

DEPARTMENT OF MICROBIOLOGY

RATHINAM COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)

Rathinam Techzone, Pollachi Road, Eachanari,

Coimbatore – 641021.



Syllabus for

B.Sc. MICROBIOLOGY

(I, II, III, IV, V & VI Semesters)

2021–2022 Batch Onwards

Vision and Mission of the Institution:

VISION

To emerge as a world renowned institution that is integrated with industry to impart Knowledge, Skills, Research Culture and Values in youth who can accelerate the overall development of India.

MISSION

To impart superior quality education at affordable cost, nurture academic and research excellence, maintain eco-friendly and future-ready infrastructure, and create a team of well qualified teaching professionals who can build global competency and employability.

CORE PURPOSE

Transform the youth into National Asset.

Vision and Mission of the Department:

VISION

Our vision is to provide quality higher education to the youth. Apart from imparting subject knowledge and skills, we focus on molding the students with better conduct and character with an utmost commitment to the societal needs and National development. Spirited by the motto “Industry – Ready Education” The Department of Microbiology aims to comprehend the vision of a Microbiologist and transcend knowledge for enriching human life.

MISSION

Our mission is to develop knowledgeable, motivated and skilled youngsters in the field of Microbiology who can establish companies/industries catering the basic needs of agriculture, industry and health sector of people all over the globe and could provide a clean, sustainable environment for the future generation.

Program Educational Objectives (PEO)

PEO 1	:	Preparedness – The students shall excel in various Microbiological aspects or to succeed in industry / technical profession through global, rigorous education.
PEO 2	:	Core competency – The students shall be provided with a strong foundation in the fundamentals of core Microbiology and allied subjects required to troubleshoot routine problems caused by microbes and also to pursue higher studies.
PEO 3	:	Comprehensive knowledge – The students would acquire good scientific and research breadth so as to comprehend, analyze, design, and create novel bio products and solutions for the real life problems.
PEO 4	:	Professionalism and Ethical standards – The students shall be imparted with professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Microbiological issues to broader social context.

Mapping of Institute's Mission to PEO:

Institute Mission	PEO's
Knowledge and skill enhancement	PEO1, PEO3
Research oriented study	PEO2, PEO3
Core competent skill enhancement	PEO1, PEO2
Enhancing young Bio-entrepreneurs	PEO1, PEO4

Mapping of Department's Mission to PEO:

Department Mission	PEO's
Imparting critical thinking	PEO1
Enhancing research skills	PEO2, PEO3
Developing professionalism	PEO1, PEO4
Viable technical knowledge and core competency	PEO2, PEO4

Program Outcomes (PO):

P01	:	The candidates shall acquire current knowledge in Microbiology which would enable them to enrich themselves to be competitive in the Life science sector.
P02	:	Students would gain the ability to articulate and have a cognitive thinking on the different aspects relevant to Microbiology.
P03	:	Students would be imparted with the ability to design and execute comprehensive techniques and become familiar with routine laboratory practices.
P04	:	Students shall attain scientific writing and communication skills to aid them in written, oral and visual presentation, including an original research proposal.
P05	:	Students shall acquire the ability to prepare them for careers in the industry, agriculture and applied research, where biological system is extensively employed.
P06	:	Students would apply technical skill sets in handling various laboratory instruments, and troubleshoot related problems.
P07	:	Students would acquire entrepreneurial skills and apply ethical principles to create novel bio products enabling them to establish a startup industry.
P08	:	Students would function effectively as teams to plan tasks, execute them to achieve the set goal and analyze risk and uncertainties involved in Environment, Health and allied sectors.

PROGRAM SPECIFIC OUTCOME (PSO):

PS01	:	To equip students with essential skills for understanding the Research ethics (public policy, biosafety, and intellectual property rights) involving microorganisms to contribute to application, advancement and impartment of knowledge in the field of Microbiology.
PS02	:	To develop substantial original research of social and environmental significance with quality sufficient for publication.
PS03	:	To enable the students present their work through written, oral, and visual presentations, including an original research proposal.
PS04	:	To propose the technological knowhow in domains of Microbiology for their applications in industry and research.

Correlation between the POs/PSOs and the PEOs

Program Outcomes		PEO1	PEO2	PEO3	PEO4
PO1	:	3	1	3	1
PO2	:	3	2	3	1
PO3	:	1	2	3	3
PO4	:	3	1	3	2
PO5	:	3	3	2	3
PO6	:	2	3	3	2
PO7	:	2	3	1	3
PO8	:	3	2	1	3
PSO1	:	2	3	1	3
PSO2	:	3	2	2	3
PSO3	:	2	3	3	2
PSO4	:	3	2	2	1

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

Components considered for course delivery is listed below:

1. Class room Lecture
2. Laboratory class and demo
3. Assignments
4. Case Study
5. Project
6. Online Course
7. External Participation
8. Seminar
9. Internship

Mapping of POs with Course Delivery

Program Outcome	Course Delivery								
	1	2	3	4	5	6	7	8	9
PO1	3	3	1	1	2	1	3	3	1
PO2	3	3	2	3	3	1	1	2	3
PO3	3	3	1	3	1	1	1	2	3
PO4	3	3	2	3	3	1	1	3	1
PO5	1	2	1	3	1	3	3	3	3
PO6	1	3	1	3	3	1	2	3	3
PO7	1	3	1	3	1	1	2	3	3
PO8	3	2	1	2	3	3	2	3	3
PSO1	2	3	1	3	2	3	1	3	3
PSO2	3	2	2	3	3	2	2	3	2
PSO3	2	3	3	2	2	3	3	2	3
PSO4	3	2	2	1	3	2	2	1	2

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

Approved in the BOS Meeting held on 24-04-2021

Mapping of Courses and POs

Semester	Course Code	Course Name	Program Outcomes							
			PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
1		Basic Concepts of Microbiology	3	2	3	1	1	2	2	2
		General Biology	3	3	1	1	1	1	2	2
2		Microbial Physiology and Metabolism	3	3	2	2	1	3	1	2
		Analytical Microbiology	3	3	3	2	2	1	2	1
3		Microbial Genetics	3	3	2	3	3	2	2	1
		Microbial Taxonomy and Diversity	3	2	3	2	2	3	1	1
4		Immunology	3	3	3	3	2	3	2	2
		Medical Bacteriology	2	3	3	2	3	3	1	2
5		Food and Industrial Microbiology	2	3	2	3	3	3	3	3
		Microbial Genome and Proteomics	3	3	2	3	3	2	1	2
6		Environmental Microbiology	2	3	3	2	2	2	2	3
		rDNA Technology	3	3	3	3	3	2	3	2
		Dairy Technology	2	1	2	2	2	3	3	2

3 – Strong correlation; 2-moderate correlation; 1-Less correlation; Blank-no correlation

RATHINAM COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)**B.SC. MICROBIOLOGY DEGREE COURSE****B. Sc (MB) Curriculum Structure - Regulation - 2021****(For the students admitted from 2021 onwards)**

S.No	Semester	Part	Sub Type	Sub Code	Subject	Credit	Hours	INT	EXT	Total
1.	1	1	L1		Language – I	4	4	50	50	100
2.	1	2	L2		English for Communication – I	4	4	50	50	100
3.	1	3	Core		Core - Basic concepts of Microbiology	4	4	50	50	100
4.	1	3	Core Practical		Core Practical - Basic concepts of Microbiology Practical	2	4	20	30	50
5.	1	3	DSC		General Biology	4	4	50	50	100
6.	1	3	DSC Practical		General Biology Practical	2	4	20	30	50
7.	1	3	Allied-I		Biostatistics and Computer Application	4	4	50	50	100
8.	1	4	AEC		Ability Enhancement Course I	2	2	50		50
9.	1	6	VAC		Value Added Course – I%	2	-	50		50
						28	30			
10.	2	1	L1		Language – II	4	4	50	50	100
11.	2	2	L2		English for Communication – II	4	4	50	50	100
12.	2	3	Core		Core - Microbial Physiology and Metabolism	4	4	50	50	100
13.	2	3	Core Practical		Core Practical - Microbial Physiology and Metabolism Practical	2	4	20	30	50
14.	2	3	DSC		Analytical Microbiology	4	4	50	50	100
15.	2	3	DSC Practical		Analytical Microbiology Practical	2	4	20	30	50
16.	2	3	Allied-II		Biomolecules	4	4	50	50	100
17.	2	4	AEC		Ability Enhancement Course II	2	2	50		50
18.	2	6	VAC		Value Added Course - II%	2	-	50		50
						28	30			
19.	3	3	Core		Core - Microbial Genetics	4	5	50	50	100
20.	3	3	Core Practical		Core Practical - Microbial Genetics Practical	2	4	20	30	50
21.	3	3	DSC		Microbial Taxonomy and Diversity	4	5	50	50	100
22.	3	3	DSC Practical		Microbial Taxonomy and Diversity Practical	2	4	20	30	50
23.	3	3	Allied-III		Entrepreneurial Microbiology	4	5	50	50	100
24.	3	4	SEC		Skill Enhancement Courses – I – Waste Management	2	5	20	30	50
25.	3	4	AEC		Ability Enhancement Course III	2	2	50		50
26.	3	6	VAC		Value Added Course - III%	2	-	50		50
27.	3	6	ITR		Industrial Training Report – I	2	-	50		50

S.No	Semester	Part	Sub Type	Sub Code	Subject	Credit	Hours	INT	EXT	Total
28.	3	6	IDL		Inter Department Learning – I	2	-	50		50
						26	30			
29.	4	3	Core		Core – Immunology	4	5	50	50	100
30.	4	3	Core Practical		Core Practical - Immunology Practical	2	4	20	30	50
31.	4	3	DSC		Medical Bacteriology	4	5	50	50	100
32.	4	3	DSC Practical		Medical Bacteriology Practical	2	4	20	30	50
33.	4	3	Allied-IV		Research Methodology	4	5	50	50	100
34.	4	4	SEC		Skill Enhancement Courses – II – Virology	2	5	20	30	50
35.	4	4	AEC		Ability Enhancement Course IV	2	2	50		50
36.	4	6	VAC		Value Added Course - IV%	2	-	50		50
37.	4	6	IDL		Inter Department Learning – II	2	-	50		50
						24	30			
38.	5	3	Core		Core - Food and Industrial Microbiology	4	4	50	50	100
39.	5	3	Core Practical		Core Practical - Food and Industrial Microbiology Practical	2	4	20	30	50
40.	5	3	DSC		rDNA Technology	4	4	50	50	100
41.	5	3	DSC Practical		rDNA Technology Practical	2	4	20	30	50
42.	5	3	DSE		Elective - I	4	5	50	50	100
43.	5	3	DSE		Elective - II	4	5	50	50	100
44.	5	4	SEC		Skill Enhancement Courses – III- Medical Mycology and Parasitology	2	4	20	30	50
45.	5	6	ITR		Industrial Training Report II	2	-	50	-	50
46.	5	6	VAC		Value Added Course – V%	2	-	50		50
						26	30			
47.	6	3	Core		Core -Environmental Microbiology	4	6	50	50	100
48.	6	3	Core Practical		Core Practical -Environmental Microbiology Practical	2	4	20	30	50
49.	6	3	DSE		Elective – III	4	6	50	50	100
50.	6	3	DSE		Elective – IV	4	6	50	50	100
51.	6	3	Core Course - XI		Core Project	8	4	80	120	200
52.	6	4	SEC		Skill Enhancement Courses – IV- Textile Microbiology	2	4	20	30	50
53.	6	5	EX		Extension Activity- EX%	2	-	50		50
						26	30	2000	1950	3950
					Total credit	158				

Discipline Specific Core – Theory					
S.No.	Pre-requisite	Sub Code	Subject	Offering Department	Mandatory
2	Nil		General Biology	Microbiology	No
4	Nil		Analytical Microbiology	Microbiology	No
6	Nil		Microbial Taxonomy and Diversity	Microbiology	No
7	Nil		Medical Bacteriology	Microbiology	No
8	Nil		Microbial Genome and Proteomics	Microbiology	No
10	Nil		rDNA Technology	Microbiology	No
13	Nil		Dairy Microbiology	Microbiology	No

Discipline Specific Core – Practical					
S.No	Pre-requisite	Sub Code	Subject	Offering Department	Mandatory
2	Nil		General Biology Practical	Microbiology	No
4	Nil		Analytical Microbiology Practical	Microbiology	No
6	Nil		Microbial Taxonomy and Diversity Practical	Microbiology	No
7	Nil		Medical Bacteriology Practical	Microbiology	No
9	Nil		rDNA Technology Practical	Microbiology	No
12	Nil		Dairy Microbiology Practical	Microbiology	No

Allied					
S.No.	Pre-requisite	Sub Code	Subject	Offering Department	Mandatory
1	Nil		Biostatistics and Computer Application	Mathematics	No
2	Nil		Biomolecules	Microbiology	No
3	Nil		Entrepreneurial Microbiology	Microbiology	Yes
4	Nil		Research Methodology	Microbiology	Yes
5	Biomolecules		Biochemistry	Microbiology	No
6	Nil		Microbial Nanotechnology	Microbiology	No
7	Nil		Chemistry	Microbiology	No

Skill Enhancement Courses					
S.No.	Pre-requisite	Sub Code	Subject	Offering Dept	Mandatory
1	Nil		Skill Enhancement Courses – I Clinical Laboratory Technology	Mathematics	No

2	Nil		Skill Enhancement Courses – II Waste Management	Microbiology	No
3	Nil		Skill Enhancement Courses – III Textile Microbiology	Microbiology	Yes
4	Nil		Skill Enhancement Courses – IV Medical Mycology and Parasitology	Microbiology	Yes
5	Nil		Skill Enhancement Courses – V Virology	Microbiology	Yes
6	Nil		Skill Enhancement Courses – V Human Anatomy and Physiology	Microbiology	No

Discipline Elective					
S.No	Pre-requisite	Sub Code	Subject	Offering Department	Mandatory
1	Nil		Bioethics, IPR and Biosafety	Microbiology	No
2	Nil		Management of Human Microbial Disease	Microbiology	No
3	Nil		Bioprocess and Technology	Microbiology	No
4	Nil		Marine Microbiology	Microbiology	No
5	Nil		Plant Pathology	Microbiology	No
6	Nil		Inheritance Biology	Microbiology	No
7	Nil		Bio fertilizer and Bio pesticide	Microbiology	No
8	Nil		Advances in Microbiology	Microbiology	No
9	Nil		Microbes in Sustainable Agriculture and Development	Microbiology	No
10	Nil		Pharmaceutical Microbiology	Microbiology	No
11	Nil		Microbiological analysis of Air and Water	Microbiology	No
12	Nil		Molecular Biology	Microbiology	No
13	Nil		Bioinformatics	Microbiology	No
14	Nil		Clinical Biochemistry	Microbiology	No
15	Nil		Applied Microbiology	Microbiology	No

Ability Enhancement Course					
S.No	Course Code	Course	Pre-requisite	Offering Department	Mandatory
1		Environmental Studies	-	CS	Yes
2		Women Studies	-	Commerce II	No
3		Constitution of India	-	Commerce I	No
4		Human Rights	-	Psychology	Yes
5		Yoga	-	Tamil	No
6		NCC	-	Viscom	No
7		Communicative English	-	English	No
8		Quantitative Aptitude	-	Mathematics	No

Students should undergo an institutional training for a continuous period of 15 days before semester VI

– No End Semester Examination. Only Continuous Internal Assessment Examination (CIA).

% Value Added Course – Examination and Evaluation for Value Added Courses should be conducted by the Industry and the marks shall be submitted to the CoE for the award of Grade.

Value Added Courses offered by the Department

S. No	Sem	Type	Subject	Credits
1.	I	VAC1	Vaccine Development Technology	2
2.	II	VAC2	Microbial Diagnosis in Health Clinic	2
3.	III	VAC3	Medical Coding	2
4.	IV	VAC4	Modern Agricultural Methods	2
5.	V	VAC5	Vermicomposting Technology	2

MANDATORY CORE PAPERS

MANDATORY CORE PAPERS													
Subject Code		Subject Title			Credit		Lecture		Tutorial		Practical		Type
		Basic Concepts of Microbiology			4		4		–		–		Theory
Introduction Microbiology has played a central role in all aspects of Biological sciences, including morphogenesis, Genetics, developmental biology, Physiology, Biochemistry and Cell biology. An understanding of Microbiology and its lineage is essential to inculcate knowledge of basics.													
Course Focus on : Skill Development / Entrepreneurship / Employability / Research													
Course Outcome													
CO1		:	To describe the fundamental concepts of Microbiology, such as the classification and identification of microbes.										
CO2		:	To relate the use of different microscopic techniques according different laboratory purpose.										
CO3		:	To interpret the microscopic observation of microorganisms and maintenance of microbial cultures.										
CO4		:	To compare the core principles of sterilization and the different methods of sterilization.										
CO5		:	To illustrate the pure culture techniques and preservation of cultures										
Unit I:												[12 Periods]	
History and Scope of Microbiology: Spontaneous generation theory –conflict –Contribution of Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister, Winogradsky, Waksman, John Tyndall, Paul Ehrlich, Watson & Crick and Miescher.													
Unit II:												[12 Periods]	
Microscopy: Principles and application – Bright field, Dark field, Phase contrast, Fluorescence, Confocal, SEM & TEM– Specimen preparation for Electron microscopy.													
Unit III:												[12 Periods]	
Sterilization and Disinfection Principles– Methods of Sterilization – Physical methods – Dry heat– Moist heat, Filtration (Membrane & HEPA) – Radiation – Chemical Sterilization –Chemical agents Mode of action – Phenol coefficient test– Sterility testing.													
Unit IV:												[12 Periods]	
Culture Media preparation: Solid and Liquid– Types of Media – Semi–Synthetic, Synthetic, Enriched, Enrichment, Selective and Differential media, Natural components as media and Special Purpose Media (one eg for each type). Anaerobic culture technique – Wright's tube, Roll tube, McIntosh fildes jar method. Pure culture techniques – Tube dilution, Pour, Spread, Streak plate.													
Unit V:												[12 Periods]	
Staining techniques: Organization of bacterial cell structure - Gram positive cell wall structure and Gram Negative bacterial cell wall.Staining – Principles – Types of staining– Simple, Differential (Gram, Spore, AFB), Capsule staining (Negative and Positive), Giemsa Staining, LPCB, KOH Mount.													
Text book: 1. Prescott, L.M., Harley, J.P., and Klein, C.A. (2020). Microbiology. 11 th Edition. Wm, C. Brown publishers.													
Reference: 1. William Claus, G.W. (1989). Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York. 2. Tauro P., Kapoor, Yadav, K.K. (2019) An introduction to Microbiology first Edition, New Age International Publishers.													
Mapping of Course Outcome with Program Outcome and Program Specific Outcome:													
Course Outcome	Program Outcomes								Program Specific Outcome				
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04	
CO1	3	3	3	2	2	1	1	1	2	3	1	3	
CO2	3	2	3	1	1	3	2	1	3	2	2	3	
CO3	3	3	2	1	2	2	1	3	2	3	3	2	
CO4	1	1	3	3	1	3	2	3	3	2	2	1	
CO5	3	1	3	1	3	2	2	3	1	2	3	2	

