R., 5th ed.,1996, TMH

2.Microbiology, Hames, B.D. (Ed.), 2nd ed. , Viva Books

3.Microbiology, Tortora, Pearson Education

Web Sources

https://www.slideshare.net/jeevaraj9/strain-improvement-techniques

https://archive.nptel.ac.in/courses/102/103/102103015/

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III
ELECTIVE PAPER 2: GOOD MANUFACTURING PRACTICES AND QUALITY ASSURANCE

Paper code: Subject: **Good Manufacturing Practices And Quality Assurance**

Hours/Week: 5Credits: 3

Aim: To enable the students to understand the basic concepts on introduces definitions and requirements in GMP and gives knowledge about production of compounds for human use, and describes requirements from authorities on GMP, laws and regulations for production.

Course Objectives

1. To learn the basic concept of understanding of the principles and practice of GMP .

2.To develop knowledge on the importance of GMP and compliance of GMP.

3.To understand the basic concept on Sanitation

4.To understand the basic concept on Raw Material Testing

5.To develop a piece of knowledge on Quality Control Department

Course Out Comes

1. After completing unit 1, the students will be able to know Principles and Importance of GMP

2. After completing unit 2, the students will be able to know Design, construction, and maintenance of equipment

3..After completing unit 3, the students will be know about Sanitation programs: sanitary manufacture.

4.After Completing unit 4, the students will be know about Raw Material Testing

5.After completing unit 5, the students will be know about Good practices in production

and control, Quality Control Department and Audits

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Principles and Importance of GMP – Definition of GMP, Quality management, Personnel, Risk management, Quality control, Documentation, Inspections. Public Health Protection - adulteration definition - approved chemicals (lubricants, steam additives, etc.) - toxic chemical control and storage - hazard review: chemical, physical, biological - potential sources (humans, animals, environment) and controls Premises - Design, construction, and maintenance of the production and staff areas in the facility, Layout (design) of the facility - separation from farm/animals/pets (small scale) - perimeter, entrances, drainage - construction, heating/ventilation, humidity control - separation raw versus. pasteurize; product flow - equipment / pipe layout / drainage - water source (treatment, hardness) monitoring	**18 hours**
Unit-II	Equipment - Design, construction, and maintenance of equipment, Equipment arrangement and operation, cleaning-in-place process. Personnel - Ensuring facility personnel are qualified for their job responsibilities, personal health and disease control, personal hygiene; clothing, habits, hand wash, restrooms, plant traffic control.	**18 hours**
Unit-III	Sanitation - Sanitation programs: sanitary manufacture, packaging/labeling, including: Establishing a hygiene program for the facility - documented cleaning procedures for premises and equipment - Employee health and hygiene - Documenting health requirements and following health-related procedures. Cleaning and sanitation compounds and their uses – for process equipments - for environmental cleaning (drains, coolers, etc.) - influence of water quality, formulation control - concentrations and time. Environment sanitation and monitoring - environmental monitoring / pathogen testing - pest control programs	**18 hours**

Unit-IV	Raw Material Testing - Testing raw materials - Identifying when product or raw materials must be tested - Accepting raw materials from a vendor without additional regular testing - Supplier certification. Good practices in production and control - Controlling the manufacturing process - Stages in the production cycle – contracting quality tools – R & D - Self-inspection programs for fabricators, packagers/labelers - Testing requirements for packaging materials including supplier certification. Finished Product Testing - Finished product testing - Writing product specifications - Conditions and options for finished product testing, distributors - product storage - packaging, distribution. Process Control - refrigeration (potential hazardous compounds), pasteurization - culture, pH, incubation temperature, aging temperature.	
Unit-V	Quality Control Department and Audits - Establishing a QC department - Investigating product quality. Audits- Records - Maintaining accurate, clear, and precise documents - Identifying individuals responsible for maintaining documents. Validation - Qualification, Process validation, Cleaning validation and Computer validation. GMP regulations - US-FDA, Europe, Japan, ICH, PICS/S, WHO.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS

Compendium of Good Practices in Biotechnology, BIOTOL series

REFERENCE BOOKS

1. A WHO guide to good manufacturing practice (GMP) requirements: Volume 1,2,3,4,5. Part 2-Validation,

by Gillian Chaloner-Larsson, Ph.D, GCL Bioconsult, Ottawa

2. Good Manufacturing Practices for Pharmaceuticals, Sixth Edition by: Graham Bunn Publisher: Informa

Healthcare; 6 edition | 424 pages (2007) http://ebookee.org/Good-Manufacturing-Practices-for-Pharmaceuticals-SixthEdition_859976.html#uPYoXd8huFeqqXB9.99

3. A Primer – Good Laboratory Prcatices and current manufacturing practice, by Ludwig Huber, Published by Agilent Technologies, Germany (2002)

http://www.chem.agilent.com/Library/primers/Public/59886197.pdf.

