ITM UNIVERSITY

SYLLABUS FOR THREE-YEAR FULL TIME BACHELOR IN MICROBIOLOGY (HONOURS) 2021-2024

Programme Educational Objectives:

1. The graduating student shall become a professional assistant in the area of microbiology
2. The graduating student shall become a researcher in the field of microbiology.
3. The graduating student shall become an entrepreneur or a consultant or a freelancer in the area of microbiology.

Programme Outcome:

A student shall have:

1. An ability to apply the fundamental knowledge of bacteriology, microbial metabolism and molecular biology of microorganisms of medical, environmental, industrial and pharmaceutical importance.
2. An ability to conduct experiment, analyse and interpret result using conventional analytical tools.
3. An ability to design a system, component, or process to meet desired need within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
4. An ability to function in multidisciplinary teams.
5. An ability to identify, formulate and solve the problems in the area of microbiology.
6. An understanding of professional and ethical responsibility in the field of microbiology.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of solutions in a global, economic, environmental and societal context.
9. Recognition of the genetic engineering and microbial biotechnology for therapeutics and an ability to engage in lifelong learning in the area of biochemistry.
10. A knowledge of contemporary issues related to microbiology.
11. An ability to use the techniques, skills and modern professional tools necessary for professional practice and for research.
12. An ability to apply the relevant knowledge and managerial skills to manage the project of multidisciplinary nature.

Programme Specific Objectives:

1. Students shall be able to identify, formulate & solve the problems of immunology disorders in the area of immunology & medical microbiology

2. Students shall be able to conduct the molecular biology experiments as well as to analyse & interpret the results.

3. Students shall be able to use the recombinant DNA techniques and its applications in Microbial Biotechnology, Industrial Microbiology, Environmental management and various other fields of Microbiology.

	Core Course (14)	**Ability Enhancement Compulsory Course (AC) (2)**	**Skill Enhancement Course (SC) (2)**	**Discipline Specific Elective (DE) (4)**	**Generic Elective(GE) (4)**
I	C 1	English/ Environmental Science			GE-1
	C 2				
II	C3	Environmental Science/ English			GE-2
	C 4				
III	C 5		SC-1		GE-3
	C 6				
	C 7				
IV	C 8		SC-2		GE-4
	C 9				
	C 10				
V	C 11			DE-1	
	C 12			DE- 2	
VI	C 13			DE- 3	
	C 14			DE-4	

Semester	Course	Code	Credit
	Core Course (CO)		T+P
I	Bacteriology	BSMBT101CO	4+2
I	Microbial Physiology and Metabolism	BSMBT102CO	4+2
II	Biochemistry	BSMBT203CO	4+2
II	Microbial Tools and Instrumentation	BSMBT204CO	4+2
III	Cell Biology	BSMBT305CO	4+2
III	Industrial Microbiology	BSMBT306CO	4+2
III	Virology	BSMBT307CO	4+2
IV	Molecular Biology I	BSMBT408CO	4+2
IV	Food and Dairy Microbiology	BSMBT409CO	4+2
IV	Medical Microbiology	BSMBT410CO	4+2
V	Microbial Ecology	BSMBT511CO	4+2
V	Immunology I	BSMBT512CO	4+2
VI	Recombinant DNA Technology	BSMBT513CO	4+2
VI	Basic Concepts of Genetics and Genomics	BSMBT514CO	4+2
	Discipline Specific Electives (DE) – Any Four		
V	Phycology and Mycology	BSMBT501DE	4+2
V	Plant Pathology	BSMBT502DE	4+2
V	Molecular Biology II	BSMBT503DE	4+2
V	Microbial Biotechnology	BSMBT504DE	4+2
VI	Immunology II	BSMBT605DE	4+2
VI	Scientific Methodology and Technical Writing	BSMBT606DE	4+2
VI	Biostatistics	BSMBT607DE	4+2
VI	Biosafety and Intellectual Property Rights	BSMBT608DE	4+2
VI	Forensic Sciences	BSMBT609DE	4+2
VI	Project Work	BSMBT609DE	6
	Generic Electives (GE)-Any Four		
I	History and Scope of Microbiology	BSMBT101GE	4+2
I	Applied Microbiology	BSMBT102GE	4+2
II	Microbial Metabolism	BSMBT203GE	4+2
II	Industrial and Food and Dairy Microbiology	BSMBT204GE	4+2
III	Genetic Engineering and Biotechnology	BSMBT305GE	4+2
III	Immunology and Medical Microbiology	BSMBT306GE	4+2
IV	Biophysics	BSMBT407GE	4+2
IV	Bioinformatics	BSMBT408GE	4+2
	Ability Enhancement Compulsory Courses (AC)- Any One		
I/II	English	BSMBT101AC/BSMBT201AC	4
I/II	Environmental Sciences	BSMBT102AC/BSMBT202AC	4

	Skill Enhancement Elective Courses (SC)- Any Two		
III	Biofertilizers and Biopesticides	BSMBT301SC	4
III	Food Fermentation Techniques	BSMBT302SC	4
IV	Microbial Diagnosis in Healthcare	BSMBT403SC	4
IV	Microbial Quality Control in Food and Pharmaceutical Industries	BSMBT404SC	4
IV	Microbiological Analysis of Air and Water	BSMBT405SC	4
	Extra Credit Course (EC)		
III/IV/V/VI	Seminar	BSMBTSE01EC	2
IV/V/VI	MOOC	BSMBMO01EC	2
IV	Summer Internship	BSMBSI401EC	2

* T=Theory, P=Practical

B. Sc. Microbiology (Honours) First Semester Syllabus
Teaching and Examination Scheme

S.no	Category	Subject Code	Subject Name	Hours Per Week			C	Theory Marks		Practical Marks		Total Marks
				L	T	P		ESE	IA	ESE	IA	
1	CO	BSMBT101CO	Bacteriology	4	-		4	70	30	-	-	100
2	CO	BSMBT102CO	Microbial Physiology & Metabolism	4	-		4	70	30	-	-	100
3	GE-1 (Any one)	BSMBT101GE	History & Scope of Microbiology	4	-		4	70	30	-	-	100
		BSMBT102GE	Applied Microbiology	4	-		4	70	30	-	-	100
4	AC-1 (Any one)	BSMBT101AC	English	4	-		4	35	15	-	-	50
		BSMBT102AC	Environmental Science	4	-		4	35	15	-	-	50
5	CO Practical	BSMBP101CO	Bacteriology Practical	-	-	2	2	-	-	35	15	50
6	CO Practical	BSMBP102CO	Microbial Physiology & Metabolism Practical	-	-	2	2	-	-	35	15	50
7	GE-1 Practical	BSMBP101GE	History & Scope of Microbiology Practical	-	-	2	2	-	-	35	15	50
		BSMBP102GE	Applied Microbiology Practical	-		2	2	-	-	35	15	50
Total				**16**	**-**	**6**	**22**					**500**

*L- Lecture, P- Practical, C -Credit, IA-Internal Assessment, ESE- End Semester Examination.