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Microbial Physiology and Metabolism	4	4	–	–	Theory						
Introduction: This course deals with the study on how a microbial cell utilizes the available nutrient and obtain energy in nature. Understanding microbial physiology is vital in manipulating both the beneficial and harmful characteristics of microbes.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To identify and study the morphology of prokaryotic and eukaryotic cells.											
CO2	To understand nutritional requirements and physiological aspects of nutrient uptake in microbes.											
CO3	To analyze the role of different metabolic pathways involved in the nutrient metabolism.											
CO4	To grasp the aspect of anaerobic respiration in the microbial metabolism.											
CO5	To decipher the concept of various biosynthetic pathway involved in microbial metabolism.											
Unit I:						[12 Periods]						
Bacterial Cell structure and Function Subcellular structures of microbes – slime layer – capsule, cell wall – Gram positive and Gram negative, cytoplasmic membrane – pili – flagella – storage granules – comparison of prokaryotic and eukaryotic organisms – sporulation and germination – cell division in bacteria – binary fission.												
Unit II:						[12 Periods]						
Nutrition Nutritional requirements of microorganisms – macro elements, micro elements and growth factors, nutritional groups of microbes – transport mechanisms and types – simple diffusion – facilitated diffusion – active transport – group translocation – Ion transport. Growth curve – Generation time – factors influencing microbial growth – batch, continuous, synchronous growth – diauxic growth.												
Unit III:						[12 Periods]						
Aerobic respiration and Photosynthesis EMP – HMP – ED pathways – TCA cycle– electron transport chain (ETC) – oxidative and Substrate level phosphorylation –photosynthesis – oxygenic and an oxygenic, carbon dioxide fixation.												
Unit IV:						[12 Periods]						
Anaerobic respiration and Fermentation Anaerobic respiration – Sulphur, nitrogenous compounds and CO ₂ as final electron acceptor – Fermentation – alcoholic, lactic acid, propionic, butane diol and mixed acid fermentation.												
Unit V:						[12 Periods]						
Biosynthesis Biosynthesis of bacterial cell wall – Biosynthesis of amino acids (Pyruvate family) – Biosynthesis of fatty acids – general pathway – Biosynthesis of purine and pyrimidine nucleotides de-novo and salvage pathways – bioluminescence.												
Text Book: 1. Caldwell, D. R. (2000). Microbial physiology and Metabolism. 2 nd Edition, WMC Brown Publishers, New Delhi.												
Reference Books 1. Stainer, R.Y, Ingraham, J.L., Wheelis, M.L. and Painter, P.R. (2005). Microbial Physiology. 5 th Edition, McGraw–Hill Higher Education New York. 2. Lehninger, Nelson and Cox. (2006). Principles of Biochemistry. 4 th Edition. W.H.Freeman & Company, New York												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
CO1	3	3	3	2	2	2	2	1	3	3	3	2
CO2	3	2	2	3	2	1	3	2	3	2	3	1
CO3	3	3	3	3	1	2	2	1	3	3	2	1
CO4	3	2	3	2	2	3	3	1	1	1	3	3
CO5	3	3	2	3	2	3	2	1	3	1	3	1

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Microbial Genetics	4	4	–	–	Theory						
Introduction: This course is framed to emphasize on the knowledge of the candidate on the types of Genetic material and the regulations under which it acts. Students undertaking this course would be able to study the role of nucleic acids in regulating the microbial cells functions.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To provide the basics knowledge on the historical perspective of Genetics.											
C02	To describe the process of DNA replication.											
C03	To understand the mechanism of Transcription and Translation.											
C04	To analyze different types of mutation and its regulation.											
C05	To study the various types of gene transfer mechanisms.											
Unit I:						[12 Periods]						
Genetic Materials Genetics- historical introduction- DNA as a genetic material – structure and chemical composition of DNA- Watson and Crick model – topological forms of DNA. Organization of genes in prokaryotes - RNA as a genetic material-Introduction to epigenetics.												
Unit II:						[12 Periods]						
Replication DNA replication – semi conservative- Messelson and Stahl’s experiment- replication in Prokaryotes – mechanism and enzymology of replication – helicase, DNA gyrase, polymerases, ligase - rolling circle model – theta replication.												
Unit III:						[12 Periods]						
Transcription and Translation Enzymology and mechanism of transcription in prokaryotes - structure of mRNA, rRNA and tRNA - genetic code – characteristics of genetic code - Enzymology and mechanism of translation in prokaryotes.												
Unit IV:						[12 Periods]						
Mutation and gene regulation Mutation – spontaneous and induced mutations- mutagenesis- - Physical and chemical agents -- site specific mutagenesis- mutagenicity testing - DNA damage and repair - regulation of gene activity- operon model- lac and trp operon.												
Unit V:						[12Periods]						
Gene recombination in bacteria Transformation – transduction (Specialized & Generalized)-conjugation F+ v/s F, Hfr + v/s F- - recombination – homologous recombination - site specific recombination and transposition.												
Text Book: 1. Russell, P.J. (2016). i Genetics- A Molecular Approach. 3 rd Edition, Benjamin Cummings.												
Reference Books: 1. Klug, W.S., Cummings, M.R., Spencer, C., Palladino, M. (2011). Concepts of Genetics, 10 th Edition, Benjamin Cummings. 2. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin’s Essential Genes, 3 rd Edition, Jones and Bartlett Learning.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P O1	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	2	3	2	3	2	3	2	3	3	3	2
C02	2	3	3	2	2	3	3	1	3	2	2	3
C03	3	3	3	2	3	2	1	3	3	3	3	3
C04	2	3	2	3	3	2	3	1	3	2	3	2
C05	3	3	2	3	2	3	2	1	3	3	2	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Immunology	4	4	–	–	Theory						
Introduction: This course is framed to introduce the Science of Immunology by imparting knowledge on various types of immune systems their classification structure and mechanism of immune activation.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To describe the historical developments of Immunology and basic functions of immune system											
C02	To illustrate the various types of antigen and antibodies present in the immune system.											
C03	To classify various types of immune diseases.											
C04	To differentiate the methodologies involved in Immunohematology											
C05	To elaborate on the various clinical techniques involved in Immunotechnology											
Unit I:						[12 Periods]						
Immune system History and Scope of Immunology - Types of immunity – innate and acquired. Hematopoiesis Cell and Organs involved in immune system - Phagocytosis, apoptosis and necrosis.												
Unit II:						[12 Periods]						
Antigen and Antibody Antigen: types, chemical and molecular nature: haptens, adjuvants. Immunoglobulins types - structure and functions. Complement pathways - Classical and Alternate pathways.												
Unit III:						[12 Periods]						
Hypersensitivity and Auto immune diseases Allergy and Hypersensitivity - Classification types(I, II, III & IV) and Mechanisms – Immunodeficiency diseases (SCID & AIDS)- auto immune diseases and their treatments- systemic and organ specific auto immune diseases.												
Unit IV:						[12 Periods]						
Grafting and Immunohematology Types of grafting, mechanism of graft rejection – MHC- HLA typing -tumors of the immune system - Monoclonal antibodies and its applications (Hybridoma technology) Immunohematology - Blood transfusion - ABO grouping - Rh factor - Tissue typing.												
Unit V:						[12Periods]						
Immunotechnology Detecting antigen – antibody interaction – cross reactivity - affinity- avidity– precipitation - VDRL – agglutination - Blood grouping, WIDAL, RIA – ELISA – western blotting – immunoprecipitation – immunofluorescence, complement fixation test.												
Text Book: 1. Goldsby, R.A., Kindt, T.J., Osborne, B.A. (2013). Kuby’s Immunology. 7 th Edition. W.H. Freeman and Company, New York.												
Reference Books: 1. Murphy, K., Travers, P., Walport, M. (2008). Janeway’s Immunobiology. 7 th Edition Garland Science Publishers, New York. 2. Peakman, M., and Vergani, D. (2009). Basic and Clinical Immunology. 2 nd Edition Churchill Livingstone Publishers, Edinberg.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
C01	3	2	3	2	3	2	3	1	2	3	2	3
C02	2	3	2	2	2	3	2	2	3	3	2	2
C03	3	3	3	2	3	2	1	3	3	3	2	3
C04	2	2	2	3	2	2	3	2	3	2	3	3
C05	3	3	2	3	2	3	2	1	3	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Food and Industrial Microbiology	4	4	–	–	Theory						
Introduction: This course provides information on the role of various microbes employed in the food industries and the process involved in food production.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To classify the microorganisms involved in food industry.											
C02	To illustrate on the quality assurance and dairy hygiene in dairy industry.											
C03	To discuss on the working principles of different types of fermentors.											
C04	To understand the process of fermentation process											
C05	To elaborate on the applications of bioprocess technology.											
Unit I:						[12 Periods]						
Food Microflora and Food spoilage Introduction- Importance of Food Microbiology – types of microorganisms in food – factors influencing microbial growth of food (extrinsic and intrinsic) – Contamination and spoilage – cereals, sugar products, vegetables and fruits, meat and meat products, milk and milk products, fish and seafood – poultry, spoilage of canned foods. Food poisoning and food borne infections – bacterial and Mycotoxins. Principles of food preservation – Asepsis – physical and chemical methods.												
Unit II:						[12 Periods]						
Fermented food, Quality assurance and dairy hygiene Fermented food – pickled cucumber , saurkraut- soysauce , bread , idli – Fermented dairy products – Yoghurt, cheese and kefir. Food laws and regulation - HACCP - Codex alimentarius. Industry hygiene cleaning of dairy equipment - In-plant cleaning system. Dairy processing plant sanitation - utilization and disposal of dairy by product – whey. Nutraceuticals – omega-3 PUFA.												
Unit III:						12 Periods]						
Fermentation and Fermentor types Fermentation definition and types- submerged and solid state. Fermentor design and its types (Tower, cylindroconical & airlift) – Batch fermentation – Continuous fermentation and fed batch fermentation. Industrially important strains- Screening methods- Strain development for Improved yield- Mutation, Recombination and protoplasmic fusion. Strain preservation.												
Unit IV:						[12 Periods]						
Upstream Process and Downstream process Substrate for industrial fermentation solid and liquid media designing strategies- economical means of providing energy. Carbon, nitrogen, vitamin, mineral sources, buffers, precursors, inhibitors, inducers and antifoam. Sterilization of media Product recovery and purification - intracellular and extracellular products- cell disruption, centrifugation, filtration, flotation, chromatography, flocculation, solvent extraction, precipitation, drying, and crystallization - packaging and marketing.												
Unit V:						[12Periods]						
Application of Bioprocess Technology Commercial production of beer, wine, antibiotic- Penicillin, Enzyme- Amylase. Amino acids - Glutamic acid, Organic acid – Acetic acid. Immobilization of enzymes, Production of baker’s yeast, Spirulina, ethanol production and flavoring agents.												
Text Book: 1. Patel, A.H. (2015). Industrial Microbiology. Macmillan India Publishers, New Delhi.												
Reference Books: 1. Stanbury, P.T., and Whitaker, A. (2008). Principles of Fermentation Technology, 2 nd Edition, Elsevier, Pergamon Press, New York. 2. Fraizer, W.C., and Westhoff, D.C. (2017). Food Microbiology. 5 th Edition, TATA McGraw Hill Publishing Company Ltd. New Delhi.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04

C01	3	2	3	2	3	2	2	2	3	2	3	2	
C02	2	3	2	2	2	3	3	1	2	2	2	3	
C03	3	3	3	2	3	2	1	2	3	2	3	2	
C04	2	2	2	3	3	2	3	2	2	3	2	2	
C05	3	3	2	3	2	3	2	1	2	3	2	3	

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Environmental and Agricultural Microbiology	4	6	-	-	Theory						
Introduction: This course provides comprehensive overview of biogeochemical processes relevant to environmental scientists and engineers mediated by microorganisms. Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To summarize the various biogeochemical cycle with microbes and their application as biofertilizer											
CO2	To illustrate the occurrence, abundance and distribution of microorganisms in environment and their role											
CO3	To discuss about the diversity of microorganisms and microbial communities inhabiting the ecological habitats											
CO4	To identify the microbes responsible for nitrogen fixation, biofertilizeres.											
CO5	To know the suitable methods for managing Environmental problems.											
Unit I:						[18 Periods]						
Aerobiology Introduction to microorganisms in air – sources of microbes in air- droplet, droplet nuclei, infectious dust, factors affecting air micro flora - sampling of air –settling under gravity, centrifugal action, filtration, impingement, electrostatic precipitation, air pollution- Nano dust.												
Unit II:						[18 Periods]						
Water Microbiology Distributions of microorganism in water bodies – water borne disease - bacteriological examination of water - MPN – Indicator organisms - BOD, COD, eutrophication, waste water treatment.												
Unit III:						[18 Periods]						
Soil Microbiology and Biogeochemical cycle Factors influencing soil microbes - bacteria, fungi, actinomycetes (distributions) microbial interaction- commensalism, mutualism, syntrophism, ammensalism, parasitism and predation. Nitrogen cycle, carbon cycle, phosphorus cycle and sulphur cycle.												
Unit IV:						[18 Periods]						
Agricultural Microbiology Nitrogen fixation- symbiotic and non-symbiotic, phosphate solubilizers – Mycorrhizae association – Cultivation and mass production of <i>Rhizobium</i> , <i>Azotobacter</i> , <i>Azospirillum</i> , <i>Azolla</i> and <i>Cyanobacteria</i> , methods of application, quality control, and agronomic importance for different biofertilizers. Biopesticides – <i>Bacillus thuringiensis</i> , and <i>Pseudomonas syringae</i> . Classification of VAM and AM, Agronomic importance of biopesticides and disadvantages of the biopesticides												
Unit V:						[18 Periods]						
Applied Ecology Microbial decomposition- cellulose, hemicellulose, lignin, pectin and chitin- factors influencing degradation- solid waste treatment- saccharification – composting – gasification - vermi composting - bioremediation.												
Text Book: 1. Mishra, R.R. (2004). Soil microbiology. 1 st Edition, CBS Publishers and distributors, New Delhi.												
Reference Books: 1. Coyne, M.S. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning. 2. Okafor, N. (2011). Environmental Microbiology of Aquatic & Waste systems. 1 st Edition, Springer, New York.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	3	3	3	2	3	2	3
CO2	2	3	3	2	2	3	2	3	3	2	2	2
CO3	3	2	3	2	3	2	1	3	3	3	2	3
CO4	2	2	2	3	3	2	3	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	2	3	2

MANDATORY CORE PRACTICAL

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Core Practical –I: Basic Concepts of Microbiology Practical	2	–	–	4	Practical

Introduction:

This course provides the basic knowledge on size, shape and structure of bacteria and enables the students to know about morphology and cultivation of microorganism.

Course Focus on : Skill Development / Entrepreneurship / **Employability** / Research

Course Outcome:

CO1	To review and understand different Microbiological lab accessories
CO2	To experiment on preparing different reagents and media
CO3	To learn basic techniques of cultivating microbes under <i>in vitro</i> conditions.
CO4	To distinguish microbial characteristics from microbial colony morphologies
CO5	To differentiate microorganisms using various staining methods

LIST OF EXPERIMENTS

[30 Periods]

- Laboratory precautions
- Preparation of cleaning solutions
- Culture media preparation – Liquid and Solid medium
- Selective and differential media: Mac Conkey and Blood agar
- Methods of sterilization
- Pure culture techniques – Serial Dilution, Pour plate, Spread plate and Looping method
- Streaking techniques: Simple, Quadrant and continuous
- Enumeration of Bacteria, Fungi and Actinomycetes from soil
- Determination of Motility – Hanging drop & SIM agar.
- Cultural characteristics of Microorganisms – Colony morphology on Nutrient agar and Slants, Nutrient broth
- Maintenance and preservation of cultures
- Staining of Bacteria–
 - Simple Staining
 - Negative Staining
 - Gram Staining
 - Endospore staining
 - Acid Fast Staining (Demo)
- Observation of Fungi
 - Fungal We Mount-Lacto Phenol Cotton Blue Staining (LPCB)
 - Slide Culture Technique

Text Book:

- Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd Edition Wm, C. Brown publishers.

References

- William Claus. G.W. 1989. Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York.
- James Cappuccino. Microbiology: A Laboratory Manual (10th Edition).

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	3	3	1	1	2	1	1	1	2	3	2	3
CO2	3	3	1	1	2	1	1	1	3	3	2	2
CO3	3	3	2	1	2	1	1	2	2	3	2	3
CO4	3	2	3	1	2	1	1	2	2	2	3	3
CO5	3	2	3	1	2	1	1	2	3	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
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	Core Practical – II : Microbial Physiology and Metabolism Practical	2	–	–	4	Practical						
Introduction: Understanding microbial physiology is vital in manipulating both the beneficial and harmful characteristics of microbes. This course has been framed such that a candidate would get a complete hands on experience on the techniques involved in the characterization of the microbial diversity and physiological characteristics.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To enhance knowledge on Microbial Physiology like growth.											
CO2	To gain information on cultivation of microbes on variable factors.											
CO3	To determine the biochemical characterization of the microbial flora.											
CO4	To learn about the representative forms of various microbial cells.											
CO5	To determine the nature of microbial nutrient utilization.											
List of Experiments						[30 Periods]						
1. Micrometry – determination of size of bacteria. 2. Determination of bacterial Growth curve by turbidometric method. 3. Effect of temperature and pH on growth of microorganism 4. Biochemical characterization of microbes • IMViC test • Catalase test • Oxidase test • Urease test • Nitrate test • Triple sugar iron agar test • Carbohydrate fermentation test 5. Demonstration of alcoholic fermentation 6. Hydrolysis test • Starch hydrolysis • Gelatin • Casein hydrolysis 7. Cultivation of anaerobes – Wrights tube method, Mc Intosh fildes jar												
Text Book: 1. Alfred E. Brown (2001). Benson’s Microbiological Application – Laboratory Manual in General Microbiology. The McGraw Hill Company.												
Reference Books: 1. Cappucino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9 th edition. Pearson Education Ltd. 2. Tiwari, G. S. Hoondal (2005). Laboratory Techniques In Microbiology & Biotechnology. Swastik publishers.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
CO1	3	2	3	3	2	2	3	1	2	3	2	3
CO2	3	3	2	2	3	2	3	2	3	3	2	2
CO3	3	3	2	2	2	3	3	1	2	3	2	3
CO4	3	3	3	2	2	3	2	2	2	2	3	3
CO5	3	2	3	2	3	2	3	1	3	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Core Practical –III : Microbial Genetics Practical	2	–	–	4	Practical

Introduction:

This course has been framed to develop the hands on practical knowledge of the candidates by providing keen information on the various techniques involved in the isolation of nucleic acids from microbes and mutant organisms.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To enhance knowledge on Microbial Genetics.
CO2	To gain information on the isolation of mutants and auxotrophic microbes.
CO3	To determine the techniques of DNA and Protein isolation
CO4	To illustrate the plasmid and chromosomal DNA isolation from microbes.
CO5	To assess the genetic information based on the qualitative analysis of gene data.

List of Experiments

[30 Periods]

1. Isolation of chromosomal DNA from bacteria.
2. Isolation of plasmid DNA from *E. coli*.
3. Separation of DNA by AGE.
4. Extraction and separation of proteins by SDS- PAGE.
5. Isolation of UV induced mutant strains.
6. Isolation of auxotrophic mutants using chemical agents.
7. Isolation of antibiotic resistant mutant strains by Gradient plate technique.

Text Book:

1. Alfred E. Brown (2001). Benson's Microbiological Application – Laboratory Manual in General Microbiology. The McGraw Hill Company.

Reference Books:

1. Cappucino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Ltd.
2. Tiwari, G. S. Hoondal (2005). Laboratory Techniques In Microbiology & Biotechnology. Swastik publishers.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	2	2	3	1	3	3	2	2
CO2	3	3	2	2	3	2	3	2	2	2	3	2
CO3	3	3	2	2	2	3	3	1	2	2	2	3
CO4	3	3	3	2	2	3	2	2	3	2	2	3
CO5	3	2	3	2	3	2	3	1	3	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Core Practical –IV : Immunology Practical	2	–	–	4	Practical

Introduction:

This course focuses to impart the science of Immunology and to study various techniques involved in determining the functions of immune systems using qualitative and quantitative methods.