4. GMP manual:Good manufacturing practices and implementation,

http://www.gmppublishing.com/media/ebooks/flyer/files/gmpmanual_eu_4c_online.pdf.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III
ELECTIVE PAPER 3: APPLIED AND INDUSTRIAL MICROBIOLOGY

Paper code: Subject: **APPLIED AND INDUSTRIAL MICROBIOLOGY**

Hours/Week: 5Credits: 3

Aim: To enable the students to understand the basic concepts on the principles of Microbiology to emphasize structure and biochemical aspects of various microbes

Course Objectives

1.To learn the basic concept of understanding of to provide to the students the fundamentals of
Microbiology and solve the problems in microbial infection and their control.

2.To develop knowledge on the importance of Basics of microbial existence

3.To understand the basic concept on Structural organization and multiplication of bacteria, viruses,
algae and fungi

4.To understand the basic concept on Nutritional requirements of bacteria ;

5.To develop a piece of knowledge on Physical and chemical control of microorganisms

Course Out Comes

1. After completing unit 1, the students will be able to know classification and nomenclature of microorganisms, microscopic examination of microorganisms

2. After completing unit 2, the students will be able to know Microbes - Structure and Multiplication.

3. .After completing unit 3, the students will be know about Microbial nutrition.

4. .After Completing unit 4, the students will be know about Growth and metabolism

5. After completing unit 5, the students will be know about Control of microorganism, Industrial and environmental Microbiology

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining	**18 hours**
Unit-II	Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages	**18 hours**
Unit-III	Nutritional requirements of bacteria; different media used for bacterial culture; growth curve. Different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules	**18 hours**
Unit-IV	Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.	
Unit-V	Primary metabolites; secondary metabolites and their applications; preservation of food; production of penicillin, alcohol, vitamin B-18; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

REFERENCE BOOKS

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993

2.Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.

3.Prescott LM, Harley JP, Klein DA, Microbiology, 3 rd Edition, Wm. C. Brown Publishers, 1996.

Web Sources

https://archive.nptel.ac.in/courses/102/105/102105058/
[slideshare id=134710829&doc=antiviralsandantifungals-190305161929]
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4022204/

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III

OPEN ELECTIVE 1: ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

Paper code:

Subject: **ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY**

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts on Basics of Measurement, Molecular spectroscopy, Electrophoresis, Chromatography, Thermal Methods, Magnetic Resonance Spectroscopy and Mass Spectroscopy.

Course Objectives

1. To learn the basic concept To analyse the research findings and interpretation can be ascertained by the knowledge gained from this course.

2. To develop knowledge on the importance of the structural behavior of molecule using molecular spectroscopy.

3. To understand the basic concept on to inculcate knowledge on the various separation and purification methods

4.To understand the basic concept on Molecular Spectroscopy

5.To develop a piece of knowledge on Electrophoresis.

Course Out Comes

1..After completing unit 1, the students will be able to know Basics of Measurements ,Classification of methods,Properties of electromagnetic radiations.

2.After completing unit 2, the students will be able to know UV and visible light spectroscopy- Qualitative and Quantitative absorption.

3.After completing unit 3, the students will be know about General principle of electrophoresis,

4.After Completing unit 4, the students will be know about Principles of chromatography

5..After completing unit 5, the students will be know about Differential thermal analysis techniques. Differential scanning calorimetry - instrumentation & application, NMR – environmental effects on NMR spectra – chemical shift

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Classification of methods – calibration of instrumental methods – electrical components and circuits -signal to noise ratio – signal – noise enhancement; Properties of electromagnetic radiations and their interaction with matter	**18 hours**
Unit-II	UV and visible light spectroscopy-Qualitative and Quantitative absorption Measurement, BeerLambert law, Spectrofluorimetry, IR spectroscopy, Raman spectroscopy, NMR spectroscopy, Xray crystallography– principle, instrumentation and applications; X-Ray Photoelectron Spectroscopy	**18 hours**
Unit-III	General principle of electrophoresis, support media (agarose and polyacrylamide gels), electrophoresis of proteins by SDS-PAGE, native PAGE, gradient gels, isoelectric focusing, two dimensional PAGE, electrophoresis of nucleic acids using agarose gel, PFGE, FIGE, CHEF, capillary electrophoresis.	**18 hours**
Unit-IV	Principles of chromatography, distribution coefficient, retention time, capacity factor, plate height and resolution, peak broadening and van Deemter plot, TLC and column chromatography, matrix materials, HPLC, Affinity chromatography, ion exchange chromatography, gel exclusion chromatography and Gas chromatography	
Unit-V	Differential thermal analysis techniques. Differential scanning calorimetry - instrumentation & application. Differential thermal analysis - instrumentation & application, DTA curve. Thermogravimetry – instrumentation & application, TG curve.	**18 hours**