B.Sc. Microbiology (Honours) Second Semester Syllabus
Teaching and Examination Scheme

S.no	Category	Subject Code	Subject Name	Hours Per Week			C	Theory Marks		Practical Marks		Total Marks
				L	T	P		ESE	IA	ESE	IA	
1	CO	BSMBT203CO	Biochemistry	4	-	-	4	70	30	-	-	100
2	CO	BSMBT204CO	Microbial Tools & Instrumentation	4	-	-	4	70	30	-	-	100
3	GE-2 (Any one)	BSMBT203GE	Microbial Metabolism	4	-	-	4	70	30	-	-	100
		BSMBT204GE	Industrial and Food and Dairy Microbiology	4	-	-	4	70	30	-	-	100
4	AC-2(Any one)	BSMBT201AC	English	4	-	-	2	35	15	-	-	50
		BSMBT202AC	Environmental Science	4	-	-	2	35	15	-	-	50
5	CO Practical	BSMBP203CO	Biochemistry Practical	-	-	2	2	-	-	35	15	50
6	CO Practical	BSMBP204CO	Microbial Tools & Instrumentation Practical	-	-	2	2	-	-	35	15	50
7	GE-2 Practical	BSMBP203GE	Microbial Metabolism Practical	-	-	2	2	-	-	35	15	50
		BSMBP204GE	Industrial and Food and Dairy Microbiology Practical	-	-	2	2	-	-	35	15	50
Total				**16**	**-**	**6**	**22**					**500**

*L- Lecture, P- Practical, C -Credit, IA-Internal Assessment, ESE- End Semester Examination.

B. Sc. Microbiology (Honours) Third Semester Syllabus
Teaching and Examination Scheme

S.no	Category	Subject Code	Subject Name	Hours Per Week			C	Theory Marks		Practical Marks		Total Marks
				L	T	P		ESE	IA	ESE	IA	
1	CO	BSMBT305CO	Cell Biology	4	-	-	4	70	30	-	-	100
2	CO	BSMBT306CO	Industrial Microbiology	4	-	-	4	70	30	-	-	100
3	CO	BSMBT307CO	Virology	4	-	-	4	70	30	-	-	100
4	GE-3 (Any one)	BSMBT305GE	Genetics Engineering and Biotechnology	4	-	-	4	70	30	-	-	100
		BSMBT306GE	Immunology and Medical Microbiology	4	-	-	4	70	30	-	-	100
5	SC-1 (Any one)	BSMBT301SC	Biofertilizers and Biopesticides	4	-	-	4	70	30	-	-	100
		BSMBT302SC	Food Fermentation Techniques	4	-	-	4	70	30	-	-	100
6	CO Practical	BSMBP305CO	Cell Biology Practical	-	-	2	2	-	-	35	15	50
7	CO Practical	BSMBP306CO	Industrial Microbiology Practical	-	-	2	2	-	-	35	15	50
8	CO Practical	BSMBP307CO	Virology Practical	-	-	2	2	-	-	35	15	50
9	GE-3 Practical	BSMBP305GE	Genetics Engineering and Biotechnology Practical	-	-	2	2	-	-	35	15	50
		BSMBP306GE	Immunology and Medical Microbiology Practical	-	-	2	28	-	-	35	15	50
Total				**20**	**-**	**08**	**28**					**700**

*L- Lecture, P- Practical, C -Credit, IA-Internal Assessment, ESE- End Semester Examination.

B. Sc. Microbiology (Honours) Fourth Semester Syllabus
Teaching and Examination Scheme

S.no	Category	Subject Code	Subject Name	Hours Per Week			C	Theory Marks		Practical Marks		Total Marks
				L	T	P		ESE	IA	ESE	IA	
1	CO	BSMBT408CO	Molecular Biology I	4	-	-	4	70	30	-	-	100
2	CO	BSMBT409CO	Food and Dairy Microbiology	4	-	-	4	70	30	-	-	100
3	CO	BSMBT410CO	Medical Microbiology	4	-	-	4	70	30	-	-	100
4	GE-4	BSMBT407GE	Biophysics	4	-	-	4	70	30	-	-	100
		BSMBT408GE	Bioinformatics	4	-	-	4	70	30	-	-	100
5	SC-2	BSMBT403SC	Microbial Diagnosis in Health care	4	-	-	2	70	30	-	-	100
		BSMBT404SC	Microbial Quality Control in Food and Pharmaceutical Industries	4	-	-	2	70	30	-	-	100
		BSMBT405SC	Microbiological Analysis of Air and Water	4	-	-	2	70	30	-	-	100
6	CO Practical	BSMBP407CO	Molecular Biology I Practical	-	-	2	2	-	-	35	15	50
7	CO Practical	BSMBP408CO	Food and Dairy Microbiology Practical	-	-	2	2	-	-	35	15	50
8	CO Practical	BSMBP409CO	Medical Microbiology Practical	-	-	2	2	-	-	35	15	50
9	GE-4 Practical	BSMBP410GE	Biophysics Practical	-	-	2	2	-	-	35	15	50
		BSMBP411GE	Bioinformatics Practical	-	-	2	2	-	-	35	15	50
Total				**20**	**-**	**08**	**28**					**700**

*L- Lecture, P- Practical, C -Credit, IA-Internal Assessment, ESE- End Semester Examination.

B. Sc. Microbiology (Honours) Fifth Semester Syllabus
Teaching and Examination Scheme

S.no	Category	Subject Code	Subject Name	Hours Per Week			C	Theory Marks		Practical Marks		Total Marks
				L	T	P		ESE	IA	ESE	IA	
1	CO	BSMBT511CO	Microbial Ecology	4	-	-	4	70	30	-	-	100
2	CO	BSMBT512CO	Immunology I	4	-	-	4	70	30	-	-	100
3	DE-1	BSMBT501DE	Phycology & Mycology	4	-	-	4	70	30	-	-	100
		BSMBT502DE	Plant Pathology	4	-	-	4	70	30	-	-	100
4	DE-2	BSMBT503DE	Molecular Biology II	4	-	-	4	70	30	-	-	100
		BSMBT504DE	Microbial Biotechnology	4	-	-	4	70	30	-	-	100
5	CO Practical	BSMBP511CO	Microbial Ecology Practical	-	-	2	2	-	-	35	15	50
6	CO Practical	BSMBP512CO	Immunology I Practical	-	-	2	2	-	-	35	15	50
7	DE-1 Practical	BSMBP501DE	Phycology & Mycology Practical	-	-	2	2	-	-	35	15	50
		BSMBP502DE	Plant Pathology Practical	-	-	2	2	-	-	35	15	50
8	DE-2 Practical	BSMBP503DE	Molecular Biology II Practical	-	-	2	2	-	-	35	15	50
		BSMBP504DE	Microbial Biotechnology Practical	-	-	2	2	-	-	35	15	50
Total				**16**	**-**	**8**	**24**					**600**

*L- Lecture, P- Practical, C -Credit, IA-Internal Assessment, ESE- End Semester Examination.