Course Focus on : Skill Development / Entrepreneurship / **Employability** / Research

Course Outcome:

CO1	To enhance knowledge on Immunology.
CO2	To gain information on the agglutination reactions.
CO3	To experiment on the various methods of ELISA.
CO4	To illustrate different types of blood cells using hematological analysis.
CO5	To assess the antigen-antibody reaction with the aid of immunoelectrophoresis techniques.

List of Experiments

[30 Periods]

1. Separation of serum and plasma from blood.
2. Agglutination reactions
 - Blood Grouping
 - WIDAL test
 - RPR test
 - ASO test
3. ELISA
4. Precipitation reactions
 - Immunodiffusion – Radial and Ouchterlony's Double immunodiffusion
 - Immunoelectrophoresis – Rocket and Counter current immunoelectrophoresis.
 - ELISA
5. Hematology
 - Erythrocyte count
 - Leukocyte count
 - Differential count
 - ESR Test

Text Book:

1. Goldsby, R.A., Kindt, T.J., Osborne, B.A. (2007). Kuby's Immunology. 6th Edition. W.H. Freeman and Company, New York.

Reference Books:

1. Murphy, K., Travers, P., Walport, M. (2008). Janeway's Immunobiology. 7th Edition Garland Science Publishers, New York.
2. Peakman, M., and Vergani, D. (2009). Basic and Clinical Immunology. 2nd Edition Churchill Livingstone Publishers, Edinburgh.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	3	2	3	3	2	2	3	1	3	3	2	2
CO2	3	3	2	2	3	2	3	2	2	2	3	2
CO3	3	3	2	2	2	3	3	1	2	2	2	3
CO4	3	3	3	2	2	3	2	2	3	2	2	3
CO5	3	2	3	2	3	2	3	1	3	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Core Practical –V : Food and Industrial Microbiology Practical	2	–	–	4	Practical

Introduction:

This course focuses to develop practical knowledge on Food and Industrial Microbiology and to illustrate the modern analysis techniques.

Course Focus on : Skill Development / Entrepreneurship / **Employability** / Research

Course Outcome:

CO1	To demonstrate skill development on enzyme, beverages and organic acid production.
CO2	To develop the practical skill on food analysis techniques.
CO3	To illustrate the microbes of canned foods and assess the quality.
CO4	To demonstrate the hygienic practices in industries
CO5	To highlight both beneficial and harmful role of microbes in food industries.

List of Experiments

[30 Periods]

- Enzyme production and assay
 - Protease
 - Amylase
- Production of organic acid – citric acid by submerged fermentation.
- Alcohol production / wine
- Immobilization of cells
- Qualitative analysis of microbes in milk:
 - Methylene blue reduction test.
 - Resazurin
- Enumeration aerobic bacteria and fungi from food products:
 - Beverages and Bakery items.
 - Fruits and Vegetables.
- Determination of sterility of canned foods- Fermentation test
- Direct microscopic examination of curd – observation of *Lactobacillus* sp.

Text Book:

- Patel, A.H. (2015). Industrial Microbiology. Macmillan India Publishers, New Delhi.

Reference Books:

- Stanbury, P.T., and Whitaker, A. (2008). Principles of Fermentation Technology, 2nd Edition, Elsevier, Pergamon Press, New York.
- Fraizer, W.C., and Westhoff, D.C. (2017). Food Microbiology. 5th Edition, TATA McGraw Hill Publishing Company Ltd. New Delhi.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
CO1	3	2	3	3	2	2	3	1	3	3	2	2
CO2	3	3	2	2	3	2	3	2	2	2	3	2
CO3	3	3	2	2	2	3	3	1	2	2	2	3
CO4	3	3	3	2	2	3	2	2	3	2	2	3
CO5	3	2	3	3	2	2	3	1	3	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Core Practical –VI : Environmental Microbiology Practical	2	–	–	4	Practical

Introduction:

This course shall develop the practical knowledge on techniques involved in assessing the various environmental factors affecting the growth of the microorganism.

Course Focus on : Skill Development / Entrepreneurship / Employability / **Research**

Course Outcome:

CO1	To illustrate isolation of different types of nitrogen fixing bacteria.
CO2	To explain the water quality analysis.
CO3	To develop the practical skill on cultivation of Single Cell Proteins (SCP).
CO4	To demonstrate the techniques for air quality assessment.
CO5	To validate the parameters required for <i>in vitro</i> cultivation of cyanobacteria.

List of Experiments

[30 Periods]

1. Isolation of free-living nitrogen fixers –*Azotobacter*, *Azospirillum*.
2. Isolation of symbiotic nitrogen fixer -*Rhizobium*.
3. Isolation of ammonifiers, nitrifiers and denitrifiers.
4. Isolation of Phosphate solubilizers.
5. Isolation of Cyanobacteria from water.
6. Cultivation of SCP-Azolla.
7. Water analysis: Physicochemical parameters- pH, Turbidity, TDS, TSS, BOD, COD and DO.
8. MPN Technique – Detection of potability of water.
9. Testing of efficacy of disinfectants - Phenol Coefficient test.
10. Microbial assessment of air quality.

Text Book:

1. Mishra, R.R. (2004). Soil microbiology. 1st Edition, CBS Publishers and distributors, New Delhi.

Reference Books:

1. Coyne, M.S. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
2. Okafor, N. (2011). Environmental Microbiology of Aquatic & Waste systems. 1st Edition, Springer, New York.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	2	2	3	3	2	3	3	2
CO2	3	3	2	2	3	2	3	1	3	2	2	3
CO3	3	3	2	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	3	2	2	3	3	2	2
CO5	3	2	3	2	3	2	3	1	2	3	3	2

DISCIPLINE SPECIFIC CORE PAPERS

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	General Biology	4	4	0	0	Theory						
Introduction This course enhances the students skill set by imparting knowledge on the structure and function of prokaryotic and eukaryotic cells. Moreover, information about the plant and animal physiology ensures that the student gains an overall knowledge on their functions.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To understand the structure and function of microbial cells.											
CO2	To explain the different organelles present in prokaryote and eukaryote											
CO3	To compare the process of cell divisions in prokaryotes and eukaryotes.											
CO4	To describe about the plant and animal cell morphology and functions.											
CO5	To interpret the different functional aspects of human organ systems.											
Unit I:					[12 Periods]							
Ultrastructure of Eubacteria: Cell membrane- Extra mural layer – Slime – Capsule – Cytoplasmic inclusions – Mesosomes – Nuclear material – Reserve materials – Pigments – Cell appendages – Flagella – Pili.												
Unit II:					[12 Periods]							
Ultrastructure and functions of Eukaryotic cell organelles: Cell wall – Cell membrane – Mitochondria – Chloroplast – Endoplasmic reticulum – Golgi complex – Nucleus – Ribosomes – Other cell inclusions and Flagella.												
Unit III:					[12 Periods]							
Cell division in Bacteria: Binary fission – Cell division in Eukaryotes – Mitosis and Meiosis. Reproduction in Microbes.												
Unit IV:					[12 Periods]							
Plant cell and Animal cell: Ultrastructure of plant cell. General characters of Thallophyta–Spirogyra, Bryophyta–Liverwort, Pteridophyta–Fern, Angiosperms–Tulips and Gymnosperms–Pinus. Ultrastructure of Animal cell. General characteristics of Vertebrate –Frog and Shark and Invertebrate– Butterfly and Earth Worm												
Unit V:					[12 Periods]							
Human physiology Digestive System and Excretion, Respiratory System, Nervous System, Muscular System and Cardiovascular System.												
Textbook: 1. Prescott, L.M J.P. Harley and C.A. Klein. (2019). Microbiology. 11th Edition, C. Brown publishers.												
Reference : 1. Chatterjee, C.C. (2016). I & II, Human Physiology.11 th Edition. CBS Publishers and Distributors, Kolkata. 2. Ross and Wilson. (2016). Anatomy and Physiology, 13 th Edition, Elsevier. USA.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	2	2	1	2	2	3	3	2
CO2	3	3	1	2	2	1	2	3	3	2	2	3
CO3	3	3	2	1	2	1	2	1	3	2	2	2
CO4	3	2	3	2	2	2	1	1	3	3	2	2
CO5	3	2	3	1	2	1	2	3	2	3	2	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Analytical Microbiology	4	4	–	–	Theory						
Introduction: This course highlights the basic laboratory skills that are essential for work in clinical, Pharmaceutical, Microbiology, Biochemistry and Biotechnology laboratories. Upon successful completion of this course, students will be able to explain bioinstrumentation techniques, design and application.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To become proficient in operating various laboratory instruments.											
CO2	To acquire knowledge on operating principles of lab equipment.											
CO3	To learn basic principle of centrifugation process											
CO4	To relate practical knowledge on spectrometry											
CO5	To understand the ultimate purpose of chromatographic techniques											
Unit I:					[12 Periods]							
Buffers, Molar and Normal solutions, pH meter, pH electrodes– colomel and glass electrode.												
Unit II:					[12 Periods]							
Principles and Applications of Autoclave, Hot air oven, Incubator, Laminar air flow chamber / Biosafety cabinets, BOD incubator, Metabolic shaker, Incinerator.												
Unit III:					[12 Periods]							
Centrifugation: Principle– Types of Centrifuges – Low speed, High speed, Ultra centrifuge. Applications of Centrifuge. Lyophilizer.												
Unit IV:					[12 Periods]							
Colorimetry, Turbidometry, Spectrometry – UV & Visible Spectrophotometer. Flame Photometry, AAS.												
Unit V:					[12 Periods]							
Chromatography – Paper, Thin layer, Column, Ion–exchange, Gas and HPLC. Electrophoresis – SDS – PAGE and Agarose gel electrophoresis, PFG. Dot blot, chromatography and basics of PCR.												
Text Book: 1. Upadhyay, A., Upadhyay, K., Nirmalendhu Nath. (2016). Biophysical Chemistry. 4 th Edition. Himalaya Publishing House Pvt., Ltd.												
Reference: 1. Padmini., E. (2007). Biochemical Calculations and Biostatistics. 1 st Edition. Books and Allied Pvt., Ltd. 2. Madigan, M.T., Martinko J.M., Dunlap, P.V., and Clark, D.P. (2014). Brock Biology of Microorganisms. 14 th edition. Pearson International Edition.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	2	2	3	2	3	1	1	2
CO2	2	3	1	3	2	1	1	2	3	1	2	2
CO3	3	2	2	1	2	3	2	1	3	2	1	2
CO4	2	2	2	1	1	2	3	3	2	3	2	2
CO5	2	1	3	1	2	3	3	1	2	3	1	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Microbial Taxonomy and Diversity	4	4	–	–	Theory						
Introduction: This paper has been structured to make the students familiarize with fundamental knowledge on the classification and diversity of microorganisms.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To understand the principle of microbial taxonomy and it's types.											
C02	To describe common classification of bacteria and archaea in different ecosystems.											
C03	To describe general characteristics of fungi, algae, protozoa, and virus in different ecosystems.											
C04	To evaluate, synthesize and present scientific studies of genetic and functional microbial diversity.											
C05	To explain the taxonomy of viruses.											
Unit I:						[12 Periods]						
Principles of Taxonomy Taxonomy – Principles – Modern approaches – Numerical, Molecular, Serotaxonomy and Chemotaxonomy. Introduction to Microbial Classification and Taxonomy –Taxonomic ranks.												
Unit II:						[12 Periods]						
Taxonomy of Bacteria Bergey's Manual, Binomial Nomenclature and Universal Phylogenetic tree. Classification system: Phenetic and Phylogenetic, Whittaker's Five Kingdom and Carl Woese's three kingdom classification system and their application. Difference between prokaryotic and eukaryotic microorganism.												
Unit III:						[12 Periods]						
Taxonomy of Fungi General Characteristics of Fungi – Life Cycle of <i>Aspergillus</i> , <i>Mucor</i> , <i>Rhizopus</i> and <i>Penicillium</i> – Modes of reproduction and its economic importance.												
Unit IV:						[12 Periods]						
Taxonomy of Algae and Protozoa General characteristics of algae including algal cell ultra-structure. Classification of algae–Chlamydomonas, Volvox, Diatoms, red algae and brown algae. Application of Algae in agriculture, industry, environment and food. General characteristics of protozoa with special references with <i>Entameoba histolytica</i> , <i>Trichomonas</i> , <i>Giardia</i> and <i>Plasmodium</i> .												
Unit V:						[12 Periods]						
Taxonomy of viruses Virus– Morphology, general characteristics, classification (Baltimore classification) and multiplication of viruses. The structure of viruses – virion size – General structure properties – helical capsids, icosohedral capsid – nucleic acids – Viral envelopes and enzymes.												
Text Book: 1. Duby, R.C. (2014) Textbook of Microbiology. 5 th edition. S. Chand Publishing.												
Reference Books: 1. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. (2005). General Microbiology. 5 th edition. McMillan. 2. Cappucino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9 th edition. Pearson Education Ltd.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
C01	3	2	1	1	2	2	3	2	3	1	1	2
C02	2	3	1	3	2	1	1	2	3	1	2	2
C03	3	2	2	1	2	3	2	1	3	2	1	2
C04	2	2	2	1	1	2	3	3	2	3	2	2
C05	2	1	3	1	2	3	3	1	2	3	1	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Medical Bacteriology	4	4	-	-	Theory						
Introduction: This course provides the ability to characterize, isolate and identify different microbes. It includes a detailed study of characterization, etiology, pathogenicity, clinical systems, and laboratory diagnosis of disease causing Microorganisms.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To provide the basics knowledge about infections.											
CO2	To describe the morphology and cultural characters of Gram positive bacteria.											
CO3	To understand the morphology and cultural characters of Gram negative bacteria.											
CO4	To compare the morphology and cultural characters of mycobacteria, spirochetes and intracellular parasites.											
CO5	To appraise the methods of diagnosis of infections.											
Unit I:			[12 Periods]									
Infections Normal microflora of human body - Sources and types of infections- methods of transmission – Virulence Factors - adhesion, exotoxins and endotoxins - Epidemic, Endemic and Pandemic diseases- Infectious disease cycle. Factors influencing the Human microflora based on environmental conditions.												
Unit II:			[12 Periods]									
Gram positive organisms Gram positive organisms - Morphology, cultural characteristics, pathogenicity <i>Staphylococcus aureus</i> , <i>Streptococcus pyogenes</i> , <i>Pneumococcus</i> , <i>Bacillus anthracis</i> , <i>Clostridium tetani</i> and <i>Clostridium botulinum</i> .												
Unit III:			[12 Periods]									
Gram negative organisms Gram negative organisms Morphology, cultural characteristics, pathogenicity and clinical manifestations of <i>E. coli</i> , <i>Klebsiella pneumoniae</i> , <i>Salmonella typhi</i> , <i>Shigella dysenteriae</i> , <i>Pseudomonas aeruginosa</i> , <i>Vibrio cholerae</i> , <i>Neisseria gonorrhoeae</i> , and <i>Neisseria meningitidis</i> .												
Unit IV:			[12 Periods]									
Mycobacteria, Spirochetes and Intracellular parasites Morphology, cultural characteristics, pathogenicity and clinical manifestations of <i>Corynebacterium diphtheriae</i> , <i>Mycobacterium tuberculosis</i> , <i>Mycobacterium leprae</i> . <i>Spirochaetes – Treponema pallidum</i> , and <i>Leptospira icterohaemorrhagiae</i> , <i>Mycoplasma pneumoniae</i> , <i>Rickettsia rickettsii</i> and <i>Chlamydia trachomatis</i> .												
Unit V:			[12Periods]									
Diagnosis Laboratory diagnosis of common bacterial infections– Process of sample collection, transportation and processing- antibiotics- modes of action-Antibacterial susceptibility testing- drug resistance.												
Text Book: 1. Ananthanarayan, R., and Paniker, C.K.J. (2020). Textbook of Microbiology. 11 th Edition, University Press Publication.												
Reference Books: 1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., and Clark, D.P. (2014). Brock Biology of Microorganisms. 14 th edition. Pearson International Edition. 2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott, Harley and Klein's Microbiology. 9 th edition. McGraw Hill Higher Education.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	2	3	1	2	3	2	3
CO2	2	3	3	2	2	3	3	1	3	3	2	2
CO3	3	3	3	1	3	2	1	3	3	3	1	3

CO4	2	3	2	3	3	2	3	2	3	2	3	3
CO5	3	3	2	3	2	3	2	1	3	2	3	2
Subject Code			Subject Title			Credit	Lecture	Tutorial	Practical	Type		
			Microbial Genome and Proteomics			4	4	-	-	Theory		
Introduction: This course enables the students to gain a thorough knowledge on genome and proteome identification, analysis and applications. The course also educate students on stand-alone and online software for genetic studies.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To define genome and genetic assembly.											
CO2	To illustrate the practical use of genome maps and gene markers.											
CO3	To use different expression systems in microarray analysis.											
CO4	To compare the different proteome database generated from 2D electrophoresis.											
CO5	To interpret various techniques of analytical proteomics											
Unit I:											[12 Periods]	
Genome Sequencing: Gene and pseudogenes, Gene structure, Genomes, Sequencing Genomes- methodology, chain termination method, chemical degradation method, automated DNA sequencing, shotgun sequencing and assembly of contiguous DNA sequence. cDNA and Genomic library construction.												
Unit II:											[12 Periods]	
Genomic Mapping: Different types of genome maps and their practical uses, Genetic and Physical mapping techniques. Map resources. Practical uses of genome maps. Genetic Markers - Mini and Micro satellite, STS and EST, SNPs.												
Unit III:											12 Periods]	
Gene Expressions and Microarrays: Expression systems - Bacteria, Yeast and Viral. Concepts of microarrays, spotter analysis, Normalization –total intensity, using regression techniques, ratio statistics. Tools for microarray analysis- MADAM, spot finder, SAGE. Applications of Microarrays.												
Unit IV:											[12 Periods]	
Experimental Proteomics: Proteome analysis- 2D gel electrophoresis: general strategy, immobilized pH gradients, sample preparation, isoelectric focusing, staining, transfer of proteins from gels, image acquisition and analysis of gels. 2DE databases.												
Unit V:											[12Periods]	
Analytical Proteomics: RP-HPLC, Mass Spectrometry – ESI MS and MALDI techniques and applications. Characterization of protein complexes – Protein – DNA, Protein – protein interactions, yeast two-hybrid system and protein micro arrays – biomarkers.												
Text Book: Primrose, S.B., and Twyman, R.M. (2006). Principles of Genome Analysis. 7th Edition. Wiley Blackwell, Oxford.												
Reference Books: 1. Stekal, D. (2003). Microarray Bioinformatics. 1 st Edition. Cambridge University Press, Cambridge. Richard, P. S. (2004). Proteins and Proteomics – A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York. 2. Gibson, W., and Muse V. (2005). A Primer of Genome Science. 2 nd revised Edition. Sinauer Associates Inc. USA.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4

C01	3	2	3	3	3	3	2	2	2	3	2	3
C02	2	3	2	2	2	3	3	1	3	3	2	2
C03	3	2	3	3	3	1	1	3	3	3	1	3
C04	1	3	1	1	3	2	1	1	3	2	3	3
C05	3	2	2	3	2	1	1	2	3	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	rDNA Technology	4	4	–	–	Theory						
Introduction: This course shall describe the cloning and expression strategies used in various field of Life science. It also deals with the pros and cons of using <i>in vitro</i> modification of nucleic acids.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To understand the importance of plasmid and viruses for genetic engineering.											
CO2	To analyze the different gene transfer techniques.											
CO3	To produce transgenic products and commercial products.											
CO4	To explain techniques in rDNA and to construct genomic libraries.											
CO5	To interpret various techniques involved in Genetic Engineering.											
Unit I:						[12 Periods]						
Restriction Enzymes and cloning vectors: Outline of Genetic Engineering- Nucleases: Exonucleases, Endonucleases, Restriction, RNases Methylases, Polymerases: DNA Pol I, Ligases: T4 DNA Ligase, <i>E. coli</i> DNA Ligase, desirable properties of vectors Plasmid Vectors - pSC101 & pBR322- Phage Vectors - Cosmids - Phagemids - BACs and YACs.												
Unit II:						[12 Periods]						
Gene Transfer Techniques: Physical – biolistic method , chemical- Calcium chloride and DEAE methods , biological <i>in vitro</i> package method- <i>Agrobacterium tumefaciens</i> mediated gene transfer - Screening and selection of recombinants- direct method – selection by complementation, marker inactivation , Indirect methods- Immunological and genetics.												
Unit III:						[12 Periods]						
Transgenic plants and animals: Ti plasmid – insect, virus, herbicide resistant plants – microbial insecticides – bacteria, fungi and viruses.- Transgenic tobacco plant. Transgenic animals – mice – retroviral method – DNA microinjection method – embryonic stem cell method- Application-Transgenic – sheep.												
Unit IV:						[12 Periods]						
Production of microbial products using rDNA Technology: Proteins (Insulin) -Pharmaceuticals – Interferons - Human growth hormone (somatostatin) - Antibiotics (cephalosporin) -Biopolymers (Xanthan gum). Bioplastics.												
Unit V:						[12Periods]						
Techniques used in rDNA: Genomic Library and cDNA Library. RAPD, RFLP, micro array and PCR applications. DNA finger printing technology, Human genome project, history and applications.												
Text Book: 1. Brown, T.A. (2010). Genomes. 6 th Edition. Garland Science.												
Reference Books: 1. Winnecker, E.D., (1987). From gene to clones – Introduction to Gene Technology. 2 nd Edition. VCH Publication, FRG. 2. Bernard R. Glick., and Jack J. Pasternak. (2003). Molecular Biotechnology – Principles and Applications of Recombinant DNA, ASM Publication, University of Michigan, USA.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	3	2		2	3	2	3	3
CO2	2	3	2	2	2	3	2	3	2	3	2	2
CO3	1	2	3	1	3	3	3	1	3	2	3	3
CO4	3	3	3	2	2	3	2	1	1	3	1	1
CO5	2	3	3	3	3	2	1	2	3	2	2	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Dairy Microbiology	4	4	0	0	Theory

Introduction:

This course deals with the process involved in Dairy industry that are used to obtain, process and preserve milk. It is intended to provide knowledge in various unit operations and basic concepts in dairy processing.