Unit-VI	Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applications of 1H and 13C NMR-Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values –instrumentation.	**05 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS:

1. Willard H.W., Merritt L.L., Dean J.A. & Settle F.A "Instrumental Methods of Analysis", East West

Publishers, 6th Edition. 2004

2. Skoog, D.A. F. James Holler, and Stanky, R. Crouch "Instrumental Methods of Analysis".

Cengage Learning, 2007

REFERENCE BOOKS:

1. Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B. "Bioseparations: Science and Engineering",
Oxford University Press, 2006.
2. Wilson K. and Walker J. "Principles and Techniques of Biochemistry and Molecular Biology",
Cambridge University Press, 6th edition, 2005

Web Sources

https://archive.nptel.ac.in/courses/104/106/104106075/

https://nptel.ac.in/courses/104108078

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III
OPEN ELECTIVE 2: BIOCHEMICAL THERMODYNAMICS

Paper code: Subject: **BIOCHEMICAL THERMODYNAMICS**

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts on solve problem in realistic cases by applying thermodynamics,and to estimate thermodynamic properties of substances in gas and liquid states.

Course Objectives

1. To learn the basic concept laws of thermodynamics
2. To develop knowledge on Partial molar properties

3.To understand the basic concept on General criterion for equilibrium and their application

4.To understand the basic concept on Equilibrium conversion in single and multiple reactions

5.To develop a piece of knowledge on Stoichiometry.

Course Out Comes

1. After completing unit 1, the students will be able to Illustrate the application of thermodynamics
in design & operation of process industries

2. After completing unit 2, the students will be able to know Design & solve problem in realistic cases by applying thermodynamics concepts

3. .After completing unit 3, the students will be know estimate thermodynamic properties of substances in gas and liquid states

4. After completing unit 4, the students will be know about interpret the phase equilibria concepts in multi-component systems

5. .After completing unit 5, the students will be know about understand about biochemical equilibrium and able to calculate the kinetics of biological systems

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Review of laws of thermodynamics and their applications; thermodynamic analysis of processes. Thermodynamic properties of fluids and their interrelationship: PVT behavior of pure substances; Equation of state; Generalized correlations and acentric factor; Thermodynamics charts; Estimation of thermodynamic properties	**18 hours**
Unit-II	Partial molar properties; Chemical potential; Gibbs-Duhem equation; Ideal and non-ideal solutions; Fugacity and fugacity coefficient; Activity and activity coefficient; Excess properties of mixtures.	**18 hours**
Unit-III	General criterion for equilibrium and their application; Stability constraints; Gibbs phase rule and its derivation for reacting and non-reacting systems; Vapour-liquid, liquid-liquid, and vapour-solid equilibrium for ideal and non-ideal systems.	**18 hours**
Unit-IV	Chemical equilibrium constants; Homogeneous and heterogeneous reactions; Standard Gibbs free energy change; Equilibrium conversion in single and multiple reactions. Thermodynamics of microbial growth stoichiometry, maintenance, Calculation of the Operational Stoichiometry of a growth process including Heat using the Herbert – Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation.	
Unit-V	Reference properties, energy properties, derived properties, work function, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S). GibbsHelmholtz equation. Concept of Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, solids and liquids.	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS:

1.Smith J.M, Van Ness H.C, Abbott M.M, "Introduction to Chemical Engineering Thermodynamics",
McGraw-Hill, 7th edition, 2005
2.Narayanan K.V, "A Text Book of Chemical Engineering Thermodynamics", Prentice Hall of India,
2nd edition, 2013.
3.Christiana D Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals",
CRC Press Taylor & Francis, 1st edition, 2010.

REFERENCE BOOKS:

1. Hougen O.A., Watson K.M., and Ragatz R.A., "Chemical Process Principles Part II", John Wiley & Sons,
2ndedition. 2004.
2. Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley & Sons, 4thedition, 2006.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III

OPEN ELECTIVE 3: BIOPROCESS PRINCIPLES

Paper code: Subject: **BIOPROCESS PRINCIPLES**

Hours/Week: 5Credits: 2

Aim: To enable the students to understand the basic concepts on Production of Ethanol,Optimization of Amylase production by Plackett and Burman method,Stoichiometry of cell growth and product formation,Modes of operation.

Course Objectives

1.To learn the basic concept the basic principles of fermentation process

2.To develop knowledge on the basic configuration and parts of a fermentor.