B. Sc. Microbiology (Honours) Sixth Semester Syllabus
Teaching and Examination Scheme

S.no	Category	Subject Code	Subject Name	Hours Per Week			C	Theory Marks		Practical Marks		Total Marks
				L	T	P		ESE	IA	ESE	IA	
1	CO	BSMBT613CO	Recombinant DNA Technology	4	-	-	4	70	30	-	-	100
2	CO	BSMBT614CO	Basic Concepts of Genetics & Genomics	4	-	-	4	70	30	-	-	100
3	DE-3	BSMBT605DE	Immunology II	4	-	-	4	70	30	-	-	100
		BSMBT606DE	Scientific Methodology & Technical Writing	4	-	-	4	70	30	-	-	100
4	DE-4	BSMBT607DE	Biostatistics	4	-	-	4	70	30	-	-	100
		BSMBT608DE	Biosafety and Intellectual Property Rights	4	-	-	4	70	30	-	-	100
		BSMBT609DE	Forensic Sciences	4	-	-	2	70	30	-	-	100
		BSMBT610DE	Project work	6	-	-	6	70	30	-	-	100
5	CO Practical	BSMBP613CO	Recombinant DNA Practical	-	-	2	2	-	-	35	15	50
6	CO Practical	BSMBP614CO	Basic Concepts of Genetics & Genomics Practical	-	-	2	2	-	-	35	15	50
7	DE-3 Practical	BSMBP605DE	Immunology Practical	-	-	2	2	-	-	35	15	50
		BSMBP606DE	Scientific Methodology & Technical Writing Practical	-	-	2	2	-	-	35	15	50
8	DE-4 Practical	BSMBP607DE	Biostatistics Practical	-	-	2	2	-	-	35	15	50
		BSMBP608DE	Biosafety and Intellectual Property Rights Practical	-	-	2	2	-	-	35	15	50
		BSMBP609DE	Forensic Sciences Practical	-	-	2	2	-	-	35	15	50
Total				**16/18**		**8**	**24/26**					**600**

*L- Lecture, P- Practical, C -Credit, IA-Internal Assessment, ESE- End Semester Examination.

SUMMARY OF CREDIT SYSTEM

S.NO	SEMESTER	NO. OF CREDIT	CO	GE	SC	DE	AC	ECC
1	I	22	12	6			4	
2	II	22	12	6			4	
3	III	28	18	6	4			
4	IV	28	18	6	4			
5	V	24	12			12		
6	VI	24	12			12		
GRAND TOTAL		148	84	24	8	24	8	
MOOC Courses/Seminar/Summer Internship		2						2/2/2
GRAND TOTAL		148/150/152/154	84	24	8	24	8	2/4/6

ASSESSMENT PROCEDURE FOR AWARDING MARKS

1. Appearance in End Semester Examination is mandatory for all courses including Theory, Laboratory and Project work.

All the Theory, Laboratory and other courses as per the curriculum will be assessed for the award of credit based on

i. Continuous Comprehensive Evaluation (CCE)

ii. End Semester Examination (ESE)

S.No	Category of Course		Continuous Comprehensive Evaluation	End Semester Examination
1	Theory Courses	Core Course (CO)	30	70
		Discipline Specific Elective (DE)	30	70
		Generic Elective (GE)	30	70
		Skill Enhancement (SE)	30	70
		Ability Enhancement Compulsory Course(AC)	15	35
2	Practical Courses		15	35

Continuous Comprehensive Evaluation (CCE)

I. Theory courses

Category	Marks
Class Test I	5
Class Test II	5
Class Test III	5
Assignment	5
Attendance	5
Class Participation	5
Total Marks	30

II. Practical courses

Category	Marks
Record Note Book	5
Viva Voce	5
Class participation	5
Total Marks	**15**

III. Project Work

Internal Review I	15 Marks
Internal Review II	15 Marks
Total Marks	**30**

End Semester Examination

I. Theory course: It will comprise of a 70 Marks Written Paper for each subject at the End of Each Semester (June/December).

II. Practical course: Each subject will assessed 35 marks for the practical in all subjects. The practical examination will conducted before/after the ESE individually for the subjects.

III. Project Work: It will comprise of the following-
Project Evaluation/ Dissertation-50 Marks
Viva Voce-20 Marks

Assessment of online courses/Seminar/Summer Internship: Students may be permitted to earn extra credit through Summer Internships (at renowned Institutes/Research Laboratories, Industry's etc., which are provided with a certificate), Seminars and online courses (which are provided with a certificate from known sources such as NPTEL and other MOOC based platforms with the approval of Departmental Committee and subject to a maximum of two additional credits.

Criteria for passing B.Sc.

	Continuous Assessment Minimum	**End Semester Minimum**	**Overall Passing**
Theory	40% (12 out of 30 marks)	40% (28 out of 70 marks)	45% (in CCE and ESE together)
Practical	40% (06 out of 15 marks)	40% (14 out of 35 marks)	45% (in CCE and ESE together)
Project	40% (12 out of 30 marks)	40% (28 out of 70 marks)	45% (in CCE and ESE together)

C-1: Bacteriology

Semester –I

THEORY	Subject Code: BSMBT101CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module gives detailed understanding about bacteria, its structure and growth conditions and the various factors affecting the growth of bacteria.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Identify cell structures and its organization
CO.2 – Summarize the different methods of sterilization and isolation of pure cultures
CO.3 – Explain growth and reproduction in bacteria
CO.4 – Classify bacteria based on specific characteristics
CO.5 – State the general characteristics of important Archeaebacteria and Eubacteria.