Course Focus on : Skill Development / Entrepreneurship / **Employability** / Research

Course Outcome:

C01	To inculcate knowledge on protective factors involved in milk production.
C02	To understand the methods of enhancing the quality of milk by different industrial techniques.
C03	To learn the principles, effects and application of homogenization in milk industries.
C04	To determine the process of advanced dairy product preservation.
C05	To gain insight on the problems involved in dairy industry and utilizing current trends to overcome problems.

Unit I: [12 Periods]

Use of bio-protective factors for preservation of raw milk: effects on physicochemical, microbial and nutritional properties of milk and milk products, present status of preservation of raw milk by chemical preservatives; thermal processing for preservation.

Unit II: [12 Periods]

Methods of determining lethality of thermal processing, UHT processed milk products, their properties and prospects, types of UHT plants, aseptic fillers, heat stability and deposit formation aspects, effect on milk quality; techno- economic considerations; retort processing.

Unit III: [12 Periods]

Principles and equipment for bacto-fugation and Bactotherm processes, Microfluidization of milk: Principle, equipment, effects and applications, Homogenization and their applications in dairy industry.

Unit IV: [12 Periods]

Dehydration: advances in drying of milk and milk products; freeze concentration, freeze dehydration: physicochemical changes during freeze drying and industrial developments.

Unit V: [12 Periods]

Current trends in cleaning and sanitization of dairy equipment: biological; detergents; Automation; Ultrasonic techniques in cleaning; bio-detergents, development of sanitizers- heat; chemical; radiation, mechanism of fouling and soil removal; Bio-films, assessing the effectiveness of cleaning and sanitization of dairy products.

Text Book:

1. Smit, G. (2003). Dairy Processing – Improving Quality. CRC-Wood head Publ.

Reference Books:

1. Fellow, P. (1988). Food Processing Technology. Elliss Horwood Ltd. Gould GW. 1995. New Methods of Food Preservation. Blackie.
2. Burton, H. (1998). Ultra-high Temperature Processing of Milk and Milk Products. Elsevier.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
C01	3	3	3	2	3	1	3	3	3	2	3	3
C02	2	3	2	3	2	1	3	3	2	3	2	2
C03	3	2	3	3	3	1	1	3	3	2	3	3
C04	3	3	2	3	2	1	3	1	1	3	1	1
C05	3	3	3	2	3	1	3	3	3	2	2	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Molecular Biology	4	4	0	0	Theory						
Introduction: This course presents the importance of nucleic acid and its regulatory process.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To understand the genome organization in Prokaryotes and Eukaryotes											
C02	To know the central Dogma of the organisms.											
C03	To apply the mechanisms of gene regulation.											
C04	To analyze the DNA repair mechanism and bacterial genetics											
C05	To understand the chromosomal variation and mapping.											
Unit I:						[12 Periods]						
Genome Organization : Genome organization – Prokaryotic and Eukaryotic; Chromosome structure and function, chromatin; Chloroplast DNA; Mitochondrial DNA; Gene families; Gene Clusters												
Unit II:						[12 Periods]						
Central Dogma : Prokaryotic and Eukaryotic DNA replication, Transcription, Translation and regulation mechanisms – Post transcriptional modification– Post translational modifications - Ribosomes, protein biosynthesis and transportation- Different mechanisms of Signal transduction.												
Unit III:						[12 Periods]						
Gene Regulation Mechanisms: General aspects of Regulation, The lactose operon model, The Galactose operon, The Arabinose operon, The Tryptophan operon, Relative positions of Promoters and Operators, Feedback Inhibition												
Unit IV:						[12 Periods]						
DNA Repair Mechanisms: DNA repair mechanisms; Mutagenesis, Mutations - Types and Mutants, Biochemical Basis of Mutants, Mutagenesis, Mutational Hot Spots, Reversion. Transposable elements - Insertion sequence and transposons, Integrons and Antibiotic-Resistance cassettes; Bacterial Genetics (Conjugation, Transformation, Generalized transduction, Specialized Transduction)												
Unit V:						[12 Periods]						
Chromosomal Variations And Mapping: Chromosomal variation in Number & Structure – Chromosomal aberrations & evolution. Chromosome Mapping - Haploid mapping, Diploid mapping - Oncogenesis: Development and causes of cancer, Types of cancer, Oncogenes: Retro viral, proto, tumor suppressor gene.												
Text Book:												
Reference Books:												
1. Harvey Lodish, Baltimore. Arnold Berk et al. “Molecular cell biology” 7th edition. Publisher: W. H. Freeman, 2011.												
2. David Freifelder, “Molecular Biology”, 3rd edition Jones & Bartlett publications, 2009.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	3	2	3	3	3	1	2	3	3	3	1
C02	3	2	2	2	2	2	3	2	2	2	2	3
C03	3	2	2	2	2	2	1	1	2	2	2	1
C04	3	2	3	3	1	3	1	1	3	1	3	1
C05	3	2	2	3	2	3	3	2	3	2	3	3

DISCIPLINE SPECIFIC CORE PRACTICAL

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	General Biology Practical	2	–	–	4	Practical

Introduction:

This course provides the basic knowledge on the study of cells, cellular organelles, and an array of processes that take place within the smallest unit of life, the cell.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

C01	:	To review and understand different Microbiological lab accessories
C02	:	To experiment on preparing different reagents and media
C03	:	To learn basic techniques of cultivating microbes under <i>in vitro</i> conditions.
C04	:	To distinguish microbial characteristics from microbial colony morphologies
C05	:	To differentiate microorganisms using various staining methods

LIST OF EXPERIMENTS

[30 Periods]

1. Identification of representative forms of Algae – *Anabaena*, *Volvox*.
2. Identification of representative forms of Fungi – Yeast, *Penicillium* by LPCB method.
3. Identification of representative forms of Parasites – *Entamoeba*, *Plasmodium*.
4. Identification of Onion Peel cells
5. Identification of Monocot and Dicot stem and root cells
6. Identification of Barr body from Buccal smear

Text Book:

1. Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.

References

1. William Claus. G.W. 1989. Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York.
2. Wilson. K and Goulding. K.H. 1986. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, ELBS, London.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	3	1	1	2	1	1	1	3	3	3	1
C02	3	3	1	1	2	1	1	3	2	2	2	3
C03	3	3	2	1	2	1	1	2	2	2	2	1
C04	3	2	3	1	2	1	1	3	3	1	3	1
C05	3	2	3	1	2	1	1	3	3	2	3	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Analytical Microbiology Practical	2	–	–	4	Practical

Introduction:

This course highlights the basic laboratory skills that are essential for work in clinical, Pharmaceutical, Microbiology, Biochemistry and Biotechnology laboratories. Upon successful completion of this course, students will be able to explain bioinstrumentation techniques, design and application.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	:	To employ suitable methods for sample analysis
CO2	:	To experiment on different microscopic and chromatographic techniques
CO3	:	To learn basic techniques of separating protein samples.
CO4	:	To distinguish and separate solutes using different centrifugation techniques.
CO5	:	To infer on the cell morphology using microscopic techniques.

LIST OF EXPERIMENTS

[30 Periods]

1. Separation of bacterial samples (protein/amino acids/ sugars) by paper chromatography.
2. Separation of mixtures by thin layer chromatography.
3. Demonstration of column packing in any form of column chromatography.
4. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
5. Study of UV absorption spectra of macromolecules (protein/nucleic acid/ bacterial pigments)
6. Separation of components of a given mixture using a laboratory scale centrifugation.
7. Separation of components of a given mixture using a density gradient centrifugation.
8. Assessment of sterility of Hot air oven and Autoclave.
9. PCR operation protocol – Demonstration.
10. Ray diagrams of phase contrast microscopy– Demonstration

Text Book:

1. Prescott, L.M J.P. Harley and C.A. Klein 2020. Microbiology 11th edition Wm, C. Brown publishers.

References

1. William Claus. G.W. 1989. Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York.
2. Wilson. K and Goulding. K.H. 1986. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, ELBS, London.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	2	1	1	1	3	3	3	1
CO2	3	3	1	1	2	1	1	3	2	2	2	3
CO3	3	3	2	1	2	1	1	2	2	2	2	1
CO4	3	2	3	1	2	1	1	3	3	1	3	1
CO5	3	2	3	1	2	1	1	3	3	2	3	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Microbial Taxonomy and Diversity Practical	2	–	–	4	Practical

Introduction:

This paper has been structured to make the students familiarize with fundamental knowledge on the classification and diversity of microorganisms.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To understand the principle of microbial taxonomy and it's types.
CO2	To describe common groups of bacteria and archaea in different ecosystems.
CO3	To describe common groups of fungi, algae, protozoa, and virus in different ecosystems.
CO4	To evaluate, synthesize and present scientific studies of genetic and functional microbial diversity.
CO5	To infer the composition of microbial communities and for the function and occurrence of individual groups.

LIST OF EXPERIMENTS

[30 Periods]

1. Isolation and characterization of thermophiles from hot water springs
2. Isolation and characterization on halophiles isolated from sea water
3. Isolation and characterization on alkalophiles isolated from sea water
4. Biogenic methane production using different wastes
5. Isolation of *Thobacillus* sps. From metal sulfides/ rock coal/ acid mine waters.
6. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
7. Studying isolation and propagation of animal viruses by chick embryo technique
8. Identification of cytopathic effects of plant viruses using photographs

Text Book:

1. Prescott, L.M J.P. Harley and C.A. Klein 2020. Microbiology 11th edition Wm, C. Brown publishers.

References

1. Extremophiles by Johri B.N. 2000. Springer Verlag, New York
2. Microbial Diversity by Colwd, D. 1999, Academic Press.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	2	3	1	3	3	3	1
CO2	2	3	3	2	2	3	3	1	2	2	2	3
CO3	3	3	3	1	3	2	1	3	2	2	2	1
CO4	2	3	2	3	3	2	3	2	3	1	3	1
CO5	3	3	2	3	2	3	2	1	3	2	3	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Medical Bacteriology Practical	2	–	–	4	Practical						
Introduction: This course provides the ability to characterize, isolate and identify different microbes. It includes a detailed study of characterization, etiology, pathogenicity, clinical systems, and laboratory diagnosis of disease causing Microorganisms.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To provide the basics knowledge about infections.											
C02	To describe the morphology and cultural characters of Gram positive bacteria.											
C03	To understand the morphology and cultural characters of Gram negative bacteria.											
C04	To compare the morphology and cultural characters of mycobacteria, spirochetes and intracellular parasites.											
C05	To appraise the methods of diagnosis of infections.											
LIST OF EXPERIMENTS [30 Periods]												
1.	Identification of clinically important bacteria using morphological, biochemical characterization. <i>Staphylococcus aureus</i> <i>Streptococcus pyogenes</i> <i>E.coli</i> <i>Salmonella</i> <i>Klebsiella</i> <i>Pseudomonas</i> <i>Proteus</i>											
2.	Antibacterial sensitivity assay by Kirby-Bauer method.											
3.	Determination of minimal inhibitory concentration (MIC) of an antibiotic.											
Text Book: 1. Ananthanarayan, R., and Paniker, C.K.J. (2020). Textbook of Microbiology. 11 th Edition, University Press Publication.												
Reference Books: 1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., and Clark, D.P. (2014). Brock Biology of Microorganisms. 14 th edition. Pearson International Edition. 2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott, Harley and Klein’s Microbiology. 9 th edition. McGraw Hill Higher Education.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	2	3	2	3	2	3	1	3	3	3	1
C02	2	3	3	2	2	3	3	1	2	2	2	3
C03	3	3	3	1	3	2	1	3	2	2	2	1
C04	2	3	2	3	3	2	3	2	3	1	3	1
C05	3	3	2	3	2	3	2	1	3	2	3	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Microbial Genome and Proteomics Practical	2	–	–	4	Practical

Introduction:

This course enables the students to gain a thorough knowledge on genome and proteome identification, analysis and applications. The course also educate students on standalone and online software for genetic studies.

Course Focus on : Skill Development / Entrepreneurship / Employability / **Research**

Course Outcome:

CO1	:	To define genome and genetic assembly.
CO2	:	To illustrate the practical use of genome maps and gene markers.
CO3	:	To use different expression systems in microarray analysis.
CO4	:	To compare the different proteome database generated from 2D electrophoresis.
CO5	:	To interpret various techniques of analytical proteomics

LIST OF EXPERIMENTS

[30 Periods]

1. DNA isolation from malarial parasite infected blood sample
2. Estimation of cellular DNA by standard method (Burton's)
3. Study on the microbial extracellular protein using SDS-PAGE
4. Quantification of microbial enzymes using standard methods (Lowry's)
5. Demonstration of Southern blotting.

Text Book:

1. Brown, T.A. (2002). Genomes. 4th Edition. Garland Science.

Reference Books:

1. Richard, P. S. (2004). Proteins and Proteomics – A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York.
2. Gibson, W., and Muse V. (2005). A Primer of Genome Science. 2nd revised Edition. Sinauer Associates Inc. USA.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	3	3	2	2	2	2	2	2	3	3	3	1
CO2	3	3	2	2	2	2	2	3	2	2	2	3
CO3	3	3	2	2	2	2	2	2	2	2	2	1
CO4	3	2	3	2	2	2	2	3	3	1	3	1
CO5	3	2	3	2	2	2	2	3	3	2	3	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	rDNA technology Practical	2	–	–	4	Practical

Introduction:

This course shall describe the cloning and expression strategies used in various field of Life science. It also deals with the pros and cons of using *in vitro* modification of nucleic acids.

Course Focus on : Skill Development / Entrepreneurship / Employability / **Research**

Course Outcome:

CO1	To understand the importance of plasmid and viruses for genetic engineering.
CO2	To analyze the different gene transfer techniques.
CO3	To produce transgenic products and commercial products.
CO4	To explain techniques in rDNA and to construct genomic libraries.
CO5	To interpret various techniques involved in Genetic Engineering.

LIST OF EXPERIMENTS

[30 Periods]

1. Preparation of competent cells for transformation.
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments.
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Designing of primers for DNA amplification.
7. Amplification of DNA by PCR.

Text Book:

1. Brown, T.A. (2002). Genomes. 4th Edition. Garland Science.

Reference Books:

1. Winnecker, E.D., (1987). From gene to clones – Introduction to Gene Technology. 2nd Edition. VCH Publication, FRG.
2. Bernard R. Glick., and Jack J. Pasternak. (2003). Molecular Biotechnology – Principles and Applications of Recombinant DNA, ASM Publication, University of Michigan, USA.
3. Sathyanarayana, U. (2013). Biotechnology, Books and Allied Pvt., Ltd. New Delhi.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	3	2	2	2	3	2	2	2
CO2	2	3	2	2	2	3	2	3	3	2	2	2
CO3	1	2	3	1	3	3	3	1	3	2	2	2
CO4	3	3	3	2	2	3	2	1	2	3	2	2
CO5	2	3	3	3	3	2	1	2	2	3	2	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Dairy Microbiology Practical	2	–	–	4	Practical

Introduction:

This course deals with the process involved in Dairy industry that are used to obtain, process and preserve milk. It is intended to provide knowledge in various unit operations and basic concepts in dairy processing.

Course Focus on : Skill Development / Entrepreneurship / **Employability** / Research

Course Outcome:

CO1	To inculcate knowledge on protective factors involved in milk production.
CO2	To understand the methods of enhancing the quality of milk by different industrial techniques.
CO3	To learn the principles, effects and application of homogenization in milk industries.
CO4	To determine the process of advanced dairy product preservation.
CO5	To gain insight on the problems involved in dairy industry and utilizing current trends to overcome problems.

LIST OF EXPERIMENTS

[30 Periods]

1. MBRT of milk samples
2. Standard plate count of milk sample.
3. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
4. Isolation of food borne bacteria from milk products.
5. Preparation of yogurt.

Text Book:

1. Smit, G. (2003). Dairy Processing – Improving Quality. CRC-Wood head Publ.

Reference Books:

1. IDF Bulletin (1981). New Monograph on UHT Milk. Document No. 133, Intern. Dairy Fed., Brussels.
2. Fellow, P. (1988). Food Processing Technology. Elliss Horwood Ltd. Gould GW. 1995. New Methods of Food Preservation. Blackie.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	1	3	3	2	1	2	3
CO2	2	3	2	3	2	1	3	3	3	2	2	2
CO3	3	2	3	3	3	1	1	3	2	3	1	3
CO4	3	3	2	3	2	1	3	2	3	3	2	2
CO5	3	3	3	2	2	1	2	3	3	3	3	3

DISCIPLINE SPECIFIC ALLIED COURSES

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Biostatistics and Computer Application	4	4	-	-	Theory

Introduction:

This course has been designed to enable the students to learn the Application of Statistics in the field of Biology.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To provide the basics of Biostatistics.
CO2	To describe the Measures of location and dispersion.
CO3	To apply the concept of probability theory in research
CO4	To identify the hardware parts in a computer
CO5	To illustrate different utilities available in Microsoft Excel software

Unit I: [12 Periods]

Nature and Scope of Statistical methods and their limitations - Data collection - Classification and Tabulation - Primary and Secondary data and their applications in life sciences - Diagrams - Line diagram, Bar diagram and Pie diagram - Graphical presentation - Histogram and Ogives.

Unit II: [12 Periods]

Measures of Location and Dispersion - Stem and Leaf plots - Box and Whisker Plots - Co-efficient of variation - Skewness and its measures.