3.To understand the basic concept on the basics of metabolic stoichiometry and microbial kinetics in batch, fed-batch and continuous mode of operation.

4.To understand the basic concept on Stoichiometry of cell growth and product formation.

5.To develop a piece of knowledge on Modes of operation.

Course Out Comes

1.After completing unit 1, the students will be able to the general requirements of a fermentation process.

2.After completing unit 2, the students will be able to know the basic configuration of a fermentor and

its ancillaries.

3.After completing unit 3, the students will be know demonstrate an ability to design good media.

4.After completing unit 4, the students will be know about explain the sterilization kinetics and design the sterilization equipment for batch and continuous process.

5.After completing unit 5, the students will be know about able to model microbial growth, substrate utilization and product formation.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	General requirements of fermentation processes, Basic concepts of Upstream and Downstream processing in Bio process, Process flow sheeting – block diagrams, pictorial representation, Basic configuration of Fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes	**18 hours**
Unit-II	Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentation – medium optimization methods- OFAT, PB , RSM. Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, sterilization of air, design of sterilization equipment for batch and continuous process.	**18 hours**
Unit-III	Stoichiometry of cell growth and product formation – Elemental balances, degrees of reduction of substrate and biomass and available electron balances, Yield coefficients of biomass and product formation, Maintenance coefficients, energetic analysis of microbial growth and product formation, Oxygen consumption and heat evolution in aerobic cultures, Thermodynamic efficiency of growth.	
Unit-IV	Modes of operation – batch, fed-batch and continuous cultivation, Simple unstructured kinetic models for microbial growth – Monod model, Growth of filamentous organisms and yeast, Product formation kinetics – Leudeking - Piret models, substrate and product inhibition on cell growth and product formation.	**18 hours**
Unit-V	Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor	**05 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS:

1. Peter F. Stanbur.,, Stephen J. Hall ., A. Whitaker., "Principles of Fermentation Technology", Science & Technology Books. 2007.

3. Shuler., Michael L., Fikret Kargi . "Bioprocess Engineering", Prentice Hall, 2008.

4. Doran M Pauline., "Bioprocess Engineering Principles", Elsevier, 2 nd Edition, 2018.

REFERENCE BOOKS:

1. Bailey, James E., David F. Olli., "Biochemical Engineering Fundamentals", 2 nd Edition. McGraw Hill, 1986.

2. Blanch H. W., Clark D. S., "Biochemical Engineering", 2nd Edition, CRC Press. 2007.

3. Rajiv Dutt., "Fundamentals of Biochemical Engineering", Springer, 2008.

4. Ghasem D. Najafpour., "Biochemical Engineering and Biotechnology", Elsevier, 2007.

5. D.M. Himmelbla, "Basic principles and calculations in chemical Engineering", 6th edition, Pearson education,2006.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

PRACTICALS – III (4 credits)

Environmental Biotechnology

Taxonomic characterization of individual micro-organisms or Metagenomic DNA analysis

• Isolation of genomic DNA of an isolated micro-organism from environmental sample using kit and

manual method OR Isolation of metagenomic DNA from environmental sample (soil/water) using kit and manual method

• Quantitation of isolated DNA by spectrophotometer/nanodrop

• Designing of universal, bacteria or archaeal specific standard 18S rRNA primers by bioinformatics software and manual method

• Amplification of 18S rRNA sequence from isolated DNA by Polymerase Chain reaction (PCR) a) Bioinformatic analysis of obtained 18S rRNA sequence and construction of phylogenetic tree using MEGA 5.0 to obtain the taxonomic identification and closest neighbor or 18S rRNA based classification of soil microorganisms

• Characterization of isolated micro-organism for morphological, biochemical, physiological, chemotaxonomic and genotypic information for designation of taxonomic genus and species name.

• Amplified Ribosomal DNA Restriction Analysis (ARDRA) of the PCR amplified 18S

rRNA using tetracutter restriction enzymes and pattern analysis by preparation of cladogram b) Bioinformatic analysis of obtained 18S rRNA sequence and construction of phylogenetic tree using MEGA 5.0 to obtain the taxonomic identification and 18S rRNA based classification of soil microorganisms

2.Environmental Monitoring Techniques

a)Water and waste water quality test methods:

i. Physical parameters: pH / conductivity / turbidity/colour, hardness/TDS / TSS

ii. Chemical parameters: CO2 / alkalinity / chlorides /. Nitrate/Nitrite/NH4 + /PO4 2- / /F/Cl

iii. Biological parameters: DO / BOD / COD /

iv. Evaluation of bacterial count by calculating the MPN index and isolation of fecal coliform (byMPN methods using selective media) for water potability from drinking water and environmental sources

v. Estimation of total bacterial (microbial load) count, isolation of coliphage estimation of PFU/ml (plaque forming units) from sewage water.

b) Soil analysis (physical and chemical parameters): water holding capacity, moisture, above mentioned tests for water analysis, estimation of pesticides and chemicals, estimation of metal ions by atomic absorption spectroscopy (demo). c)Solid waste characterization (physical and chemical parameters)

3. Degradation of pesticides (organochlorine/organophosphate) in soil by microorganisms and analysis of degradation by gas chromatography/HPLC.