Unit	Topic/ Sub-Topic	Contact hour
1	Cell structure and Its Organization: (Prokaryotic& Eukaryotic cell structure), archaeal bacteria, Flagellar structures, twitching, gliding and spirochete motility, cell wall organization.Cytoplasm, Ribosomes, inclusion bodies ,nucleoid, plasmids, bacterial cytoskeleton	12
2	Culture media preparation. Sterilization and Isolation of Pure Cultures & Nutritional categories: A brief overview Culture media:Components of media,Synthetic or defined media, Complex media,supportive media, enriched media, selective media, differential media, enrichment culture Sterilization: Physical methods of heat, filtration and radiations Pure culture isolation: Streaking, serial dilution and plating methods. Cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria.	12
3	Growth and Reproduction in Bacteria Asexual methods of Reproduction, Phases of growth: Logarithmic representation of bacterial populations, calculation of generation time,synchronous growth.	8
4	Bacterial Systematics- Introduction to taxonomy, nomenclature and systematic Types of classification Taxonomic ranks Techniques for determining microbial taxonomy and phylogeny,Phylogenetic trees, Evolution of three domains of life	12
5	Important Archaea bacteria and Eubacteria Important archaeal and Eubacterial groups according to Bergey's Manual of Systematic Bacteriology Archaea: General characteristics of genera belonging to Nanoarchaeota(Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus), Euryarchaeota(Thermophiles, Eubacteria:Morphology, ecological significance and economic importance Gram Negative: Nonproteobacteria Deinococcus, Thermus, Spirochetes Alpha proteobacteria- Rhizobium, Agrobacterium Beta proteobacteria –Neisseria, Burkholderia, Thiobacillus Gamma proteobacteria – Enterobacteriaceae family, Purple sulphur bacteria, Pseudomonas Gram positive: Low G+C: Mycoplasma, Bacillus, Clostridium, Lactobacillus, Staphylococcus. High G+C: Streptomyces, Bifidobacterium,Corynebacterium, Mycobacterium Cyanobacteria: General account and importance	16

C1: Bacteriology Practical

PRACTICAL	Subject Code: BSMBP101CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1: Recall the basic lab glassware to be used in the laboratory.
CO.2: Apply serial dilution technique to isolate the bacteria.

CO.3: Practice different methods to culture bacteria in the laboratory
CO.4: Illustrate a method to differentiate between gram positive and gram negative bacteria.
CO.5: Identify extracellular enzyme producing micro –organisms isolated from the soil.
CO.6: Compare the different kind of bacteria and fungi from spoiled food.
CO.7: Illustrate the technique for isolation of autotrophic and Cyanobacteria from root nodules.
CO.8: Illustrate the isolation and identification of micro-organisms from the phyllosphere and Rhizopshere.

S.no	List of Experiments	Contact hours
1	Basic Lab glassware: Test tubes, screw capped tubes, pipette, Pasteur pipettes, Erlenmeyer flask, Eppendorf tubes, pipette tips, cover slip and slides	2
2	Serial dilution	2
3	Bacterial broth culture, slant and stab culture.	3
4	Staining of Bacteria	6
5	Isolation of Extracellular enzyme producing bacteria from soil- amylase	3
6	Identification of bacteria & fungi from spoiled foods	5
7	Isolation of autotrophic bacteria and cyanobacteria, rhizobia from root nodules	6
8	Isolation of phyllosphere & Rhizosphere bacteria	3

Recommended Books

- Prescott, Harley and Klein's Microbiology, by Willey JM, Sherwood LM and Woolverton CJ, McGraw 2. Hill Higher Education 8th Ed, 2011
- Microbiology: An Introduction by Tortora GJ, Funke BR and Case CL., Person Education, 9th Edition, 2008.
- Microbiology by Pelczar Jr MJ, Chan ECS and Krieg NR. Tata McGraw Hill, 5th Ed, 2011 (Reprint).
- Microbiology: Principles and Explorations, Black JG Prentice Hall 7th edition,2008.
- General Microbiology, Stanier RY, Ingraham JL, Wheelis ML and Painter PR. McMillan Publishing, 5th Edition 2005.
- Understanding Bacteria, Srivastava S and Srivastava PS,Kluwer Academic Publishers, 2003.
- Microbiological Applications Laboratory Manual in General Microbiology, Benson, The McGraw Hill Companies, 8th Edition

C-2: Microbial Physiology & Metabolism

Semester –I

THEORY	Subject Code: BSMBT102CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module gives us detailed knowledge about the growth and metabolism of bacteria.

Course Outcomes (COs)

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

CO.1 – Describe the nutritional requirements of microbes and the effect of environmental factors on the growth of microorganisms.

CO.2 – Classify the various transport mechanisms in microbes.

CO.3 – Define the metabolic pathways in microbes.

CO.4 – Distinguish between various fermentation mechanisms in microbes.

CO.5 – Discuss about anoxygenic and oxygenic photosynthesis in bacteria and cyanobacteria.

Unit	Topic/ Sub Topic	Contact hours
1	Microbial Growth and Effect of Environment on Microbial Growth- Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate Temperature and temperature ranges of growth, pH and pH ranges of growth Effect of solute and water activity on growth Effect of oxygen concentration on growth Nutritional categories of microorganisms	12
2	Nutrient uptake and Transport- Passive and facilitated Diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake	9
3	Chemoheterotrophic Metabolism – Aerobic Respiration Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate Pathway, TCA cycle, Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors	12
4	Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation- Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction), Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways	12
5	Chemolithotrophic and Phototrophic Metabolism- Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism -groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria	15

C2: Microbial Physiology and Metabolism Practical

PRACTICAL	Subject Code: BSMBP102CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1 – Demonstrate the Winogradsky column.

CO.2 – Describe the procedure of sterilization.

CO.3 – Describe the process of preparation of basic culture media.

CO.4 – Demonstrate the basic concept of cultivation of microorganisms

CO.5 – Analyse the growth curve of bacteria

CO.6 – Describe the effect of environmental factors on microbial growth.

CO.7 – Estimate the generation time of bacteria.

S.no	List of Experiments	Contact hours
1	Winogradsky column	6
2	Sterilization procedures and contamination check	6
3	Preparation of basic culture media	3
4	Plating techniques	3
5	Growth curve of bacteria	6
6	Factors affecting the growth curve: pH, Salt concentration & temperature	3
7	Generation time of bacteria	3

Recommended Books:

- Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM and Woolverton CJ, McGraw Hill Higher Education, 7th Ed., 2008
- Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM and Woolverton CJ, McGraw Hill USA, 9th Ed.
- Brock Biology of Microorganisms. Madigan MT and Martinko JM, Prentice Hall International Inc,10thedition,2006
- Microbial Physiology Moat AG and Foster J, John Wiley& Sons, 4th edition,2002.
- Microbial Physiology,Reddy SR and Reddy SM, Scientific Publishers India, 2005.
- Text Book of Bacteriology, Jigar R Rathod, 2nd Edition.
- Microbiological Applications Laboratory Manual in General Microbiology, Benson, The McGraw Hill Companies 8th Edition

C-3: Biochemistry

Semester –II

THEORY	Subject Code: BSMBT203CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the basic concepts of biochemistry and the functions of carbohydrates, protein, lipids. The module also gives insight to importance of biomolecules.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Define the laws of Bioenergetics
CO.2- Classify carbohydrates
CO.3- Describe lipids and their functions
CO.4- Describe protein structures, classification and their applications
CO.5- Explain structure, function of enzymes and their kinetics