Unit III: [12 Periods]

Probability - Concept and Definition - Addition and Multiplication theorems of Probability (statement only) - simple problems - Binomial, Poisson and Normal distributions (without proof) - simple problems.

Unit IV: [12 Periods]

Introduction to Computers - Classification - Generations - Low, Medium and High level languages - Software and Hardware - Operating Systems - Compilers and Interpreters - Personal, Mini, Main frame and Super computers - their characteristics and application, BIT, BYTE, WORD computer memory and types; data representation and storage, binary codes, binary system.

Unit V: [12 Periods]

Microsoft Excel - Data entry - Graphs - Aggregate functions - formulae and functions (students are expected to be familiar with all operations) - different number systems and conversions, input and output devices, secondary storage media - Numerical problems based on Units I to IV may be worked using Microsoft Excel

Text Book:

1. Daniel W.W (1995) Bio statistics : A Foundation for Analysis in Health Science, 6th Edition, John Wiley
2. Camphell R.C (1989) Statistics for Biologist, Cambridge University Press

Reference Books:

1. Snedecor G.W and Cochran W.G (1967) Statistical Methods, Oxford Press
2. R.K Taxali: PC Hardware and Software, Galgotia Publication.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	3	2	1	3	3	2	3
CO2	3	2	3	3	3	2	1	1	3	2	3	2
CO3	2	3	2	3	2	2	3	1	2	3	3	3
CO4	3	3	3	2	2	3	2	1	3	2	3	2
CO5	3	2	3	3	1	3	1	2	3	3	2	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Biomolecules	4	4	–	–	Theory						
Introduction: Biochemistry is a branch of science which deals with the chemistry of living organisms and that of their biological processes. Biomolecule deals with the ability to comprehend chemical combinations and reactions that occurs due to biological processes such as growth, reproduction, metabolism, heredity.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To provide the knowledge of carbohydrates.											
C02	To describe the structure and functions of amino acids.											
C03	To understand the molecular basis of lipids											
C04	To understand the structure and molecular basics of nucleic acids.											
C05	To present the basis of enzymes and its actives.											
Unit I:						[12 Periods]						
Carbohydrates Monosaccharides, disaccharides and polysaccharides – classification, structure, biological and physiological importance.												
Unit II:						[12 Periods]						
Amino acids Classification of amino acids – essential amino acids – properties – zwitter ion – isoelectric. Proteins: classification and function of proteins– structural level of organization.												
Unit III:						[12 Periods]						
Lipids Classification and properties of lipids. Types of fatty acids – saturated, unsaturated and essential fatty acids. Classification and significance of lipoproteins, glycolipids and phospholipids. Biological significance of steroids and cholesterol.												
Unit IV:						[12 Periods]						
Nucleic acids Components of DNA and RNA. Double helical structure of DNA – Structure and types of RNA.												
Unit V:						[12 Periods]						
Enzymes Classification of enzymes with examples, coenzymes and cofactors (structures not needed) – Active site: Lock and key model– induced fit hypothesis. Factors affecting enzyme activity. Enzyme inhibitors. Chemical and industrial applications of enzymes.												
Text Book: 1. Ambika Shanmugam., (2016) Fundamentals of Biochemistry for Medical students, WMC Brown Publishers, New Delhi.												
Reference Books: 1. Campbell, M.K. (2012) Biochemistry, 7 th edition. Published by Cengage Learning. 2. Tymoczko, J.L., Berg, J.M., and Stryer, L. (2012) Biochemistry: A short course, 2 nd edition. W.H.Freeman.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	3	3	2	2	3	2	1	2	2	3	2
C02	3	2	3	3	1	2	1	1	3	3	2	1
C03	2	3	2	3	2	2	3	1	3	2	2	3
C04	3	3	3	2	2	3	2	1	2	2	3	2
C05	3	2	3	3	1	3	1	2	3	1	3	1

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Biochemistry	4	4	–	–	Theory						
Introduction: Biochemistry is a branch of science which deals with the chemistry of living organisms and that of their biological processes. It deals with the ability to comprehend chemical combinations and reactions that occurs due to biological processes such as growth, reproduction, metabolism, heredity.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To provide the basics of Biochemistry and buffer systems.											
C02	To describe the process of Bioenergetics.											
C03	To understand the properties of vitamins and minerals.											
C04	To understand the types of Hormones and its functions.											
C05	To present the basis behind the inborn errors of metabolism.											
Unit I:						[12 Periods]						
Buffer system pH – acid base indicators - Henderson – Hasselbalch equation – buffer systems of blood and body fluids acidosis and alkalosis – distribution of fluids in the body – dehydration.												
Unit II:						[12 Periods]						
Bioenergetics Basic principles of thermodynamics – entropy, enthalpy and free energy. High energy phosphates, oxidation – reduction reactions – oxidases, dehydrogenases, oxygenases – organization of the respiratory chain in mitochondria.												
Unit III:						[12 Periods]						
Vitamins and Minerals Classification, properties and physiological functions of vitamins – fat soluble – (A,D,E and K) and water soluble (B and C) – deficiency – Macronutrients – Physiological importance of Calcium , Phosphorus, Magnesium, Sodium and Potassium – Trace elements – Physiological functions of Iron, Copper and Iodine												
Unit IV:						[12 Periods]						
Hormones General characteristics – classification – functions of thyroid stimulating hormone (TSH) – oxytocin – vasopressin – thyroid – thyrosine – pancreas – insulin – diabetes.												
Unit V:						[12 Periods]						
Inborn errors of Metabolism Hereditary anemias – sickle cell anemia and thalassemia – errors of carbohydrate (galactosemia) and protein metabolism (phenylketonuria) – disease and syndromes.												
Text Book: 1. Ambika Shanmugam., (2016) Fundamentals of Biochemistry for Medical students, WMC Brown Publishers, New Delhi.												
Reference Books: 1. Campbell, M.K. (2012) Biochemistry, 7 th edition. Published by Cengage Learning. 2. Tymoczko, J.L., Berg, J.M., and Stryer, L. (2012) Biochemistry: A short course, 2 nd edition. W.H.Freeman.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	2	3	3	2	2	3	1	2	2	3	2
C02	3	3	2	2	3	2	3	2	3	3	2	1
C03	3	3	2	2	2	3	3	1	3	2	2	3
C04	3	3	3	2	2	3	2	2	2	2	3	2
C05	3	2	3	2	3	2	3	1	3	1	3	1

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type		
	Entrepreneurial Microbiology	4	4	–	–	Theory		
Introduction Microbiology has played a central role in all aspects of Biological sciences, including morphogenesis, Genetics, developmental biology, Physiology, Biochemistry and Cell biology. Entrepreneurial Microbiology introduces the candidates in the various opportunities and modalities in the field of Microbiology and train them to take up versatile avenues matching with Global business market.								
Course Focus on : Skill Development / Entrepreneurship / Employability / Research								
Course Outcome								
CO1	:	To develop the ability to discern distinct entrepreneurial traits						
CO2	:	To classify the parameters to assess opportunities and constraints for new business ideas in Biology						
CO3	:	To develop the skills for product development						
CO4	:	To determine, identify and/or apply the principles of entrepreneurship						
CO5	:	To illustrate the entrepreneurial strategies to attain better opportunities						
Unit I:						[12 Periods]		
Evolution of the concept of entrepreneur Entrepreneurship: concept of Entrepreneurship, development – need – role of resource, talent and spirit – process of entrepreneurship to socio-economic gains								
Unit II:						[12 Periods]		
Institutions and schemes of government of India Schemes and programmes, Department of science and technology schemes, Nationalized banks – other financial institutions etc., – SFC-NSIC-SSIC-SIDBI-DIC-TAHDCO-CODISSIA-SID-MSME and commercial banks etc.,								
Unit III:						[12 Periods]		
Skills for entrepreneurs Communication skills, problem solving skills; Business plan development; Market need – market research, SWOT analysis, identify your competition. Financial plan – obtain financing for your business, insure your business, Marketing – mix-product, distribution, price, promotion, set marketing goals								
Unit IV:						[12 Periods]		
Small scale entrepreneurship Biocomposting- Domestic waste, agricultural and industrial waste- vermi – composting. SCP production – mushroom cultivation. Biofertilizers and Biopesticides. Development of diagnostic and research kits (plasmid DNA isolation, serum electrophoresis, WIDAL test kits, ABO blood grouping kits)-Kit validation method (anyone) – Translation of academic research to a commercial product.								
Unit V:						[12 Periods]		
Patenting and Open Source IPR History of patenting, characteristics of a patent, composition, subject matter and, Inventor, Infringement, cost of patent. Patents in India and other countries- Open source and commercial software-WIPO.								
TextBook: 1. S.L Gupta., “Entrepreneurship Development”, International Book house, India								
Reference Books 1.Ronald M Atlas and Richard Bartha., “Microbial Ecology”, Pearson publication, Germany. 2.Greene., “Entrepreneurship ideas inaction”, Thomson learning, New York. 3.Anil kumar S.,” Entrepreneurship Development”, New Age International, India. 4.Satyanarayana U ., “Biotechnology”, Books and Allied P Ltd, Kolkata, India. 1. .								
Mapping of Course Outcome with Program Outcome:								
PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1								
CO2								
CO3								
CO4								
CO5								

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Research Methodology	4	4	–	–	Theory						
Introduction: Research Methodology introduces students to the nature, scope, and significance of research and research methodologies. Additionally, the course studies primary and secondary research methods with applications to specific problems, using qualitative and quantitative designs for individual investigation on current problems within a student's area of interest. Students will complete an individual research proposal based on a business topic of interest, using the course's textbooks and selected scholarly and peer reviewed sources.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To know the basic of research and formation of problems											
C02	Understand and apply the major types of research designs and errors											
C03	Formulate clearly defined scaling techniques and report writing											
C04	Analyze and summaries the basic terms such as mean, medium and mode											
C05	To deal with T-Test, Chi Square-Test etc											
Unit I:						[12 Periods]						
Research – Meaning – Scope and Significance – Utility of Business research – Qualities of good researcher – Types of research – Research Process-Research design– Identification, Selection and formulation of research problems- Setting objectives – literature review												
Unit II:						[12 Periods]						
Sampling – Methods and techniques – Sample size – Sampling error – Field work and data collection- Tools of data collection- Secondary data sources and usage- online data sources- Primary data collection methods – Interview schedule- Questionnaire – Observation, interview and mailed questionnaire – online surveys -pilot study and final collection of data.												
Unit III:						[12 Periods]						
Measurement and scaling techniques – Processing and analysis of data – Editing and coding – Transcription and Tabulation – Statistical tools used in research – Hypothesis -Measures of Central tendency – Mean – Median - Mode- Standard deviation – Correlation – simple & multiple correlations.												
Unit IV:						[12 Periods]						
Test of significance – ‘t’ Test - large sample, test of significance for attributes, analysis of variants - Chi-square test and ANOVA test – Ranking Concept & Methods												
Unit V:						[12 Periods]						
Interpretations - Report writing– Types of Reports - contents and style of reports – Usage of Tables and Charts - Steps in drafting reports – Reference - Bibliography												
Note: The question paper shall cover 60% Theory 40% Problem only.												
Text Book: 1.Business Research Methods - Kothari - 4 th Edition												
Reference Books: 1. Business Research Methods - Emory 2. Business Research Methods –Rummel&Ballaine												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	1	3	2	1	2	3	2	1	3	2	1
C02	1	3	2	3	3	1	1	1	3	2	3	3
C03	2	1	2	2	2	1	2	3	1	2	2	2
C04	3	2	3	1	1	2	2	2	2	3	1	1
C05	1	1	2	3	2	2	1	1	1	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Biostatistics and Computer Application Practical	2	-	-	4	Practical

Introduction:

This course has been designed to enable the students to learn the Application of Statistics in the field of Biology.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To provide the basics of Biostatistics.
CO2	To describe the Measures of location and dispersion.
CO3	To apply the concept of probability theory in research
CO4	To identify the hardware parts in a computer
CO5	To illustrate different utilities available in Microsoft Excel software

List of Experiments

1. Diagrams
 - a. Line diagram
 - b. bar diagram
 - c. Pie diagram
 - d. Histogram
2. Measures of Location
 - a. Mean (Arithmetic)
 - b. Median
 - c. Mode
3. Measures of Dispersion
 - a. Range
 - b. Quartile & Standard Deviation
 - c. Skewness
 - d. Kurtosis

Text Book:

1. Daniel W.W (1995) Bio statistics : A Foundation for Analysis in Health Science, 6th Edition, John Wiley

Reference Books:

1. Snedecor G.W and Cochran W.G (1967) Statistical Methods, Oxford Press
2. R.K Taxali: PC Hardware and Software, Galgotia Publication

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	3	2	3	2	2	3	2	1	1	3	2	1
CO2	3	2	3	3	3	2	1	1	3	2	3	3
CO3	2	3	2	3	2	2	3	1	1	2	2	2
CO4	3	3	3	2	2	3	2	1	2	3	1	1
CO5	3	2	3	3	1	3	1	2	1	2	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Allied Practical –: Biomolecules Practical	2	–	–	4	Practical

Introduction:

The course aims to develop the skills in biochemical analysis and to develop the skills of the students in Qualitative and analysis of biomolecules. A successful student will be able to equip themselves with the basic biochemical tools and standard operation procedures.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To perform qualitative identification of carbohydrate.
CO2	To perform qualitative identification of amino acid.
CO3	To perform separation of carbohydrates by paper chromatography.
CO4	To perform Separation of amino acids by paper chromatography.
CO5	To determine the acid number and iodine number of lipids.

List of Experiments

[30 Periods]

QUALITATIVE ANALYSIS**1. Analysis of carbohydrates**

- Monosaccharides – Hexoses – Glucose and Fructose
- Disaccharides – Sucrose and Lactose
- Polysaccharide – Starch

2. Analysis of Amino acids

- Histidine
- Tyrosine
- Tryptophan
- Arginine

3. Characterization of Lipids

- Determination of acid number
- Determination of iodine number

Text Book:

- Ambika Shanmugam., (2016) Fundamentals of Biochemistry for Medical students, WMC Brown Publishers, New Delhi.

Reference Books:

- Martin Holtzhauer. (2006). Basic Methods for the Biochemical Lab. 1st Edition. Springer, Germany.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	3	2	3	3	2	2	3	1	3	2	2	3
CO2	3	3	2	2	3	2	3	2	2	3	2	3
CO3	3	3	2	2	2	3	3	1	2	2	3	3
CO4	3	3	3	2	2	3	2	2	2	2	3	2
CO5	3	2	3	2	3	2	3	1	2	3	2	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Allied Practical – Biochemistry Practical	2	–	–	4	Practical

Introduction:

The course aims to develop the skills in biochemical analysis and to develop the skills of the students in Qualitative and analysis of biomolecules. A successful student will be able to equip themselves with the basic biochemical tools and standard operation procedures.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

C01	To perform quantitative identification of carbohydrate.
C02	To perform quantitative identification of proteins.
C03	To perform separation of carbohydrates by paper chromatography.
C04	To perform Separation of amino acids by paper chromatography.
C05	To determine the acid number and iodine number of lipids.

List of Experiments**[30 Periods]****QUALITATIVE ANALYSIS**

1. Measurement of pH.
2. Preparation of Buffers – Acids and Alkaline Range.
3. Preparation of Solutions (Molar and Normal Solutions).
4. Protein estimation (Lowry *et al*).
5. Quantitative of determination protein by Bradford method.
6. Determination of Maximum absorption ($\mu_{\max}$) spectra of standard Proteins.
7. Quantitative determination of carbohydrate by Anthrone method.
8. Estimation of Carbohydrates (DNSA method).

Text Book:

1. Mu, P., & Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.

Reference Books:

1. Martin Holtzhauer. (2006). Basic Methods for the Biochemical Lab. 1st Edition. Springer, Germany.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	2	3	3	2	2	3	1	3	2	2	3
C02	3	3	2	2	3	2	3	2	2	3	2	3
C03	3	3	2	2	2	3	3	1	2	2	3	3
C04	3	3	3	2	2	3	2	2	2	2	3	2
C05	3	2	3	2	3	2	3	1	2	3	2	3

SKILL ENHANCEMENT COURSES

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Skill Enhancement Courses – I Clinical Laboratory Technology	2	4	–	–	Theory

Introduction:

This course was intended to create a skill set among the candidates on the clinical lab techniques. Students would be imparted with knowledge on the various methodologies involved in clinical analysis of samples.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To understand different types of microbial diseases.
CO2	To describe the process of collection of samples in labs.
CO3	To understand the methods of processing clinical samples.
CO4	To analyze and perform clinical serology.
CO5	To study about the antibiogram analysis in lab.

Unit I: [12 Periods]

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Unit II: [12 Periods]**Collection of clinical samples**

How to collect clinical samples (oral cavity, throat swab, tissue sample, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit III: [12 Periods]**Processing of Clinical Samples**

Examination of sample by staining – Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa-stained thin blood film for malaria. Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, distinct colony properties of various bacterial pathogens

Unit IV: [12 Periods]**Clinical serology**

Serological Methods - Agglutination, ELISA, immune fluorescence, Nucleic acid based methods – PCR, Nucleic acid probes, Typhoid, HBV, HCV, HIV and Dengue.

Unit V: [12 Periods]**Antibiogram analysis**

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method (Kirby Bauer Method) Determination of minimal inhibitory concentration (MIC) of an antibiotic by broth dilution method (LC50, LC90).

Text Book:

1. Ananthanarayan R and Paniker CKJ (2020). Textbook of Microbiology, 11th edition, Universities Press Private Ltd.

Reference Books:

1. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
2. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and McCartney Practical Medical Microbiology, 14th edition, Elsevier.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	3	2	2	3	3	3	1	2	3	2	2	3
CO2	2	3	3	1	2	3	3	1	2	3	2	3
CO3	3	2	2	3	2	3	3	3	2	2	3	3
CO4	3	2	2	2	2	3	2	3	2	2	3	2
CO5	3	3	3	3	1	2	3	3	2	3	2	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Skill Enhancement Courses – II Waste Management	2	4	–	–	Theory

Introduction:

This course was intended to create a general awareness among the candidates on the importance of waste management. Students would be imparted with knowledge on the various methodologies involved in managing different type of wastes.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To provide the basics of municipal solid waste.
CO2	To describe the process of collection and segregation of waste.
CO3	To understand the importance of nuclear and e-waste.
CO4	To analyze different methods involved in the biomedical management of wastes
CO5	To analyze different methods involved in waste management.

Unit I: [12 Periods]

Municipal solid waste

Definition - Sources and types of solid waste- composition and its determinants of solid waste-factors influencing generation--methods of sampling and characterization.

Unit II: [12 Periods]

Collection and segregation

Collection: Collection of Solid waste – collection services –Transport– transfer stations – types –waste segregation – equalization - reduction in volume and strength.

Unit III: [12 Periods]

Nuclear wastes and e-waste

Characteristics – Types – Uranium mining and processing – Power reactors – Refinery and fuel fabrication wastes – spent fuel – Management of nuclear wastes – Hazard analysis health and environmental effects.

Unit IV: [12 Periods]

Biomedical and chemical wastes

Biomedical wastes – Types – Management – color coding for waste - control of biomedical wastes Chemical wastes – Sources – Domestic and industrial - Inorganic pollutants – Environmental effects – Treatment and disposal techniques – Physical, chemical and biological processes – Health and environmental effects.

Unit V: [12 Periods]

Management of wastes

Disposal of Solid Wastes – land fill – incineration and composting, recycling- reuse- anaerobic digestion- energy recovery- standards for composting- treated leachates and incineration.