ENVIRONMENTAL MONITORING AND QUANTITATIVE ANALYSIS. (3 credit)

QUANTITATIVE ANALYSIS

Gas chromatographic techniques

Titrimetric methods

Colorimetric methods

AA Spectrophotometric analysis

HPLC techniques

Ion exchange chromatography

Electrophoresis methods

PCR technique

ENVIRONMENTAL MONITORING USING REMOTE SENSING

Remote Sensing – Raster Analysis

Remote Sensing – Vector Analysis

GIS Analysis

GPS in Remote Sensing Analysis

Modeling Air Pollutant analysis

Books/ Manuals Recommended:

Sawyer C., McCarty, P. and Parkin G. (2003). Chemistry for Environmental Engg. & Science, Tata McGraw Hill Publishing PvtLmt (5th Edition). pp 752.

Swamy K. K. Env. Engineering Lab Manual-. PatnaikP(1997). Handbook of Environmental Analysis- Lewis Pub.

SEMESTER IV
CORE PAPER 3: CHEMICAL REACTION ENGINEERING

Paper code: **Subject: CHEMICAL REACTION ENGINEERING**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts on Process calculations and Heat transfer Biochemical Thermodynamics , Mass Transfer Operations

Course Objectives

1.To learn the basic concept the in reaction kinetics

2.To develop knowledge on the basic develop knowledge for design of ideal reactors

3.To understand the basic concept on the basics understand the practical aspects of Non-Ideal flow.

4.To understand the basic concept on Gas - Liquid reaction

5.To develop a piece of knowledge on General characteristics and classification of catalysis

Course Out Comes

1..After completing unit 1, the students will be able to Concentration and temperature dependent

term of rate equation

2..After completing unit 2, the students will be able to know Ideal batch reactors – steady state MFR & PFR

3..After completing unit 3, the students will be know RTD of fluid in vessel

4.After completing unit 4, the students will be know about Absorption combined with chemical reaction

5. After completing unit 5, the students will be know about Catalysis-General characteristics and

classification of catalysis

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Concentration and temperature dependent term of rate equation – searching for mechanism – predictability of reaction rate from theory; Interpretation of batch reactor data – constant volume and variable volume batch reactors – temperature and reaction rate - development of rate equations for different homogeneous reactions (up to second order reactions both reversible and irreversible reactions)	**18 hours**
Unit-II	Ideal batch reactors – steady state MFR & PFR – holding time for flow systems; Design for single reactions - performance equations for single reactors – size comparison of single reactors – MFR vs PFR for first and second order reactions – multiple reactor systems -graphical comparison; RTD of fluid in vessel – relationship between F,C& E curve – conversion from tracer information - non-ideal flow models – Dispersion model and Tanks in series Model.	**18 hours**
Unit-III	Absorption combined with chemical reaction. Mass transfer coefficients and kinetic constants. Application of film penetration and surface renewal theories. Hatta number and enhancement factor for first order reaction	
Unit-IV	Catalysis-General characteristics and classification of catalysis-Physical adsorption and chemisorptions- Adsorption isotherms-Determination of surface area of a catalyst-Classification of catalyst-catalyst preparation- Mechanism of Catalyst deactivation-Pore diffusion resistance combined with surface kinetics-performance equations for reactors containing porous catalyst particles	**18 hours**
Unit-V	Thermal stability of reactors and optimal temperature progression for first order reversible reactions, Adiabatic and heat regulated reactions, Design of non-isothermal reactors, Effect of temperature on product distribution for series and parallel reactions.	**05 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS:

1. Levenspiel O, “Chemical Reaction Engineering”, John Wiley, 3rd Edition, 1999
2. Fogler H.S, “Elements of Chemical Reaction Engineering”, Prentice Hall of India, 4th edition, 2002.