Unit	Topic/Sub-Topic	Contact hours
1	Bioenergetic:First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy and mathematical relationship among them Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change.Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP	8
2	Carbohydrates:Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses.Stereoisomerism of monosaccharides, epimers.Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose. Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N-acetylneuraminic acid. Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose. Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin	14
3	Lipids: Definition and major classes of storage and structural lipids.Storage lipids. Fatty acids structure an Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification.Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine. Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides.Lipid functions: cell signals, cofactors, prostaglandins. Introduction of lipid micelles, monolayers, bilayers	12
4	Proteins:Functions of proteins,Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its significance.Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline. Non protein amino acid: Gramicidin,beta- alanine, D-alanin e and D- glutamic acid. Oligopeptides: Structure and functions of naturally occurring and glutathione and insulin and synthetic aspartame.	14
5	Enzyme:Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors.Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number. Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase. Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts	12

C3: Biochemistry Practical

PRACTICAL	Subject Code: BSMBP203CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Define basic laboratory glassware

CO.2- Describe basic laboratory instruments

CO.3- Estimate the pH of solutions

CO.4- Prepare normal solutions

CO.5- Prepare percentage and vol/vol solutions

CO.6- Illustrate paper chromatography technique

CO.7- Analyze carbohydrates, proteins and fats

S.no	List of Experiments	Contact Hours
1	Basic Lab requirements Volumetric flask, falcons, mortar and pestle, watch glass, wash bottle, beaker, measuring cylinder, dropper, burette, spatula, reagent bottle, test tube stand, pipette stand, tripod stand, Bunsen burner, wire gauze, crucible, funnel, centrifuge tubes	6
2	Instruments Separatory funnel, centrifuge, pH meter, Electric balance, hot plate	6
3	Determination of pH of various solutions using a pH meter – NaOH, sulphuric acid, distilled water	3
4	Preparation of Normal solution- NaOH	3
5	Preparation of percentage/ vov-vol solutions- Sulphuric acid	3
6	Paper Chromatography- Isolation of the pigments from leaves of Raddish	3
7	Qualitative analysis of Carbohydrate, protein & fats	6

Recommended Books:

- Lehninger Principles of Biochemistry by Nelson DL and Cox MM , W.H. Freeman and Company, 5th Ed., 2008.
- Biochemistry by Voet,D. and Voet J.G., John Wiley and Sons, 3rd Ed., 2004.
- Fundamentals of Biochemistry, Fatima.
- Campbell, MK Biochemistry, Published by Cengage Learning, 7th ed., 2012.
- Campbell, PN and Smith AD Biochemistry Illustrated, Published by Churchill Livingstone, 4th Edition, 2011.
- Biochemistry, Satyanarayan and Chakrapani, Elsevier, 4th Edition.
- Laboratory Manual for Practical Biochemistry, Ganesh MK & Shivashankara AR, Jaypee publications, 2nd Edition

C-4:Microbial Tools and Instrumentation
Semester –II

THEORY	Subject Code: BSMBT204CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course is a general introduction to the basic tools and usage of instruments in the laboratory.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Describe the principle and function of microscope.
CO.2 – Define the different chromatographic techniques and use in biological science.
CO.3 – Explain the process of separation of nucleic acid and proteins by electrophoresis.
CO.4 Analyse the problems related to the spectrophotometric and colorimetric analysis.
CO.5 – Describe the basic concept and applications of centrifugations

Unit	Topic/ Sub-Topic	Contact hours
1	Light Microscopy Parts of a compound microscope, principle of light microscopy,Determination of cell size.Use of different objective lenses (10X, 40X, Oil immersion),Principles of phase contrast microscopy,fluorescence microscopy and electron microscopy	14
2	Chromatographic Techniques: Paper and thin layer chromatography Column chromatography: Column packing and molecular exclusion	10
3	Electrophoresis: Principle and Applications,Polyacrylamide gel electrophoresis: SDS-PAGE, Agarose gel electrophoresis (demonstration), Staining and destaining of electrophoresed gels,Graphical determination of molecular weightof electrophoresed macromolecules	12
4	Spectrophotometry and Colorimetry: Principle : Determination of λmax for an unknown sample,Preparation of standard curve of glucose using DNSA,Turbidimetric analysis of a bacterial culture	12
5	Centrifugation: Basic Principle,Types of centrifuges (Preparative/Analytical) and Rotors (Fixed Angle / Swinging bucket),Concept of rpm, RCF,sedimentation coefficient ,Separation of components of a given mixture using a lab scale centrifuge	12

C4: Microbial Tools and Instrumentation Practical

PRACTICAL	Subject Code: BSMBP204CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Describe the different basic lab instrumentation
CO.2- Apply the knowledge of microscopy to its use.
CO.3- Analyze the size of different organisms viewed under th microscope
CO.4- Describe the morphology of bacteria viewed under the microscope
CO.5- Apply the knowledge of colorimetry to analysis of unknown samples
CO.6- Apply the knowledge of spectrophotometry to analysis of unknown samples
CO.7- Describe the procedures for preservation of bacteria

S.no	List of Experiments	Contact hours
1	Basic Lab instrumentation: Autoclave, incubator, Hot air oven, , Laminar air flow, bunsen burner, Electric balance, hot plate, Microscope,	3

2	Microscopy	3
3	Micrometry	3
4	Visualization of bacterial morphology,	6
5	Colorimetry	4
6	Spectophotometry	5
7	Preservation of bacteria	6

Recommended Books:

- Principles and Techniques of Biochemistry and Molecular Biology by Wilson K and Walker J, Cambridge University Press, 7th Edition, 2010.
- Cell and Molecular Biology: Concepts and Experiments by Karp G, John Wiley &Sons.Inc., 6th Ed., 2010.
- Principles and Techniques of Biochemistry and Molecular Biology by Wilson K and Walker J.
- Cell and Molecular Biology by De Robertis and De Robertis, Wolters Kluwer Pvt. Ltd. (India),8th Edition.
- Prescott, Harley and Klein's Microbiology by Willey, Sherwood and Woolverton, McGraw Hill Higher Education, 7th Edition
- Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam and Ayyagari, Tata McGrawHill.

C-5: Cell Biology

Semester –III

THEORY	Subject Code: BSMBT305CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course is a general introduction to cell biology, its importance in pathology and body functioning.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Describe the structure of plasma membrane, cell wall, cell adhesion molecules and cytoskeleton.
CO.2 – Define nuclear envelope, nuclear pore complex, nuclear lamina and nucleolus.
CO.3 – Explain the protein sorting and transport.
CO.4 – Discuss various cell signaling pathways.
CO.5 – Explain cell cycle, cell death and cell renewal.