Text Book:

1. George Tchobanoglous. (2002). Integrated Solid Waste Management, 2nd Edition, McGraw - Hill, New Delhi.

Reference Books:

1. Tchobanoglous Thiesen Ellasen.(1977). Solid Waste Engineering Principles and Management, McGraw – Hill, New Delhi.
2. J. Glynn Henry and Gary. W. Heinke. (1996). Environmental Science and Engineering. Pretice Hall of India, India.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
CO1	3	3	3	2	2	3	2	3	3	2	2	3
CO2	3	2	3	3	3	2	2	1	2	3	2	3
CO3	3	2	3	2	2	3	2	3	2	2	3	3
CO4	3	3	2	2	3	1	3	1	2	2	3	2
CO5	2	2	3	1	3	3	1	3	2	3	2	3

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Skill Enhancement Courses – III Textile Microbiology	2	4	–	–	Theory						
Introduction: This course was intended to impart knowledge on creating modified textile material using Microbiological techniques.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To know about textile microbiology and antimicrobial textiles.											
CO2	To describe modification methods and post processing methods											
CO3	To discuss about the antimicrobial textile preparation											
CO4	To demonstrate the standard Assessment methods used in textile industries											
CO5	To evaluate the validation of antimicrobial technology											
Unit I:						[12 Periods]						
Introduction to textile microbiology History - pathogen associated with textiles - antimicrobial textiles antimicrobial agents, plant extracts, metals, disinfectants, antibiotics, biopolymers - mode of action of antimicrobials.												
Unit II:						[12 Periods]						
Modification of polymers Modification methods spun-in additives and post-treatment – durable press finishing with – DMDHEU, BTCA, citric acid – advanced finishing methods – Micro encapsulation methods.												
Unit III:						[12 Periods]						
Antimicrobial textile preparation Antimicrobial coating methods – Pad - dry - reactive dye - corona - plasma technology. Textile finishing. Antimicrobial product allergies												
Unit IV:						[12 Periods]						
Antimicrobial assessment Standard methods (AATCC – 100, AATCC-124, AATCC-147), Chemical characterization – FTIR, topographic analysis – SEM. Physical and chemical properties of antimicrobial textiles.												
Unit V:						[12 Periods]						
Validation of antimicrobial technology Antimicrobial treatment - verification – antimicrobial regulation – modern textile characterization methods – general characterization of textiles – physical, chemical resistance – thermal properties.												
Text Book: 1. Yuan Gao and Robin Cranston. “Recent Advances in Antimicrobial Treatments of Textiles Textile Research Journal” SAGE publications.												
Reference Books: 1. Edlich, R. F., Panek, P. H., Rodeheaver, G. T., Kurtz, L. D. and Edgerton, M. T., Surgical sutures and infection: A biomaterial evaluation. Journal of Biomedical Materials Research, 8: 115–126. 2. Gard, PR., J.P. Reynolds, G.W. Hanlon. Use of Chlorhexidine-Releasing Nylon Fibres to Reduce Device-Related Uterine Infections. Gynecol Obstet Invest.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
CO1	3	3	3	2	2	3	2	3	2	2	3	2
CO2	2	2	3	2	2	2	2	1	3	3	2	2
CO3	3	2	3	3	2	3	1	3	2	2	3	2
CO4	3	3	2	2	3	1	3	2	2	3	1	3
CO5	2	2	3	1	3	3	1	1	1	3	3	1

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Skill Enhancement Courses – IV Medical Mycology and Parasitology	2	4	–	–	Theory

Introduction:

This course enables a student to illustrate the medically important fungi and parasite. It also emphasize on the various laboratory methods for identifying different types of fungi and parasites.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To describe the fungal characteristics, classification and mycoses
CO2	To compare the susceptibility testing- CLSI, EUCAST methods
CO3	To illustrate the life cycle and pathology of parasitic infections
CO4	To analyze the medically important helminthes
CO5	To evaluate the validation of antimicrobial technology

Unit I: [12 Periods]

Mycoses - Superficial

Characteristics of fungi- morphological classification of fungi- classification of fungal infections - superficial mycoses- surface, cutaneous infections- subcutaneous mycoses- Mycetoma, Chromomycoses, Sporotrichosis, Rhinosporidiosis.

Unit II: [12 Periods]

Systemic Mycoses

Systemic Mycoses –Histoplasmosis, Blastomycosis, Coccidioidomycoses, Opportunistic Mycoses- *Cryptococcosis*, *Candida albicans*, Aspergillosis and Penicilliosis. Antifungal agents- Antifungal susceptibility testing- CLSI, EUCAST methods.

Unit III: [12 Periods]

Protozoology

Introduction of protozoa- Morphology, life cycle, pathology - *Entamoeba histolytica*, Intestinal flagellates- *Giardia lamblia*, Genital flagellate- *Trichomonas vaginalis*, Hemoflagellates- *Leishmania donovani*, Tissue flagellate- *Toxoplasma gondii* Malarial parasite-*Plasmodium vivax* and Coccidia- *Cryptosporidium parvum*.

Unit IV: [12 Periods]

Helminthology

Helminthology- Medically important helminthes- Tapeworms- *Taenia solium*, *Taenia saginata*, Trematodes- *Schistosoma haematobium*; *Fasciola hepatica*; Nematodes-*Ascaris lumbricoides*, *Wuchereria bancrofti*

Unit V: [12 Periods]

Laboratory Methods for fungi and Parasites

Collection of specimen - wet mount, KOH and LPCB and fungal culture --Collection of specimen - Preservation and examination of stool- macroscopic and microscopic examination, Concentration methods- floatation- sedimentation techniques, duodenal contents, anal swabs, blood- thin and thick smear- staining and cerebrospinal fluid.

Text Book:

1. Subash Chandra Parija., "Textbook of Medical Parasitology protozoology and Helminthology", All India Publishers and Distributors, New Delhi.

Reference Books:

1. Ananthanarayan and Jayaram Paniker., "Textbook of Microbiology", University Press India Pvt Ltd, New Delhi. Talib. V.H., "Handbook of Medical Microbiology". CBS Publishers, New Delhi.
2. Rajesh Karyakarte and Ajith Damle., "Medical Parasitology", Books and Allied(P)Ltd, New Delhi

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
CO1	3	3	3	2	2	3	2	2	2	2	3	2
CO2	2	3	2	3	2	2	3	1	3	3	2	2
CO3	3	2	3	3	2	3	1	3	2	2	3	2
CO4	3	3	3	2	3	1	3	3	2	3	1	3
CO5	2	2	3	1	3	3	2	1	1	3	3	1

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Skill Enhancement Courses – V Virology	2	4	–	–	Theory						
Introduction: This course describes the replications and life cycle strategies of DNA and RNA Viruses. A candidate undertaking this course shall enumerate the integrated information in viral reproduction and host interaction.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To describe the structure and cultivation of Viruses											
CO2	To demonstrate the life cycle of DNA phages											
CO3	To analyze the Life cycle of bacteriophages											
CO4	To evaluate the structure and replication of plant viruses.											
CO5	To test the best therapy for viral infection											
Unit I:						[12 Periods]						
General structure and cultivation of viruses Early development of virology- General, structural properties of virus – helical, icosahedral and complex symmetry. Baltimore system of classification- cultivation of viruses experiment animals, embryonated eggs and cell cultures – Purification and Assay of viruses.												
Unit II:						[12 Periods]						
Reproduction of DNA phages Reproduction of DNA phages – dsDNA T ₄ lytic cycle – lytic cycle adsorption - penetration- synthesis -assembly - release of phage particles - one step growth experiment. ssDNA phage - ØX 174 replication												
Unit III:						12 Periods]						
Life cycle of phage Temperate bacteriophages – prophage – integration and excision. Defective phages – λ phage - conversion between lytic & lysogeny - reproduction of RNA phages.												
Unit IV:						[12 Periods]						
Plant Viruses General properties, structure, genome replication of DNA containing virus – CaMV and gemini virus- RNA containing viruses – TMV and BMV- Myco and Phycophages												
Unit V:						[12 Periods]						
Animal Viruses General properties, structure, genome replication, laboratory diagnosis, prophylaxis and treatment of DNA containing virus–Adeno, Herpes Simplex (1 & 2) - RNA containing viruses - AIDS, hepatitis (A,B& C), Ebola, dengue, influenza H1N1, SARS CoV2, polio virus- oncogenic viruses, antiviral agents.												
Text Book: 1. Prescott L.M, Harley, J.P Klein D.A., 2020 “Microbiology”, Wm C Publishers, New Delhi.												
Reference Books: 1. Luria S.E. Darnel, J.E Jr. Baltimore. D and Campbell A.,” General Virology”, Wiley and sons, France. 2. John Carter., “Virology: Principles and Applications” Wiley Publications, France.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
C01	3	3	3	2	2	2	2	2	2	2	3	2
C02	3	2	3	3	2	2	3	2	3	3	2	2
C03	3	2	3	3	2	3	1	3	2	2	3	2
C04	2	3	3	3	3	1	3	2	2	3	1	3
C05	2	2	3	1	3	2	2	1	1	3	3	1

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Skill Enhancement Courses – V Human Anatomy and Physiology	2	4	–	–	Theory						
Introduction: This course presents the Basics of Anatomy and Physiology of Human Structure.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To understand the structure of Human Body											
CO2	To able to know the tissue level of Organization.											
CO3	To become familiar with structure and functions of Nervous system.											
CO4	To know the cardiovascular systems.											
CO5	To learn about the respiratory and digestive system .											
Unit I:						[12 Periods]						
An Introduction to the Human Body: Overview of Anatomy and Physiology – Structural Organization of the Human Body – Functions of Human Life – Requirements of Human Life – Homeostasis.												
Unit II:						[12 Periods]						
Tissue Level of Organization: Types of Tissues – Epithelial Tissues – Connective Tissue Supports and Protects – Muscle tissue and Motion – Nervous Tissue Mediates perception and Response – Tissue Injury and Aging.												
Unit III:						[12 Periods]						
Nervous System and Nervous Tissue: Basic structure and Function of the Nervous System – Functional Divisions of the Nervous System – Nervous Tissue – Neurons – Parts of Neurons and types of Neurons – Glial Cells - Functions of the Nervous tissue.												
Unit IV:						[12 Periods]						
The Cardiovascular System: Heart – Anatomy, Location, Shape and Size - Structure and Functions of Blood Vessels.												
Unit V:						[12 Periods]						
Organs and Structure of the Respiratory System: Conducting Zone - Nose, Pharynx, Larynx, Trachea – Respiratory Zone – Gross Anatomy of the Lung. Digestive System – Overview of the Digestive System – Digestive system process and Regulation.												
Text Book: 1. Stuart Ira Fox – “Human Physiology” (2012), 12 th Edition, Tata MCgraw Hill publication.												
Reference Books: 1. J. Gordon Betts – “Human Anatomy and Physiology”, OpenStax, Rice University												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2	2	2	2	2	3	2
CO2	3	3	3	2	2	2	3	1	3	3	2	2
CO3	3	2	3	2	2	3	1	3	2	2	3	2
CO4	2	3	3	3	3	1	3	2	2	3	1	3
CO5	3	3	3	2	2	2	2	2	1	3	3	1

DISCIPLINE SPECIFIC ELECTIVE COURSES

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Discipline Specific Elective Management of Human Microbial Disease	2		-	-	Theory

Introduction:

Microbial diseases are emerging with vast drug resistance and so a keen knowledge about the difference in the pathogens and their characteristics is required to manage the diseases caused. A candidate undertaking this course would be able to describe the identification, classification, characterization of bacterial species.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To understand about diseases affecting mankind
CO2	To know about the types of diseases route of infection, transmission and prevention
CO3	To maximize the knowledge on the mode of action of antibiotics
CO4	To take part in the disease prevention scenario after gaining knowledge on the available measures
CO5	To choose vaccines that best suits in the prevention of a disease.

Unit I: [12 Periods]

Diseases

Infectious and non-infectious diseases, microbial and non-microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections.

Unit II: [12 Periods]

Types of Diseases

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

Unit III: [12 Periods]

Antibiotics

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides. Anti-fungal and anti-parasitic agents. Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Unit IV: [12 Periods]

Disease Prevention

General preventive measures, Transmission and prevention of microbial diseases. Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.

Unit V: [12 Periods]

Vaccinology

Importance, types, Vaccine preparation, synthetic or recombinant vaccines. Vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

Text Book:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.

Reference Books:

1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
2. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
CO1	3	3	3	2	2	3	3	2	2	2	3	2
CO2	3	2	3	3	2	3	3	2	3	3	2	2
CO3	3	2	3	2	2	3	1	3	2	2	3	2

C04	2	3	2	3	3	1	3	2	2	3	1	3	
	C05	2	2	3	1	3	2	2	1	1	3	3	
Subject Code	Subject Title					Credit	Lecture		Tutorial		Practical		Type
	Discipline Specific Elective Marine Microbiology					2			–		–		Theory

Introduction:

This course is designed to make the students get an idea about isolation, Identification and preservation of the marine microbes and its application in various fields. It also imparts knowledge about the origin and maintenance of microbial diversity and its role in the structure and function of marine ecosystems.

Course Focus on : Skill Development / Entrepreneurship / **Employability** / Research

Course Outcome:

C01	To extend knowledge on Microbiology to the marine ecosystem
C02	To illustrate different marine organisms based on the ecology of growth
C03	To understand the different marine ecosystem and their role in natural balance
C04	To elaborate on the positive and negative aspects of microbes in marine environment
C05	To attribute to the methods used for exploring marine organism and their classification

Unit I: [12 Periods]

Marine microorganisms: collection, preservation, enumeration (total and viable counts), isolation of culture and identification based on morphological, physiological and biochemical characteristics. International and national collection centres.

Unit II: [12 Periods]

Extremophiles: Thermophiles, basophiles, halophiles, psychrophiles, acid – alkaliphiles, oligotroph, toxotolerant, xerotolerant, endolith – Extremophiles and their environment, biodiversity. Genomics of extremophiles, phylogeny of extremophiles, 16S RNA classification in mitochondrial DNA genome, RAPD, RFLP studies.

Unit III: [12 Periods]

Microbiology of degradation of xenobiotic environment: Ecological considerations, decay behaviour, degradative plasmids, hydrocarbons, oil pollution, surfactants, pesticides, Bioremediation:- Factors affecting bioremediation – role of microbes in the marine nutrient cycles – diseases of marine organisms and its impact on marine biodiversity.

Unit IV: [12 Periods]

Brief account of photosynthetic and accessory pigments. Phytoplanktons and Zooplanktons, Red tides, Zones, Bioluminescence and Biopigment, Marine micro and macro organisms, Coral reefs, Mangrooves, Hydrothermal vents and water currents.

Unit V: [12 Periods]

Bar coding of marine organisms: Genome sequencing and physical mapping of genome. Marine exploration, Aquaculture-inland and freshwater, Isolation of marine bioactive compounds-separation, purification (Example: Plinabulin) and identification techniques, cryopreservation.

Text Book:

1. Se-Kwon Kim. (2013). Bioactive compounds and biotechnological applications. CLS Publishers

Reference Books:

1. Dube, H.C. (1994). A text book of fungi, bacteria and viruses. Vikas Publishing House, New Delhi.
2. Dale, J.W. (1994). Molecular genetics of Bacteria. John Wiley and Stones.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PS01	PS02	PS03	PS04
C01	3	3	3	2	2	3	3	2	3	2	2	3
C02	3	2	3	3	2	3	3	2	3	3	2	3
C03	3	2	3	2	2	3	1	3	3	2	2	3
C04	2	3	2	3	3	1	3	2	2	3	3	1
C05	2	2	3	1	3	2	2	1	3	1	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Discipline Specific Elective Biofertilizer and Biopesticide	2		-	-	Theory

Introduction:

This course has been designed to provide the student knowledge about eco friendly product which play a crucial role in determining its future use and applications in environmental management. Provides detailed idea about biofertilizer production and plant disease.

Course Focus on : Skill Development / Entrepreneurship / **Employability** / Research

Course Outcome:

CO1	To outline different microbes used for the preparation of biofertilizers
CO2	To translate the beneficial role of naturally existing microbes to industrial scale for Biopesticide production
CO3	To choose a best method for isolation of phosphate solubilizing microbes
CO4	To elaborate the importance of mycorrhizal inoculum in Biofertilizer production
CO5	To prioritize the role of microbes in the production of bioinsecticides

Unit I: [12 Periods]

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N₂ fixers: Rhizobium – Isolation, characteristics, types, inoculum production and field application, legume/pulses plants. Frankia – Isolation and characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, Azolla – Isolation, characterization, mass multiplication, their role in rice cultivation, crop response and field application.

Unit II: [12 Periods]

Free living Azospirillum, Azotobacter – isolation, characteristics, mass production and field application.

Unit III: [12 Periods]

Phosphate solubilizing microbes – Isolation, characterization, mass production, field application.

Unit IV: [12 Periods]

Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass production of VAM, field applications of Ectomycorrhizae and VAM.

Unit V: [12 Periods]

General account of microbes used as bio-insecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications,- Disadvantages of bio pesticides. Viruses – cultivation and field applications.

Text Book:

1. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.