REFERENCE BOOKS:

1. Missen R.W., Mims C.A., Saville B.A., “Introduction to Chemical Reaction Engineering and Kinetics”. John Wiley & Sons, 1st Edition, 1999.
2. Froment. G.F., Bischoff K.B., “Chemical Reactor Analysis and Design”, John Wiley and Sons, 3rd Edition, 2010.
3. James B.R., John G. E., “Chemical Reactor Analysis and Design Fundamentals”, Nob Hill Publishers, 1stEdition, 2002

Web Sources

https://www.hindawi.com/journals/bmri/2020/1870807/

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

MOOC- MASSIVE OPEN ONLINE COURSES

USRR (UNIVERSITY SOCIAL RESPONSIBILITY REPORT)

The aim of the Field Study is to help students connect with the society in the respective discipline. Following are the important features of the Field Study and the USRR:

1.Aim: The Field Study must aim at relating the subject of study with the society in so far as the application and the usefulness of the study are concerned

2.Topic selection: The topic for the Field Study must be chosen by the student in the second semester in the month of February; the process for the same shall begin on 1st February and shall end on the last working day of the month of February. Students are free to select the topic for the Field Study in consultation with the Experts and Faculty Members of their choice, both from within and outside the University

3.Period and duration: The Field Study shall be undertaken for a duration of 15 days in the summer vacation that falls immediately at the end of the second semester of the program and the same should be accounted for the Third Semester of the program

4.USRR: The USSR (University Social Responsibility Report) must be prepared by every student of the program written in 50 to 75 pages. The report shall be written based on the standard research methodology.

5.Review and evaluation schedule:

a.***Reviewing the Field work:*** First week of July

b.***Report Review:*** Second week of August

c.***Report submission:*** First week of September

d.***Report Evaluation:*** Third week of September

6.Faculty Composition: The following members may be nominated for confirming the topic and for evaluating the USRR:

a.Professor and Head of the concerned Department

b.One Faculty member with related field of specialization from the concerned Department

c.One senior faculty member from the Department of Sociology from other Institution

SEMESTER IV
CORE ELECTIVE 1: BIOFUELS

Paper code: **Subject: BIOFUELS**

Hours/Week: 5Credits: 4

Aim: To enable the students to understand the basic concepts to understand the fundamental concepts in biofuels/ bioenergy, the production mechanisms of different types of biofuels, the knowledge related to processing technologies of biofuels.

Course Objectives

1.To learn the basic concept the biofuels

2.To develop knowledge on the basic bioenergy

3.To understand the basic concept on the basics different types of biofuel

4.To understand the basic concept on processing technologies of biofuels,

5.To develop a piece of knowledge on Energy

Course Out Comes

1. After completing unit 1, the students will be able to Problems relating demand and supply of various energy sources-Coal-Petroleum.

2. After completing unit 2, the students will be able to production mechanisms by microbes

3. After completing unit 3, the students will be know Sources and processing of biodiesel

4. After completing unit 4, the students will be know about Gasification processes

5. After completing unit 5, the students will be know about Analysis of both current and future Indian regulations

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Introduction-resources-renewable and non-renewable resources (water, minerals, and energy) use and overexploitation; Classification and sources of energy; Problems relating demand and supply of various energy sources-Coal-Petroleum.	**18 hours**
Unit-II	First generation biofuels-bioethanol – production mechanisms by microbes; Second generation biofuels-methane and hydrogen – production mechanisms by microbes; Factors affecting biogas yields; Third generation biofuels-biobutanol-biodesel from algae; Fourth generation biofuels- solar to fuel method to produce biofuels. Sources and processing of biodiesel (fatty acid methyl ester); Sources and characteristics of lipids for use as biodiesel feedstock and conversion of feedstock into biodisel (transesterification); Biomethane or biogas-hydrolysis-anaerobic digestion-methanogenesis (acetoclastic, hydrogenotrophic) - rates of methane formation-one and two stage fermentation.	**18 hours**
Unit-III	Gasification processes and the main types of gasifier designs-production of electricity by combining a gasifier with a gas turbine or fuel cell; Combined-cycle electricity generation with gas and steam turbines and generation of heat and steam; Fast pyrolysis technology to produce liquid bio oil or pyrolysis oil (synthetic oil) from biomass-refined to produce a range of fuels- chemicals and fertilizers	
Unit-IV	Analysis of both current and future Indian regulations - directives on biofuels and bioenergy; Evaluation of different production alternatives to produce bioenergy; Evaluation of current and future R&D needs-legal framework to support sustainable development and increased use of biofuels; Government policies and programs with regard to biofuels and investment opportunities worldwide	**18 hours**

Unit-V	Biodiesel − Microorganisms and raw materials used for microbial Oil production − Treatment of the feedstocks prior to production of the Biodiesel − Current technologies of biodiesel production − Purification of biodiesel; Industrial production of biodiesel − Biodiesel production from single cell oil.	**05 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS:

1.Samir K. Khanal, "Bioenergy Production: Principles and Applications", Wiley-Blackwell Publishing, 1st edition, 2018

2.David M. Mousdale, "Biofuels: Biotechnology, Chemistry, and Sustainable Development", CRC Press Taylor and Francis group,1st edition, 2008

3. Gupta, Vijai Kumar; Tuohy, Maria G. (Eds.), "Biofuel Technologies Recent Developments, Springer, 1st edition, 2013

REFERENCE BOOKS:

1. Robert C. Brown, "Biorenewable Resources: Engineering New Products from Agriculture", Wiley-Blackwell Publishing, 2nd edition, 2014.