Unit	Topic/ Sub- Topic	Contact hours
1	Structure of Cell-Plasma membrane: Structure and transport of small molecules, Cell Wall: Eukaryotic cell wall, Fluid mosaic model and details,Extra cellular matrix and cell matrix interactions Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects), Ribosomes, chloroplasts and peroxisomes, Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules	15
2	Nucleus-Nuclear envelope, nuclear pore complex and nuclear lamina,Chromatin –Molecular organization, Nucleolus	7
3	Protein sorting & transport-Endoplasmic Reticulum Structure, targeting and insertion of proteins in the ER,protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids, Golgi Organization, protein glycosylation and Apparatus protein sorting and export for Golgi apparatus , Lysosomes	12
4	Cell Signalling-Signalling molecules and their receptors,Function of cell surface receptors, Pathways of intra-cellular receptors – Cyclic AMP pathway, Cyclic GMP pathway, Effector systems - adenyl cyclase, guanyl cyclase, Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin and Ras, and MAP kinase pathway, Non receptor tyrosine kinase-erythropoietin receptor JAK - STAT pathway, JNK and Hippo pathway.	14
5	Cell Cycle, Cell Death and Cell Renewal, Eukaryotic cell cycle and its regulation,Development of cancer, causes and types , Programmed cell death, Stem cells, Embryonic stem cells induced pluripotent stem cells	12

C-5: Cell Biology Practical

PRACTICAL	Subject Code: BSMBP305CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Describe the structure of the plant and animal cell
CO.2- Describe the structure of cell organelles
CO.3- Demonstrate cytochemical staining of DNA
CO.4- Demonstrate polyploidy in onion roots
CO.5- Identify cancer cells
CO.6- Identify stages in mitosis

CO.5- Identify stages in meiosis

S.no	List of Experiments	Contact hours
1.	Study a representative plant and animal cell by microscopy	3
2.	Study of the structure of cell organelles through electron micrographs	6
3	Cytochemical staining of DNA – Feulgen	6
4	Study of polyploidy in Onion root tip by colchicine treatment.	3
5	Identification and study of cancer cells by photomicrographs.	6
6	Study of different stages of Mitosis	3
7	Study of different stages of Meiosis	3

Recommended Books:

- The Cell: A Molecular Approach, Geoffrey. M. Cooper and Robert. E. Hausman, Sinauer Associates, 5th Edition, 2009.
- Molecular Cell Biology, Lodish, WH Freeman, 5th Edition.
- Molecular Biology of the Cell, Bruce Alberts, Garland Publishing.

C-6: Industrial Microbiology

Semester –III

THEORY	Subject Code: BSMBT306CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to industrially important micro-organisms, industrialequipment, procedures and its application

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Defineabout improved nutritional values and increase yield of products by modifying microorganisms.
CO.2 – Describe various bioreactors to achieve desired results.
CO.3 – Discuss industrially important microbial strains and fermentation media.
CO.4 – Illustrate the fundamentals of downstream processing for product recovery.
CO.5 – Synthesize industrial products from microorganisms with fermentation.

Unit	Topic/ Sub-Topic	Contact hours
1	Introduction to industrial microbiology & fermentation process Brief history and developments in industrial microbiology,Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations	10
2	Types of Bioreactors & measurement of fermentation parameters,Components of a typical bio-reactor,Types of bioreactors- Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters,Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration	12
3	Isolation of industrially important microbial strains & fermentation media,Sources of industrially important microbes and methods for their isolation,Preservation and maintenance of industrial strains, strain improvement,Crude synthetic and media; molasses, corn-steep liquor, sulphite waste liquor,whey, yeast extract and protein hydrolysates	14
4	Down steam processing,Cell disruption, filtration, centrifugation,extraction, solvent precipitation, lyophilization and spray drying	12
5	Microbial production of industrial products (media, microorganisms, fermentation conditions, downstream processing), Citric acid penicillin,, ethanol, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase), Wine, beer	12

C6: Industrial Microbiology Practical

PRACTICAL	Subject Code: BSMBP306CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Demonstrate DO and BOD of water samples
CO.2 – Analyse the quality of milk by MBRT and SPC
CO.3 – Demonstrate the production and estimation of wine
CO.4 – Identify lactobacillus in curd
CO.5 – Identify organic acid producing micro organisms
CO.6 – Demonstrate the production of amylase
CO.5 – Identify yeast from samples

S.no	List of Experiments	Contact hours
1.	Determination of DO & BOD	3
2.	Detection of quality of Milk by methylene blue reduction test, Detection of number of bacteria in milk by Standard Plate Count	6
3	Preparation of wine from fruits, estimation of total acidity and volatile acidity.	6
4	Isolation of lactobacillus from curd.	3
5	Screening for organic acid producing micro organisms	6
6	Production of amylase by submerged fermentation	3
7	Isolation of yeast	3

Recommended Books:

- Industrial Microbiology, Patel A.H, Macmillan India Limited, 1st Edition, 1996.
- Modern Industrial Microbiology and Biotechnology, Okafor N,Bioscientific Publishers Limited. USA, 1st Edition, 2007.
- Industrial Microbiology: An Introduction, Waites M.J., Morgan N.L., Rockey J.S. and Higton G. Wiley – Blackwell, 1st Edition 2001.
- Microbial Biotechnology: Fundamentals of Applied Microbiology, Glaze A.N. and Nikaido H., W.H. Freeman and Company, 1st Edition, 1995.
- Industrial Microbiology, Casida.

C-7: Virology

Semester –III

THEORY	Subject Code: BSMBT307CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course is a general introduction to the basic concepts of Virology. The course also gives insight to importance of Viruses and pathogenecity in human diseases.

Course Outcomes (COs)

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

CO.1 – Explain the rationale behind Baltimore classification, the nature, properties, discovery of viruses and structure of viruses.

CO.2 – Describe and review the elements of virus diversity, classification and viral life cycle.

CO.3 – Describe the intra-host dynamics and modes of viral transmission dynamics of viruses, viral multiplication and replication strategies.

CO.4 – Explain concepts of oncogenes and proto-oncogenes.

CO.5 – Describe various viral diseases and antiviral compounds, principles of viral vaccination, different diagnostic techniques, Interferon and their mode of action.