Reference Books:

2. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
3. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	3	3	2	3	2	2	3
CO2	2	2	3	2	2	3	2	3	3	3	2	3
CO3	3	2	3	2	2	1	3	3	3	2	2	3
CO4	2	3	2	3	3	1	3	2	2	3	3	1
CO5	2	2	3	1	3	2	2	3	3	1	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Bioethics, IPR and Biosafety	2		-	-	Theory						
Introduction: This course has been designed to make the students understand safety aspects in biological laboratory and to create awareness on the Intellectual property rights and patenting of Bioscience processes.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To describe the ethical values in Microbiological Research											
CO2	To apply and use of animal and human specimens for Research											
CO3	To discuss about Patenting in Biological research											
CO4	To illustrate biosafety in applying genetically modified organisms											
CO5	To prioritize the role of microbes in the laboratory process											
Unit I:						[12 Periods]						
Bioethics Bioethics – Social, Legal, and Ethical issues in biology, Bioethics committees Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells (Ministry of Environment and Forests Notification, 1989). Public education of the process of biotechnology involved in generating new forms of life for informed decision-making – ethical concerns of biotechnology research and innovation.												
Unit II:						[12 Periods]						
Animal Ethics Animal ethics - Norms in India-Licensing of animal house - Ethical clearance norms for conducting studies on human subjects, IAEC												
Unit III:						[12 Periods]						
IPR and Human relations IPR – patents- other forms of IPR (Copyright - Trademark – Designs), Farmer’s rights – WTO – GATT. Patentable subjects and protection in biology -The patenting of living organisms.												
Unit IV:						[12 Periods]						
Biosafety Protocols Biosafety for human health and environment-Bioethics of Microbiological lab waste disposal-Global scenario of transgenic microorganisms and plants. Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), State Biosafety Coordination Committee (SBCC), District Level Committee (DLC). GLP and animal house management guidelines. Ecological risk of engineered microorganisms/plants and remedial measure.												
Unit V:						[12 Periods]						
Biosafety Guidelines Biosafety guidelines for research - Containment facilities (physical and biological) - Advantage and disadvantage of genetically modified organisms and genetically modified foods- GLP and GMP.												
Text Book: 1. Bare Act, (2007).Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.												
Reference Books: 2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. Delhi. 3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	2	3	3	2	3	2	2	3
CO2	2	3	3	2	3	3	2	2	3	3	2	3
CO3	3	2	3	2	2	1	3	3	3	2	2	3
CO4	2	3	2	3	2	1	3	1	2	3	3	1
CO5	2	2	3	3	3	2	2	2	3	1	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Bioprocess and Technology	2		-	-	Theory						
Introduction: This course encompasses the use of microorganisms in the manufacture of food or industrial products. The use of microorganisms for the production of food, either human or animal, the microorganisms used in bio processes may be natural isolates; laboratory selected mutants or genetically engineered organisms.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To describe the various components of fermentors											
CO2	To identify the critical control points of the bioprocess											
CO3	To illustrate on the growth kinetics of the industrially important microbes											
CO4	To elaborate the process involved in the down streaming step											
CO5	To choose the prompt method for developing the industrially important microbes.											
Unit I:						[12 Periods]						
Fermenters and its types Design of a basic fermenter, bioreactor configuration, design features, computer control of fermentation process, measurement and control of process. Types of Bioreactors and its functions.												
Unit II:						[12 Periods]						
Critical control points Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, heat transfer, aeration/agitation, its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.												
Unit III:						12 Periods]						
Growth kinetics Growth of cultures in the fermenter. Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity.												
Unit IV:						[12 Periods]						
Down streaming process Down streaming process of microbial products - separation, extraction, and purification, drying and crystallization.												
Unit V:						[12 Periods]						
Strain improvement strategies Isolation, selection and improvement of microbial cultures. Strain improvement for the selected organism: Use of recombinant DNA technology, protoplast fusion techniques for strain improvement. Improvement of characters other than products and its application in the industry. Preservation of cultures after strain improvement program.												
Text Book: 1. Patel, A.H. (2003). Industrial Microbiology. Macmillan India Ltd. New Delhi.												
Reference Books: 1. Reed, G. (2002). Presscott and Dunn’s Industrial Microbiology. (5th ed.). CBS Publishers, New Delhi. 2. Shuler, M.L., and Kargi, F., (2005). Bioprocess Engineering Basic Concepts. Pearson Education, New Delhi.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	2	3	3	2	3	2	2	3
CO2	2	3	3	2	3	3	2	2	3	3	2	3
CO3	3	3	3	2	2	2	3	3	3	2	2	3
CO4	2	2	2	3	2	2	3	2	2	3	3	1
CO5	2	2	3	3	1	2	2	1	3	1	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Advances in Microbiology	2		-	-	Theory						
Introduction: This course encompasses the use of microorganisms in the manufacture of food or industrial products. The use of microorganisms for the production of food, either human or animal, the microorganisms used in bio processes may be natural isolates; laboratory selected mutants or genetically engineered organisms.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To understand the evolution of the microbial genome											
CO2	To identify the importance of metagenomics in modern Science.											
CO3	To illustrate the applications of host –microbe interaction in modern Microbiology											
CO4	To elaborate the process involved in synthetic Biology											
CO5	To interpret the results of infectious diseases using Molecular diagnosis											
Unit I:						[12 Periods]						
Evolution of Microbial Genomes Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence – Genomic islands, Pathogenicity islands (PAI) and their characteristics												
Unit II:						[12 Periods]						
Metagenomics Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral metagenome, meta-transcriptomics, meta-proteomics and metabolomics.												
Unit III:						[12 Periods]						
Molecular basis of host-microbe interaction Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance												
Unit IV:						[12 Periods]						
Systems and Synthetic Biology Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses												
Unit V:						[12 Periods]						
Molecular diagnostics Molecular Testing of – Chlamydia, Neisseria, Human Papilloma Virus, HIV-1, Hepatitis and Pandemic viruses. Application of Molecular diagnosis and issues faced – ethical, social and legal.												
Text Book: 1. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press												
Reference Books: 1. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons 2. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook’s Biology of Microorganisms, 14th edition, Pearson-Benjamin Cummings												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	2	3	3	2	3	2	2	3
CO2	2	2	3	2	3	3	3	2	3	3	2	3
CO3	3	3	3	2	2	2	3	3	3	2	2	3
CO4	2	2	2	3	2	3	3	1	2	3	3	1
CO5	2	2	3	3	1	2	2	2	3	1	3	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Plant Pathology	2		-	-	Theory						
Introduction: This course aims at introducing students to the basic and applied aspects of Plant Pathology. This will enable learning the techniques to save endangered species that are otherwise useful for mankind.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To understand the concept of plant diseases											
CO2	To illustrate mode of infections occurring in plants											
CO3	To identify the types of microbial infections in plants											
CO4	To elaborate the process of microbial pathogenicity in plants											
CO5	To choose the prompt method for preventing and managing plant diseases											
Unit I:						[12 Periods]						
Concept of plant disease Definitions of disease, disease cycle and pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.												
Unit II:						[12 Periods]						
Mode of infection Infection, invasion, colonization, dissemination of pathogens and perennation. Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.												
Unit III:						12 Periods]						
Plant diseases a. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus. Leaf blotch disease in turmeric. Bud rot, gray leaf blight, leathal bole rot, and stem bleeding diseases in coconut b. Important diseases caused by fungi: White rust of crucifers - <i>Albugo candida</i> , Downy mildew of onion – <i>Peronospora</i> , Powdery mildew of wheat - <i>Erysiphe graminis</i> . c. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro.												
Unit IV:						[12 Periods]						
Microbial pathogenicity Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction). Concept of resistance gene and avirulence gene. Defense mechanism in plants (Overview).												
Unit V:						[12 Periods]						
Plant Disease Management Principles and practices involved in the management of plant diseases by different methods, viz. regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes.												
Text Book: 1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,												
Reference Books: 1. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi. 2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	3	2	2	3	2	3	3	2	2	3	2	3

C02	2	3	3	3	3	3	2	2	3	2	3	3	
C03	3	2	2	3	2	2	3	3	3	2	2	2	
C04	2	2	2	2	2	2	3	3	2	3	2	3	
C05	2	2	3	2	1	2	2	1	3	3	1	2	

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Inheritance Biology	2		-	-	Theory						
Introduction: This course imparts knowledge on the different aspects of Genetics and pedigree analysis. By understanding the information behind the nature of inheritance, the candidate would be able to identify the importance of genetic diseases and the role of modern techniques involved in the treatment of such diseases.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
C01	To summarize the genetics analysis and experimentation of different organisms											
C02	To relate the Mendelian principles to human gene inheritance											
C03	To illustrate relationship between linkage and gene recombination											
C04	To elaborate on the rules of inheritance											
C05	To determine the structural organization in chromosomes											
Unit I:						[12 Periods]						
Structural organization of chromosomes Centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities-Klinefelter syndrome, Turner syndrome, Down syndrome												
Unit II:						[12 Periods]						
Mendel's Laws Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity.												
Unit III:						[12 Periods]						
Linkage and recombination Genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over, mapping Homologous and non-homologous recombination, including transposition, site-specific recombination.												
Unit IV:						[12 Periods]						
Rules of extra nuclear inheritance Organelle heredity - Chloroplast mutations in Chlamydomonas, mitochondrial, mutations in Saccharomyces, Maternal effects – Shell coiling in Limnaea peregra Infectious heredity - Kappa particles in Paramecium. Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Polygenic inheritance, heritability and its measurements, QTL mapping. Evolutionary genetic stability, genetic shift of microbes, maternal microbiome inheritance												
Unit V:						[12 Periods]						
Historical developments Model organisms in genetic analyses and experimentation: <i>Escherichia coli</i> , <i>Saccharomyces cerevisiae</i> , <i>Neurospora crassa</i> , <i>Caenorhabditis elegans</i> <i>Drosophila melanogaster</i> , <i>Arabidopsis thaliana</i> .												
Text Book: 1. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6 th Ed. John Wiley and Sons Inc.												
Reference Books: 1. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings. 2. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	3	2	2	3	2	3	3	2	2	3	2	3
C02	2	3	3	3	3	3	2	2	3	2	3	3
C03	3	2	2	3	2	2	3	3	3	2	2	2
C04	2	2	2	2	2	2	3	3	2	3	2	3

C05	2	2	3	2	1	2	2	1	3	3	1	2	
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Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Discipline Specific Elective Microbes in Sustainable Agriculture and Development	2		-	-	Theory

Introduction:

This course imparts knowledge on the different aspects of Genetics and pedigree analysis. By understanding the information behind the nature of inheritance the candidates would be able to identify the importance of genetic diseases and the role of modern techniques involved in the treatment of such diseases

Course Focus on : Skill Development / **Entrepreneurship** / Employability / Research

Course Outcome:

CO1	To know the habitat of soil microbes
CO2	To understand the bio-geo chemical cycles
CO3	To illustrate biocontrol agents
CO4	To elaborate microbes in sustainable environment
CO5	To explain the application of microbes in agriculture development

Unit I: [12 Periods]

Microbial habitat

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil, Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit II: [12 Periods]

Biogeochemical cycle

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit III: [12 Periods]

Biocontrol agents

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds.

Unit IV: [12 Periods]

Microbes for sustainable Agriculture

Plant growth promoting bacteria, bio-fertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs

Unit V: [12 Periods]

Microbes for Agricultural development

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters, Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals. Microbes for livestock management.

Text Book:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.

Reference Books:

1. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
2. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	2	3	3	1	2	3	2	3
CO2	2	3	3	3	3	3	2	2	3	3	3	3
CO3	3	2	2	3	2	3	2	1	2	3	2	2
CO4	3	2	2	2	2	2	3	3	2	2	2	2
CO5	2	2	3	2	3	2	2	2	3	2	1	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Discipline Specific Elective Instrumentation and Bio-techniques	2		-	-	Theory

Introduction:

The course offers the students with an opportunity to gain knowledge on the bioinstrumentation and concepts of principles and applications.

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Course Outcome:

CO1	To learn the principles and instrumentation of Microscopes
CO2	To relate the principles of chromatographic techniques
CO3	To illustrate methodology of electrophoresis techniques
CO4	To elaborate on the principles of centrifugation
CO5	To determine the use of advanced instrumentation mechanism and bio-techniques

Unit I: [12 Periods]**Microscopy**

Bright field and dark field microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy).

Unit II: [12 Periods]**Chromatography**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column Chromatography - packing types (IEC, AC, SEC), fraction collection. GLC and HPLC.

Unit III: [12 Periods]**Electrophoresis**

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit IV: [12 Periods]**Centrifugation**

Principles of centrifugations – RCF and sedimentation coefficient. Types of centrifuges – rotors - fixed angle and swinging bucket rotors. Types of Centrifugation – differential, density gradient and ultracentrifugation. Analytical centrifugation.

Unit V: [12 Periods]**Advanced instrumentation**

Principle, Instrumentation and application of spectrophotometer, colorimeter and turbidometer. MALDI-TOF, FTIR, MS, NMR.

Text Book:

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.

Reference Books:

1. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
2. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	2	3	2	3	2	2	3	1	2	3	2	3
CO2	2	3	3	3	3	3	3	2	3	3	3	3
CO3	3	2	2	3	3	3	2	1	2	3	2	2
CO4	3	2	2	2	2	3	3	3	2	2	2	2
CO5	2	2	3	2	3	2	2	2	3	2	1	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Microbiological analysis of Air and Water	2		–	–	Theory						
Introduction: This paper teaches varying techniques involved in the air and water analysis. A candidate undertaking this course shall be able to describe the major concept of the microbes associated with the air and water and how to diagnose and treat the diseases associated.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To list the microbes responsible for air borne infection											
CO2	To experiment of air sample collection and quality control											
CO3	To illustrate control measure for air microbes											
CO4	To elaborate on the Microbiology of water											
CO5	To validate the quality of water samples using laboratory techniques											
Unit I:						[12 Periods]						
Aeromicrobiology Bioaerosols, Air borne microorganisms (bacteria, viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens												
Unit II:						[12 Periods]						
Air sample collection and quality control Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics. Current status of air quality and management, Delhi air pollution												
Unit III:						12 Periods]						
Control measures Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration. Precipitation, chemical disinfection, filtration, high temperature, UV light												
Unit IV:						[12 Periods]						
Water Microbiology Water borne pathogens and water borne diseases, water contamination.												
Unit V:						[12 Periods]						
Microbiological analysis of water Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests												
Text Book: 1. Da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water. A Laboratory Manual, CRC Press.												
Reference Books: 1. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press. 2. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007). Manual of Environmental Microbiology, 3rd edition, ASM press.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
CO1	2	3	2	3	2	2	3	2	2	3	2	3
CO2	2	3	3	3	3	3	3	2	3	3	3	3
CO3	3	2	2	2	3	3	3	3	2	3	2	2
CO4	3	2	2	2	2	3	3	3	2	2	2	2
CO5	2	2	3	2	3	2	2	3	3	2	1	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Molecular Biology	2		-	-	Theory						
Introduction: Candidates studying this paper would be familiar with techniques involved in Molecular Biology, embryo manipulation, cell and tissue culture to manipulate the genomes of animals for ways to improve the livestock for food production and biomedical purpose.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To describe the structure of nucleic acids											
CO2	To interpret on the different modes of DNA replication											
CO3	To illustrate about DNA transcription and transcription process											
CO4	To elaborate on translation process											
CO5	To infer the role of gene regulatory mechanism.											
Unit I:						[12 Periods]						
Nucleic acid structure DNA Structure: Miescher to Watson and Crick- historic perspective, DNA Structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA. Important advantage of DNA double helix, coding and non-coding RNA's												
Unit II:						[12 Periods]						
DNA replication Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D- loop (mitochondrial), (theta) mode of replication and other accessory protein, Mismatch and excision repair.												
Unit III:						[12 Periods]						
Transcription Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit, Transcription in Eukaryotes: RNA polymerases, general Transcription factors. Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance												
Unit IV:						[12 Periods]						
Translation Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote												
Unit V:						[12 Periods]						
Regulation of DNA machinery Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Sporulation in Bacillus, Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.												
Text Book: 1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.												
Reference Books: 1. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press. 2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	2	2	3	2	2	3	2	3
CO2	2	3	3	3	3	3	3	1	3	3	3	3

C03	3	2	3	2	3	3	3	1	2	3	2	2	
C04	3	2	2	2	2	3	3	2	2	2	2	2	
C05	2	2	3	2	3	2	2	3	3	2	1	2	

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Pharmaceutical Microbiology	2		-	-	Theory						
Introduction: Candidates studying this paper would be familiar with Microbiological techniques involved in pharmaceutical industries.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To learn about Microbiological lab practices											
CO2	To determine the microbes in pharmaceutical and food samples											
CO3	To identify the pathogenic microbes of pharmaceutical industries											
CO4	To elaborate on the rapid detection methods of samples											
CO5	To infer the role of HACCP in microbiological standards											
Unit I:						[12 Periods]						
Microbiology Lab practices Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL- 1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration												
Unit II:						[12 Periods]						
Determining Microbes in Food / Pharmaceutical Samples Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products. Expression system of biopharmaceutical products and its advantages and disadvantages												
Unit III:						[12 Periods]						
Pathogenic Microorganisms of Importance in Food & Water Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, McConkey Agar, Saboraud Agar Ascertaining microbial quality of milk by MBRT. How microbes could modify the drug metabolism												
Unit IV:						[12 Periods]						
Rapid analysis Molecular methods - Nucleic acid probes, PCR based detection, biosensors. Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)												
Unit V:						[12 Periods]						
HACCP for Microbial Standards Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water												
Text Book: 1. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.												
Reference Books: 1. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer 2. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	P01	P02	P03	P04	P05	P06	P07	P08	PS01	PS02	PS03	PS04
C01	2	3	2	3	2	2	3	2	2	3	2	3
C02	2	3	3	3	2	3	3	1	3	3	3	3
C03	3	2	3	2	3	3	2	1	2	3	2	2
C04	3	2	2	2	2	3	3	2	2	2	2	2
C05	2	2	3	2	3	2	2	3	3	2	1	2

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	
	Discipline Specific Elective Applied Microbiology	2		-	-	

Introduction:

Candidates studying this paper would be familiar with techniques involved in production of different types of products related to Microbiology.

Course Focus on : Skill Development / **Entrepreneurship** / Employability / Research

Course Outcome:

CO1	To identify the possibilities of manufacturing Microbiological products
CO2	To interpret different production methods of microbiological products
CO3	To develop and strengthen the entrepreneurial quality in Microbiology
CO4	To produce the products of economic value
CO5	To infer the role of patent in defining a product

Unit I: [12 Periods]**Mushroom cultivation**

Mushroom cultivation – cultivation of *Agaricus campestris*, *Agaricus bisporous*, *Volvariella volvacea*, Nutritional value, cultivation method, control of pathogen and pest, Medicinal value of Mushroom, Advantages of mushroom.

Unit II: [12 Periods]**Composting**

Composting – Microbiology of composting, preparation of compost, types of composting, advantages of composting, vermicomposting, biofertilizer – chemical fertilizer versus biofertilizer, organic farming, *Rhizobium*, *Azospirillum*, *Azotobacter* and phosphate solubilizer as biofertilizer.

Unit III: [12 Periods]**Microbes in diagnostics kits**

Production of kits – Microbes in diagnostics - plasmid DNA isolation, serum electrophoresis and diagnostic kits - WIDAL, ABO blood grouping.

Unit IV: [12 Periods]**Commercial product production**

Commercial product production - Beer, Wine, Antibiotics- Penicillin, enzymes- amylase and protease. Aminoacids - lysine, glutamic acid.

Unit V: [12 Periods]**Business prospects of Microbiology:**

Entrepreneurial development – activity, institute involved, process of entrepreneurship -socio-economic gain, schemes and programme for entrepreneurship. History of patent, characteristics of patent, inventor- cost of patent, patent in India and other Countries.

Text Book:

1. R.C Dubey, “Textbook of Biotechnology” New age Publishers, New Delhi.

Reference Books:

1. Ronald M Atlas and Richard Bartha, “Microbial Ecology”, Pearson publication, Germany.
2. Greene, “Entrepreneurship ideas in action”, Thomson learning, New York.
3. Anil kumar S, “Entrepreneurship Development”, New Age International, India.
4. Satyanarayana U., “Biotechnology”, Books and Allied P Ltd, Kolkata, India.