2. Pogaku, Ravindra, Sarbatly, RosalamHj. (Eds.), "Advances in Biofuels", Springer, 2013.

3. Martin Kaltschmitt and Hermann Hofbauer, "Biomass Conversion and Biorefinery", Springer Publishing, 2008.

4. B Pandya, "Conventional Energy Technology - Fuels and chemical Energy", TMH(1987)

5. S.P. Sharma and Chander Mohan, "Fuels and Combustion", TMH, 1stediton, 1984 6. Kash Kori, C, "Energy resources, demand and conservation with special reference to India", TMH, 1st edition, 1975.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2

CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER IV
CORE ELECTIVE 2: BIOPOLYMER TECHNOLOGY

Paper code: Subject: **BIOPOLYMER TECHNOLOGY**

Hours/Week: 5 Credits: 3

Aim: To enable the students to understand the basic concepts to understand the different types of bio polymers in biomedical applications, environmental protection, application of bio surfactant in food industry and to examine the different properties and market analysis through case studies

Course Objectives

1.To learn the basic concept the different types of bio polymers

2. To develop knowledge on the basic environmental protection

3.To understand the basic concept on the basics surfactant in food industry

4.To understand the basic concept on market analysis

5.To develop a piece of knowledge on Fermentability of Biodegradable Materials

Course Out Comes

1. After completing unit 1, the students will be able to employ the greener technologies to solve the environmental issues

2.After completing unit 2, the students will be able to familiar the different types of plant and animal derived bio polymers and their application as commercial bio plastics

3.After completing unit 3, the students will be know illustrate the synthesis and application of bio polymers in nano scale drug delivery systems, as bio mimetic materials and waste water treatment methods.

4.After completing unit 4, the students will be know about understand the properties of biosurfactants and their use in food industries

5..After completing unit 5, the students will be know about to evaluate the tensile strength, hydration, viscoelastic properties using different testing methods.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	**Course Contents**	**Teaching hours**
Unit I	Bio polymers - definition, Plant and Animal bio polymers- poly nucleotide, poly amides, polysaccharides, poly isoprene, lignin, poly phosphate and polyhydroxyalkanoates. Application and chemical synthesis of super absorbent polymers-Polyethylene glycol, Polypropylene glycol, Polytetramethylene glycol, Poly glycerine. Bio plastics and environment, Commercial bio plastics. Natural fibers like silk, wool, flax, jute, linen, cotton, bamboo. Bio composite- properties and applications.	**18 hours**
Unit-II	Industrial bio polymers: Production of poly phenol resins by the enzyme soybean per oxidase; Novel synthesis of Artificial Bio polymers in Biomedical Applications- An Overview, Hydro gel as potential Nano scale drug delivery system , Low cost foods and drugs using immobilized enzymes on Bio polymers, Physio chemical characteristics of bio polymers. Biodegradable polymers for medical purposes, Bio polymers in controlled release systems. Synthetic polymeric Membranes and their biological applications	**18 hours**
Unit-III	Biosurfactants: Source, characteristics and properties of Biosurfactants; Production of Biosurfactants via the fermentation and bio transformation routes; Production of Biosurfactants with immobilized cells; Integrated bio process for continuous production of Biosurfactants including downstream processing; Applications of Biosurfactants – Food Industry, Environmental Control.	**18 hours**
Unit-IV	An Overview of Available Testing Methods, Comparison of Test Systems for the Examination of the Fermentability of Biodegradable Materials, Evaluation of the properties of bio polymers to make good bio materials; Tensile strength (both elasticity and breaking strength); Hydration, visco – elastic properties; viscosity. Criteria used in the evaluation of Biodegradable polymers – petridish screen – environmental chamber method – soil burial tests etc.	