Unit	Topic/ Sub- Topic	Contact hours
1	Nature and properties of Viruses- Introduction: Discovery of viruses, nature and definition of viruses,general properties concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin, Structure of Viruses: Capsid symmetry, enveloped and non- enveloped viruses, Isolation, purification and cultivation of viruses,Viral taxonomy: Classification and nomenclature of different groups of viruses	12
2	Bacteriophage-Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage	12
3	Viral Transmission, Salient features of viral nucleic acids and Replication Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174,Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage) terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmentedgenomes (picornavirus), capping and tailing TMV Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) Assembly, maturation and release of virions	22
4	Viruses and Cancer-Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes	10
5	Prevention & control of viral diseases-Antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination	4

C-7: Virology Practical

PRACTICAL	Subject Code: BSMBP307CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1 – Describe the structure of important animal viruses

CO.2 – Describe the structure of important plant viruses

CO.3 – Describe the structure of important bacterial viruses

CO.4 – Demonstrate isolation and enumeration of bacteriophages

CO.5 – Demonstrate the isolation and propagation of animal viruses
CO.6 – Describe the cytopathic effects of viruses
CO.7 – Demonstrate local lesion technique for assaying plant viruses

S.no	List of Experiments	Contact hours
1	Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs	3
2	Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs	6
3	Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.	6
4	Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique	3
5	Studying isolation and propagation of animal viruses by chick embryo technique	6
6	Study of cytopathic effects of viruses using photographs	3
7	Perform local lesion technique for assaying plant viruses.	3

Recommended Books:

- Virology: Principles and Applications, Carter J and Saunders V; John Wiley and Sons, 2nd Edition.
- Understanding Viruses, Shors Teri; Jones & Bartlett Learning USA, 2013.
- Introduction to Modern Virology,Dimmock NJ, Easton AL, Leppard KN, Blackwell Publishing Ltd, 6th Edition, 2007.
- Virology Principles and Applications, John Carter, Wiley Publication.
- Plant Viruses, Nayudu MV, Tata McGraw Hill India, 2008.

C-8: Molecular Biology I

Semester –IV

THEORY	Subject Code: BSMBT408CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to cell biology, its importance in pathology body functioning.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Recall the experiments and the concepts of hereditary material
CO.2 – Describe the structure and salient features of DNA and RNA
CO.3 – Explain the Chromatin structure and organization in Eukaryotes and prokaryotes
CO.4 – Distinguish the process of replication in prokaryotes as well as eukaryotes
CO.5 – Explain the process of DNA damage and various DNA repair mechanisms.
.

Unit	Topic/ Sub Topic	Contact hours
1	Nucleic Acids convey Genetic Information DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.	12 hrs
2	The Structures of DNA and RNA / Genetic Material DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, and Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA -- mitochondria and chloroplast DNA.	12hrs
3	Genome Structure, Chromatin and the Nucleosome Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly. Organization of Chromosomes	12 hrs
4	The Replication of DNA (Prokaryotes and Eukaryotes)Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative, Semi discontinuous,RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins	12 hrs
5	The Mutability and Repair of DNA-Definitions, Mutation, muton, replicon, principles of mutation, Replication Errors, DNA Damage, differenttypes of mutations, deletions, duplications, UV induced mutations, repair mechanisms against mutations and their importance.	12 hrs

C-8: Molecular Biology I Practical

PRACTICAL	Subject Code: BSMBP408CO
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Identify different types of RNA and DNA with micrographs
CO.2- Describe the semi- conservative method of replication with schematics
CO.3- Describe the structure of DNA with the help of X-ray diffraction photographs

CO.4- Demonstrate genomic DNA extraction

CO.5- Demonstrate Agarose gel electrophoresis and visualization

S.no	List of Experiments	Contact hours
1.	Study of different types of DNA and RNA using micrographs and model / schematic representations	7
2.	Study of semi-conservative replication of DNA through micrographs / schematic representations	6
3.	Study the structure of DNA with the help of X-ray diffraction photographs	6
4.	Extraction of genomic DNA	7
5.	Agarose gel electrophoresis and visualization	4

Recommended Books:

- Molecular Biology of the Gene, Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R , Cold Spring Harbour Lab. Press, Pearson Publication6th Edition, 2008.
- The World of the Cell, Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP, Pearson Benjamin Cummings Publishing, San Francisco, 7th Edition , 2009.
- Cell and Molecular Biology, De Robertis EDP and De Robertis EMF, Lippincott Williams and Wilkins, Philadelphia, 8th Edition.
- Cell and Molecular Biology: Concepts and Experiments,Karp G, John Wiley & Sons. Inc.,6th Edition, 2010.
- Cell and molecular biology: A lab Manual, K.V Chaitanya.
- Molecular cloning: A laboratory manual, Green & Sambrook, 4th Edition.

C-9: Food & Dairy Microbiology

Semester –IV

THEORY	Subject Code: BSMBT409CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course is intended to teach the students the relationship of micro-organisms with food and dairy products

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Define the fundamental concepts and scope of food and dairy microbiology.
CO.2 – Recognize the characteristics of important pathogens and spoilage microorganisms in food.
CO.3 – Explain the principles of food preservation and methods to slow microbial growth.
CO.4 – Prepare the various fermented milk products with the help of starter cultures
CO.5 – Examine the food borne diseases in the human body.

Unit	Topic/ Sub –Topic	Contact hours
1	Foods as a substrate for microorganisms.Basic concepts and scope of food and dairy microbiology. Study of primary sources of microorganisms in foods. Effect of intrinsic (pH, moisture content) and extrinsic (temperature and relative humidity) factors on microbial growth in various foods.	10
2	Microbial Spoilage of various foods,Effect of outer covering –spoilage of intact fruits and fruits with damaged skins. Study of spoiled vegetable, bread and egg samples.Study of spoilage of milk for acid, gas and proteolysis.	10
3	Methods of food Preservation Comparison of shelf life of pasteurized, UHT milk, raw milk both at low and room temperature. Aseptic packaging – layers of tetra packs and comparison of shelf life of such packaged fruit juices. Study of specimens of various canned foods (vegetables, fruits, pickles etc) and treatments given to them for preservation. Food preservation: Physical, chemical and biological methods.	14
4	Microbiology and Process of Fermented Foods. Use of starter cultures and preparation of Dahi. To perform various tests such as pH and titratable acidity of various fermented milk products(yogurt,market dahi,etc) available in market. Surveying of probiotic drinks. available in the market	12
5	Food-Borne Diseases Case study of food intoxications: Staphylococcus aureus, Clostridium botulinum. Case study of food infections: E. coli, Salmonellosis.	14

C-9: Food & Dairy Microbiology Practical

PRACTICAL	Subject Code: BSMBP409CO
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1-Identify the pH of natural food
CO.2- Estimate presence of citric acid by titrimetric method
CO.3- Estimate glucose by DNS & Yeast growth curve
CO.4-Demonstrate bread preparation
CO.5-Demonstrate Pigment extraction and assessment of fresh foods

CO.6-Identify adulterants in food
CO.7-Estimate protein in foods
CO.8-Analyze the quality of ice cream