Mapping of Course Outcome with Program Outcome and Program Specific Outcome

Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	3	2	3	2	2	2	3	2
CO2	2	2	3	3	3	3	2	2	3	3	2	2
CO3	3	2	3	2	3	3	3	1	2	2	3	2
CO4	3	2	2	2	2	3	3	2	2	3	1	3
CO5	2	2	3	2	3	2	2	3	1	3	3	1

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Discipline Specific Elective Clinical Biochemistry	2		-	-	Theory						
Introduction: Candidates studying this paper would be familiar with techniques involved in diagnosis various organ function tests in laboratory and their interpretation methods.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To understand the importance of laboratory diagnosis											
CO2	To interpret the results arrived in different biochemical lab tests											
CO3	To develop and strengthen the laboratory skill											
CO4	To impart knowledge on core diagnostic methods											
CO5	To infer the role of lab diagnosis in saving lives											
Unit I:						[12 Periods]						
Renal function tests Blood Serum Urea, Urea, Nitrogen, Serum creatinine, Uric acid, Calcium, phosphorous, Magnesium, Determination of Sodium, potassium, estimation of chlorides, Urine analysis.												
Unit II:						[12 Periods]						
Liver function tests Serum total protein, albumin, total bilirubin, Assay of GGT, Assay of LDH, Urine bilirubin, Urine urobilinogen, Pancreatic function test, Blood amylase, faecal trypsin. ALT, AST, ALP.												
Unit III:						12 Periods]						
Lipid profile Serum cholesterol, Triglycerides, HD & LDL Cholesterol, Total/HDL Ratio. Cardiac fraction test - Creatinine phosphokinase.												
Unit IV:						[12 Periods]						
Gastric function test Collection and Assessment of gastric juice, colour, pH, gravity & mucous in gastric juice, test for blood, Starch, amylase & acidity, faecal trypsin, faecal occult blood.												
Unit V:						[12 Periods]						
Lab diagnosis of diabetes Diagnosis & screening tests for diabetes - Urine glucose, Blood glucose, Conventional diagnostic tests - OGTT, Rapid I/V GTT, HBA ₁ C, Rapid diagnostics.												
Text Book: 1. Ramnik Sood, "Laboratory Technology -Methods and interpretation"-Vol.I 4th ed. Jaypee Brothers Medical Publishers, Chennai												
Reference Books: 1. Kanai L. Mukherjee, 2010, "Medical laboratory technology" Vol.1.Tata McGraw Hill, New Delhi. 2. Rajan S, "Manual for Medical laboratory technology" Anjana Book House, Chennai 3. Talib VH, Khurana SR, "A handbook of Medical laboratory technology"CBS Publishers, New Delhi.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
C01	2	3	2	3	3	2	2	2	2	2	3	2
C02	2	2	3	3	3	3	3	2	3	3	2	2
C03	3	2	3	2	3	3	3	2	2	2	3	2
C04	3	2	2	2	2	3	3	2	2	3	1	3
C05	2	2	3	2	3	2	2	3	1	3	3	1

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Chemistry	2		-	-	Theory						
Introduction: To introduce the concepts which gives knowledge about industrial chemistry. On successful completion of this paper the students should gain the knowledge about bonding, Dye, Fertilizer, industrial Chemistry, Chromatography and Stereoisomerism.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To understand the Molecular orbital theory											
CO2	To interpret the results of Industrial chemistry											
CO3	To develop and strengthen Stereoisomerism Optical isomerism											
CO4	To impart knowledge on dye and their preparations											
CO5	To infer the Kinetics and Chromatography											
Unit I:						[12 Periods]						
Chemical Bonding Molecular orbital theory, bonding, antibonding and non-bonding orbitals. Molecular orbitals. MO configuration of H ₂ , N ₂ , O ₂ , F ₂ . Bond order. Diamagnetism and paramagnetism. Diborane: Preparation and properties, structure, preparation and uses of NaHB ₄ , Borazole-Chemistry. Interhalogen compounds: ICl, BrF ₃ , IF ₃ - Preparation, properties, hybridization and structure, shape. Basic properties of iodine. Sodium hydrosulphite, peracids of sulphur: preparation, properties and uses. Structure.												
Unit II:						[12 Periods]						
Industrial Chemistry Synthesis, properties and uses of silicones. Fuel gases: natural gas, water gas, semi water gas, carburetted water gas, producer gas, oil gas (manufacturing details not required). Fertilizers: urea, ammoniu sulphate, ammonium nitrate, potassium nitrate NPK fertilizer. Triple superphosphate. Pollution of air, water and soil-sources, remedies.												
Unit III:						[12 Periods]						
Bonding Chemistry Orbital overlap, hybridization, geometry of organic molecules- CH ₄ , C ₂ H ₄ , C ₂ H ₂ , C ₆ H ₆ . Inductive effect. Electrometric, mesomeric, hyperconjugative and steric effects. Effect in properties of compounds Stereoisomerism Optical isomerism: symmetry, elements of symmetry. Cause of optical activity, tartaric acid, Racemisation, Resolution. Geometric isomerism of maleic and fumaric acids. Keto-enol tautomerism in Acetoacetic esters.												
Unit IV:						[12 Periods]						
Conductance Types (definition only) - Ostwald dilution law - Kohlraush's law- -Applications Conductometric titrations. 2. pH and its calculations- Buffers in living systems-Action of buffer solutions- Henderson Hasselbalch equation Chemistry Terms: Chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic effect, hypsochromic effect- Dyes: azo and triphenylmethane dyes-Preapration one exampleMethyl Orange, Malachite green.												
Unit V:						[12 Periods]						
Solutions Types Liquid in Liquid. Raoult's law. Deviation from ideal behaviour. Binary liquid mixtures. Fractional distillation. Kinetics: Rate, order, molecularity, pseudo first order, determination of order. Measurement of reaction. Effect of temperature on the rate. Energy of activation. Chromatography: Principle and application of column, paper and thin layer chromatography.												
Text Book: 1. Dr. V. Veeraiyan,,"Text book of Ancillary chemistry", Volume I, High mount Publishing house, Chennai-14, Edition-2008												
Reference Books: 1. P.L. Soni, "Text Book of Inorganic Chemistry", Sultan Chand & Sons, New Delhi, 2013 2. Puri and Sharma, "Text book of Inorganic Chemistry", Vishal publishing, 2014												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	3	2	2	2	2	2	3	2

C02	2	2	3	3	3	3	3	2	3	3	2	2	
C03	3	2	3	2	3	3	3	2	2	2	3	2	
C04	3	2	2	2	2	3	3	2	2	3	1	3	
C05	2	2	3	2	3	2	2	3	1	3	3	1	

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type						
	Microbial Nanotechnology	2		-	-	Theory						
Introduction: Candidates studying this paper would be familiar with techniques involved in nanoparticles synthesis and application of bio nanoparticles.												
Course Focus on : Skill Development / Entrepreneurship / Employability / Research												
Course Outcome:												
CO1	To understand the importance of Nanoparticles											
CO2	To interpret the results of nanoparticles synthesis											
CO3	To develop and strengthen the nanoparticles and their characterization											
CO4	To impart knowledge on core drug delivery systems											
CO5	To infer the merits and demerits of nano particles											
Unit I:						[12 Periods]						
Introduction to bionanotechnology Milestones in History – bionanotechnology – concept and future prospects – application in Life Sciences. Terminologies – nanotechnology, bionanotechnology, nanobiomaterials, biocompatibility, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles, nanosensors. Biotechnology to bionanotechnology, natural bionanomachines. Current status of bionanotechnology.												
Unit II:						[12 Periods]						
Synthesis of nanoparticles Molecular nanotechnology – nanomachines – collagen. Uses of nanoparticles – cancer therapy – manipulation of cell and biomolecules. Cytoskeleton and cell organelles. Types of nanoparticles production – physical, chemical and biological. Microbial synthesis (bacteria, fungi and yeast) of nanoparticles – mechanism of synthesis.												
Unit III:						[12 Periods]						
Types of nanoparticles and methods of characterization Nanoparticles – types, functions – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Characterization of nanoparticles – UVVis spectroscopy, particle size analyzer, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD. Other tools and techniques required for bionanotechnology: rDNA technology, site directed mutagenesis, fusion proteins, X- Ray crystallography, NMR. Bioinformatics: molecular modeling, docking, computer assisted molecular design.												
Unit IV:						[12 Periods]						
Applications of bionanotechnology Drug and gene delivery – protein mediated and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and Protein Microarrays. Nanotechnology in health sectors. Nanomedicines, Antibacterial activities of nanoparticles. Nanotechnology in agriculture. Toxicology in nanoparticles – Dosimetry.												
Unit V:						[12 Periods]						
Merits and demerits of nanoparticles Advantages of nanoparticles – drug targeting, protein detection, MRI, development of green chemistry – commercial viability of nanoparticles. Disadvantages – pollution and health risks associated with nanoparticles.												
Text Book: 1. Elisabeth Papazoglou and Aravind Parthasarathy. Bionanotechnology. Morgan and Claypool Publishers. 2007.												
Reference Books: 1. David E Reisner and Joseph D Bronzino. Bionanotechnology: Global Prospects. CRC Press. 2008. 2. Claudio Nicolini. Nanobiotechnology and Nanobiosciences Pan Stanford Publishing Pte. Ltd. 2009.												
Mapping of Course Outcome with Program Outcome and Program Specific Outcome												
Course Outcome	Program Outcomes								Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	3	2	2	2	2	2	3	2
CO2	2	2	3	3	3	3	3	2	3	3	2	2
CO3	3	2	3	2	3	3	3	2	2	2	3	2
CO4	3	2	2	2	2	3	3	2	2	3	1	3

C05	2	2	3	2	3	2	2	3	1	3	3	1
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Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
19BCSAFC	Environmental Studies	2	2	0	0	FC

Approved in the BOS Meeting held on 24-04-2021

Course Focus on : Skill Development / Entrepreneurship / Employability / Research

Unit I

A Multidisciplinary Subject – Natural Resources – Forest Resources – Water Resources – Mineral Resources – Food Resources – Energy Resources – Land Resources.

Unit II

Ecosystem – Concepts of Ecosystem – Characteristics – Food Chains – Food Web – Ecological Pyramids – Energy Flow in an Ecosystem – Nutrient Cycling – Primary Production – Ecosystem Regulation – Ecological Succession – Major Ecosystem Types.

Unit III

Biodiversity and its Conservation – Diversity – Biogeographically Classification of India – Value of Biodiversity – Global Biodiversity – Biodiversity: National, Regional or Local – Hot Spots of Bio Diversity – Threats to Biodiversity – Loss of Habitat – Poaching – Man-wildlife Conflicts – Endangered Species of India – Endemic Species of India – Conservation of Biodiversity.

Unit IV

Environmental Pollution – Air pollution – Noise Pollution – Water Pollution – Thermal Pollution – Marine Pollution – Soil Pollution – Nuclear Hazards – Solid Waste Management – Role of an Individual in Prevention of Pollution – disaster Management.

Unit V

Social Issues and the Environment – From unsustainable to sustainable development – Urban problems related to energy – Water Conservation – Rainwater Harvesting – Watershed Management – Resettlement and Rehabilitation Issues – Environmental Ethics – Climate change – Global Warming – Acid Rain – Ozone Layer Depletion – Environmental Legislation.

Reference books:

1. Michael Allaby., and Routledge. (1996). Basics of Environmental Science. 2nd Edition, London.
2. Aubha Kaushik., Kaushik, C. P. (2004). Perspectives in Environmental Studies. 2nd Edition. New Age International Publishers.
3. Saravanan, K., Ramachandran, S., Baskar, R. (2005). Principles of Environmental Science and Technology. New Age International Publishers.

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
19BCMAFC	Women Studies	2	2	0	0	FC
Course Focus on : Skill Development / Entrepreneurship / Employability / Research Unit I Laws, Legal Systems and Change Definition - Constitutional law, CEDAW and International Human Rights – Laws and Norms – Laws and Social Context – Constitutional and Legal Framework. Unit II Politics of land and gender in India Introduction – Faces of Poverty – Land as Productive Resources – Locating Identities – Women’s Claims to Land – Right to Property - Case Studies. Unit III Women’s Rights: Access to Justice Introduction – Criminal Law – Crime Against Women – Domestic Violence – Dowry Related Harassment and Dowry Deaths – Molestation – Sexual Abuse and Rape – Loopholes in Practice – Law Enforcement Agency. Unit IV Women’s Rights Violence Against Women – Domestic Violence - The Protection of Women from Domestic Violence Act, 2005 - The Marriage Validation Act, 1982 - The Hindu Widow Re-marriage Act, 1856 - The Dowry Prohibition Act, 1961 Unit V Special Women Welfare Laws Sexual Harassment at Work Places – Rape and Indecent Representation – The Indecent Representation (Prohibition) Act, 1986 - Immoral Trafficking – The Immoral Traffic (Prevention) Act, 1956 - Acts Enacted for Women Development and Empowerment - Role of Rape Crisis Centers.						
Reference books: 1. Nitya Rao. (2012) Good Women do not Inherit Land. Social Science Press and Orient Blackswan Pvt Ltd. New Delhi. 2. International Solidarity Network “Knowing Our Rights” An imprint of Kali for Women 2006 3. Kaushik P.D. (2007) Women Rights. Bookwell Publication. 4. Aruna Goal. (2004). Violence Protective Measures for Women Development and Empowerment. Deep and Deep Publications Pvt Ltd. 5. Monica Chawla. (2006). Gender Justice. Deep and Deep Publications Pvt Ltd. 6 6. Preeti Mishra. (2007). Domestic Violence against Women. Deep and Deep Publications Pvt Ltd. 7. Clair M. Renzetti, Jeffrey L. Edleson, Raquel Kennedy Bergen. (2001). Source Book on Violence Against Women. Sage Publications.						

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
19BCCAFC	Constitution of India	2	2	0	0	FC
Course Focus on : Skill Development / Entrepreneurship / Employability / Research Unit I Making of Constitution - Constituent Assembly - Dr.Rajendra Prasath - Dr.B.R.Ambedkar - Salient features - Fundamental Rights. Unit II Union Executive - President of India - Vice-President - Prime Minister - Cabinet - Functions Unit III Union Legislature - Rajiya Sabha - Lok Sabha - Functions and Powers Unit IV Union Judiciary - Supreme Court - Functions - Rule of law Unit V State - Executive - Legislature - Judiciary						
Reference books: 1. Agharwal., R. C. (1977). National Moment and Constitutional Development – New Delhi. 2. Chapra, B.R. (1970). Constitution of India. New Delhi. 3. Rao B.V. (1975). Modern Indian Constitution, Hyderabad. 4. Nani Palkhivala. (1970). Constitution of India, New Delhi. 5. Krishna Iyer, V.R. (2009) Law and Justice, New Delhi.						

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Value Education – Human Rights	2	2	0	0	FC
Course Focus on : Skill Development / Entrepreneurship / Employability / Research UNIT I: Concept of Human Values, Value Education Towards Personal Development - Aim of education and value education; Evolution of value oriented education; Concept of Human values; types of values; Components of value education. Personal Development: Self-analysis and introspection; sensitization towards gender equality, physically challenged, intellectually challenged. Respect to - age, experience, maturity, family members, neighbors, co-workers. Character Formation towards Positive Personality: Truthfulness, Constructively, Sacrifice, Sincerity, Self-Control, Altruism, Tolerance, Scientific Vision. UNIT II: Value Education towards National and Global Development - National and International Values: Constitutional or national values - Democracy, socialism, secularism, equality, justice, liberty, freedom and fraternity. Social Values - Pity and probity, self-control, universal brotherhood. Professional Values - Knowledge thirst, sincerity in profession, regularity, punctuality and faith. Religious Values - Tolerance, wisdom, character. Aesthetic values - Love and appreciation of literature and fine arts and respect for the same. National Integration and international understanding. UNIT III: Impact of Global Development on Ethics and Values - Conflict of cross-cultural influences, mass media, cross-border education, materialistic values, professional challenges and compromise. Modern Challenges of Adolescent Emotions and behavior; Sex and spirituality: Comparison and competition; positive and negative thoughts. Adolescent Emotions, arrogance, anger, sexual instability, selfishness, defiance. UNIT IV: Introduction – Law – Functioning of Court – Hierarchy of Courts – seeking Justice – Dragged into the Net – Help thy Neighbor – You snooze, You Lose - Crime & Punishment – Introduction to Criminal Law – Encounter with Criminal Law – Limitation and other restrictions for prosecution – Major offences and punishments - Guardianship and Minority – Civil Marriage – Compulsory Registration of Marriages – Relief through Family Court – Writing a Will. UNIT V: Protection of Women under Civil Law – Protection of Women under Criminal law – Protection of Child under Civil and Criminal Law - Protection of Workmen - Consumer Protection – Consumer friendly forums – Defective and Hazardous Good – Deficiency in Service – Unfair and Restrictive trade practices – Quality of Goods – Right to Information Act – Cyber Crimes – E- Commerce. Textbook: 1. KWIRC. (2005). Human Rights Education for Beginners. NHRC. 2. Yetukuri Venkateswara Rao. (2008). Layman's Guide to Law. Asia Law House. 3. Value Education – Human Rights. (2009) Learning Material. Bharathiar University. 4. Sastry, T. S. N. (2011). Introduction to Human Rights and Duties. University of Pune.						

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Yoga	2	2	0	0	FC
Course Focus on : Skill Development / Entrepreneurship / Employability / Research Unit I - Yoga and Physical Health 1.1. Physical Structure - Three bodies - Five limitations 1.2. Simplified Physical Exercises - Hand Exercises -Leg Exercises – Breathing Exercises - Eye Exercises – Kapalapathi 1.3. Maharasanas 1-2 - Massages - Acu-puncture – Relaxation 1.4. Yogasanas - Padmasana- Vajrasanas - Chakrasanas. (Side)- Viruchasanas- Yoga muthra – Patchimothasanas – Ustrasanas - Vakkarasanas - Salabasanas Unit II - Art of Nurturing the life force and Mind 2.1. Maintaining the youthfulness - Postponing the ageing process 2.2. Sex and Spirituality - Significance of sexual vital fluid - Married life - Chastity 2.3. Ten stages of Mind 2.4 Mental frequency - Methods for concentration Unit III -Sublimation 3.1. Purpose and Philosophy of life 3.2. Introspection - Analysis of Thought 3.3. Moralization of Desires 3.4. Neutralization of Anger Unit IV - Human Resources Development 4.1. Eradication of worries 4.2. Benefits of Blessings 4.3. Greatness of Friendship 4.4. Individual Peace and World Peace Unit V - Law of Nature 5.1. Unified force- Cause and Effect system 5.2. Purity of Thought and Deed and Genetic Centre 5.3. Love and Compassion 5.4. Cultural Education - Fivefold Culture						

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	NCC	2	2	0	0	FC
Course Focus on : Skill Development / Entrepreneurship / Employability / Research Unit I - INTRODUCTION TO NCC Introduction to NCC, NCC Motto, Flag, Aims, Cardinal points of NCC, Organization of defense forces in general, Organizational structure of Indian Army, Organizational structure of NCC, Ranks in Army, Navy and Air Force, Honors and Awards. Unit II - MILITARY HISTORY World war I & World war II Famous Battles / Wars of India: Battle of the Ten Kings - 14th century BCE, Kalinga War - 262 BC, Battle of Takkolam – 949, Battle of Saragarhi -12 September 1897, Indo – Pak War 1971, Kargil War 3 May–26 July 1999. Unit III - NATIONAL INTEGRATION Meaning and Importance, Unity in Diversity, Indian History and culture, Religion and customs of India, India and its Neighbors, contribution of Youth in National Building. Unit IV – LEADERSHIP Meaning, Leadership Traits, Types of Leadership, Discipline & Duty of an Indian Citizen, Motivation, Code of Ethics, Perception, Communication, Importance of Team Work. Biography of Successful Leaders: Vijayalaya Chola, Rajaraja Chola I, Rajendra Chola I, Jalal ud din Muhammad Akbar (Akbar the Great) (1556–1605), Muhiuddin Muhammad Aurangzeb Alamgir (1658–1707), Chatrapati Shivaji Maharaj, Peshwa Bajirao I (17 April 1720 – 28 April 1740), Field Marshal Cariappa, Field Marshal Sam Maneksha, Unit V - CIVIL DEFENCE AND DISASTER MANAGEMENT Civil Defence: Meaning, Organization and its Duties, Civil Defence Services, Fire Fighting: Meaning, Mode of Fire, Fire Fighting Parties, Fire Fighting Equipment's. Introduction, Classification of Disaster: Natural Disaster & Man Made Disaster; Disaster Management During Flood, Cyclone and Earth Quake, Assistance in Removal of Debris, Collection and Distribution of Aid Material, Message Services.						
Reference books: 1. Cadet's Hand Book- Common Subject, All Wings, by DG NCC, New Delhi. 2. Cadet's Hand Book -Specialized Subject, Army, by DG NCC, New Delhi.						

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Communicative English	2	2	0	0	FC
Unit I - Vocabulary building - Puzzle Unit II - Common error in English - Role Play Unit III - Advertising - Newspaper Reading Unit IV - Write the missing Verbs - Question Framing Unit V - Description - Letter writing						

Subject Code	Subject Title	Credit	Lecture	Tutorial	Practical	Type
	Quantitative Aptitude	2	2	0	0	FC
Course Focus on : Skill Development / Entrepreneurship / Employability / Research Unit I Introduction: Competitive Exams – Types- Eligibility and Criteria - Public and Private sectors. Unit II Number Series – Simplifications – Average – Percentage - Profit and Loss - Partnership Unit III Time and Work - Time and Distance - Permutations and Combinations - Probability Unit IV Problems on Ages - Coding and Decoding - Blood Relation Unit V Direction Sense test - Sitting Arrangements - Syllogism						