Unit-V	Bio polymers: Synthesis from a simple biological monomer (i.e. Hyaluronate polymers); Dextran (used in chromatography columns); Rubber like materials produced by bacteria and fungi – Polyhydroxybutyrate (PHB), Polycaprolactone (PCL), Xanthan gum; Production of a co polymer of PHB and PHV(Polyhydroxyvaleric acid), sold as Bio pol by fermentation on Alcaligenes eutrophus; Biodegradable polymers. Techniques of polymerization: bulk, solution, suspension, emulsion, plasma etc. Different initiating systems such as free radicle polymerization, redox, cationic & anionic polymerization (different terms such as living polymers, inifers, telechelics). Their kinitics & control over structure of polymer	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS:

1. Emo Chiellini , Helena Gil, “Bio related Polymers: Sustainable Polymer Science and Technology”, Springer 2001.

2. Johnson .R.M, L.Y. Mwaikambo and N. Tucker, “Bio polymers”, Rapra Technology, 2003

REFERENCE BOOKS:

1. Naim Kosaric (Ed)., “Biosurfactants”, Marcell Dekker Inc, 1993.

Web Sources

https://onlinecourses.nptel.ac.in/noc22_ch28/preview

https://nptel.ac.in/courses/102104057

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

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Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER IV
CORE ELECTIVE 3: MEDICAL BIOTECHNOLOGY

Paper code: **Subject: MEDICAL BIOTECHNOLOGY**

Hours/Week: 5 Credits: 3

Aim: To enable the students to understand the basic concepts to understand the classification, diagnosis and therapy of pathogenic infections the concepts of stem cells and tissue engineering.

Course Objectives

1. To learn the basic concept and to understand the classification, diagnosis and therapy for pathogenic infections

2. To develop knowledge on the stem cells and tissue engineering

3.To understand the basic concept on the Monoclonal Antibodies

4.To understand the basic concept on Embryonic and adult stem cells

5.To develop a piece of knowledge on Vaccines

Course Out Comes

1. After completing unit 1, the students will be able to understand the classification, diagnosis and therapy for pathogenic infections

2. After completing unit 2, the students will be able to exhibit knowledge on recent trends in diagnosis of various disorders.

3. After completing unit 3, the students will be know Learn the production of monoclonal antibodies as diagnostic tools and therapeutic agents

4. After completing unit 4, the students will be know about exhibit knowledge on stem cells, tissue engineering and gene product

5. After completing unit 5, the students will be know about to the types, preparation and testing of vaccines, recombinant products and growth factors

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	124 **Course Contents**	**Teaching hours**
Unit I	Classification of pathogenic microbes; Leptospira, Brucella, Bacillus anthraces; Medical Parasitology: Amoebiasis, Cryptoporidiosis, Giardiasis, Malaria, Toxoplasmosis; Viruses: Adenoviruses, Retroviruses; Medical Mycology: Superfical Mycoses, Subcutaneous Mycoses, Systemic Mycoses	**18 hours**
Unit-II	Prenatal diagnosis: Invasive techniques - Amniocentesis, Fetoscopy; Non-invasive techniques – Ultrasonography, X-ray, Diagnosis using protein and enzyme markers, DNA/RNA based diagnosis; Hepatitis, HIV - CD 4 receptor; Microarray technology in cancer diagnosis. Genetic disease, type of inheritance, single-gene and multifactorial inheritance, example of genetic diseases. Therapeutic intervention in blood disorder by stem cell transplantation/gene therapy	**18 hours**
Unit-III	Monoclonal Antibodies: Production, Target drug delivery using monoclonal antibodies; Gene Therapy: types, vectors used in gene therapy; Immunotherapy in cancer; Application of nano biosystems in diagnosis and therapy.	**18 hours**
Unit-IV	Embryonic and adult stem cells: Totipotent, pluripotent and multipotent cells: Testing and generation of embryonic stem cells; Potential uses of stem cells: cell based therapies and clinical applications. Biomaterials: Characterization, Host reactions, Extracellular matrix, Scaffolds, Artificial organs, Applications.	
Unit-V	Vaccines- Preparation and testing, standardization and storage study; New generation of vaccines: Hepatitis, AIDS, Malaria; Minicells as vaccine; Production of recombinant pharmaceutical products– Biotechnologically derived products (therapeutic proteins): Interferons, Interleukins, Insulin, Growth Hormones; Recombinant coagulation factors and thrombolytic agents, Somatostatin, Somatotropin, Ketopeptide	**18 hours**
Total Teaching hours		**90**

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

TEXT BOOKS:

1. Judit Pongracz, Mary Keen, “Medical Biotechnology”, Elsevier Health Sciences, 2009.

2. Bernard R. Glick, Terry L. Delovitch, Cheryl L. Patten, “Medical Biotechnology”, ASM Press, Washington DC, 2014

REFERENCE BOOKS:

1. Albert Sasson , “Medical biotechnology: achievements, prospects and perceptions”, United Nations University Press, 2005.

2. Yuan Kun Lee, “Microbial biotechnology: principles and applications”, World Scientific, Edition 2006.

Web Sources

https://onlinecourses.nptel.ac.in/noc22_bt39/preview

https://ocw.mit.edu/courses/7-013-introductory-biology-spring-2013/resources/lecture-23-stem-cells/

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

PROJECT (8 credit)