S.no	List of Experiments	Contact hours
1.	Identification of pH of natural food	3
2.	Estimation of citric acid by titrimetric method	3
3.	Estimation of glucose by DNS & Yeast growth curve	4
4.	Preparation of bread using yeast	6
5.	Pigment extraction and assessment of fresh foods	5
6.	Identification of adulterants in foods (turmeric etc)	3
7.	Quantitative estimation of proteins in foods (soy, pulses etc)	3
8.	Analysis of quality of ice creams.	3

Recommended Books:

- Food Microbiology: Fundamentals and Frontiers,Doyle, MP and Beuchat, LR. ASM Press, Washington DC, USA, 3rdEdition, 2007.
- Food Microbiology: An introduction, Montville, TJ and Matthews, KR, ASM Press, Washington DC, USA,2ndEdition 2008.
- Fundamental Food Microbiology,Ray B and Bhunia AK, CRC Press, 4th Edition, 2008.
- Food Microbiology,Frazier WC and Westhoff DC., Tata McGraw-Hill Publishing Company Ltd, New Delhi, India, 4th Edition 2008.
- Modern Food Microbiology Jay JM, Loessner MJ and Golden DA. CBS Publishers and Distributors, Delhi, India, 7th Edition 2005.
- Applied Dairy and Food Microbiology Rameshwar Singh, Agrotech Publishing Academy.
- Laboratory manual of food microbiology Garg, Neelima , K L; Mukherji, K GI K International.

C-10: Medical Microbiology

Semester –IV

THEORY	Subject Code: BSMBT410CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course is designed to provide general introduction to cell biology, its imporatnce in pathology body functioning.

Course Outcomes (COs)

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

CO.1 – Apply the concept about resident and transient microbial flora of human body and their pathogenecity for diagnosis and immunological analysis with respect of various infections

CO.2 – Describe various diseases caused by bacteria, its symptoms, transmission and control.

CO.3 – Recognize the different medical conditions of an individual suffering from various viral and protozoan infections.

CO.4 – Identify the various pathological fungal species appropriately from an infected patient

CO.5 – Interpret about antibiotics, antifungal and antiviral drugs going to be applied on the patients.

Unit	Topic/ Sub -Topic	Contact hours
1	Normal microflora of the human body and host pathogen interaction Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections, Transmission of infection, Pathophysiologic effects of LPS.	15
2	Bacterial diseases: Symptoms, mode oftransmission, prophylaxis and control Respiratory Diseases: Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis.,Gastrointestinal diseases: Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori.Others: Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema	14
3	Viral and protozoan diseases: Viral diseases: Transmission, symptoms,prophylaxis and control,Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu Protozoan diseases: Symptoms, transmission and control. Malaria, Kala-azar.	15
4	Fungal diseases: Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete's foot). Systemic mycoses: Histoplasmosis, Opportunistic mycoses: Candidiasis	9
5	Antimicrobial agents: General characteristics and mode of action Antibacterial agents : Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action, of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.	7

C-10: Medical Microbiology Practical

Name of the subject: Medical Microbiology	Subject Code: BSMBP410CO
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1-Identify pathogens from clinical samples

CO.2-Identify bacteria by IMViC test
CO.3-Identify normal flora
CO.4-Identify antibiotic producing organisms
CO.5-Identify,isolate and cultivate micro organisms
CO.6-Demonstrate blood collection techniques
CO.7-Identify microbial toxins
CO.8-Estimate bleeding and clotting time of blood

S.no	List of Experiments	Contact hours
1.	Isolation, cultivation of pathogen and identification from clinical specimen	3
2	IMViC	6
3	Isolation of Normal flora	3
4	Isolation of antibiotic producing organisms by crowded plate technique	3
5	Isolation cultivation & identification of E.coli	3
6	Blood collection techniques,Special media	6
7	Test for microbial toxins	3
8	Bleeding time & clotting time	3

Recommended Books:

- Textbook of Microbiology, Ananthanarayan R. and Paniker C.K.J, University Press Publication, 8th Edition 2009.
- Jawetz,Melnick and Adelberg's Medical Microbiology, Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A, McGraw Hill Publication, 25th Edition., 2010
- Mims MedicalMicrobiology, Goering R., Dockrell H., Zuckerman M. and Wakelin D., Elsevier4th Edition, 2007.
- Prescott, Harley and Klein's Microbiology, Willey JM, Sherwood LM, and Woolverton CJ., McGraw Hill Higher Education7th Edition, 2008.
- Experiments in Microbiology, Plant pathology & Biotechnology, Aneja KR, New age International (p) Limited,4th Revised Edition.

C-11: Microbial Ecology

Semester –V

THEORY	Subject Code: BSMBT511CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course is designed to provide andintroduction to the Microbiology of the Environment and its management.

Course Outcomes (COs)

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

CO.1 – Describe the enormous microbial diversity in nature, their relation with environment and potential in the ecosystem.

CO.2 – Classify the microflora of soil, water, animal, air and their dispersal.

CO.3 – Explain the role of microorganisms in different biological interactions.

CO.4 – Illustrate about biogeochemical cycles - Carbon, Nitrogen, Sulphur Phosphorus cycle and microbes involved.

CO.5 – Examine the sanitary quality of water and sewage water through treatment methods employed in waste water treatment.

Unit	Topic/ Sub -Topic	Contact hours
1	History, and atmospheric ecology, Contributions of Kluyver, Van Niel, Martin Alexander, and Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of Microbes, Microbial analysis of air, settling plate and Anderson techniqueAtmosphereic pollutants, Types of wastes.	10
2	Microorganisms & their natural habitats A. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat ofmicrobes, Soil microflora B. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats, bacteriological analysis of water for coliforms and faecal streptococci (MTFT, MFT), Water treatment using SSF and RSF, methods of chlorination, Differences between fecal and non fecal organisms. C. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. d. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.	12
3	Succession of microbial communities in the decomposition of plant organic matter Biological Interactions A. Microbe–Microbe Interactions, Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents, B. Microbe–Plant Interactions, Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic – biofertilizers) C. Microbe–Animal Interactions, Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont	12
4	Biogeochemical cycles an introduction Carbon cycle:, Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin), Nitrogen cycle: Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution., Phosphorous cycle: Phosphate immobilization and phosphate solubilization, Sulphur Cycle: Microbes involved in sulphur cycle	12
5	Solid & Liquid Waste Management Sources and types of solid waste, methods of disposal of solid waste (incineration, composting, sanitary landfill), Liquid Waste Management, Composition of sewage; strength of sewage (BOD and COD); Primary, secondary (aerobic – oxidation pond, trickling filter, rotating biological contractor/biodisc system, activated sludge process and anaerobic – septic tank, imhoff tank, anaerobic digestor) and tertiary sewage treatment, Bioleaching Biodeterioration Microbial deterioration of metals (corrosion), textile and paper	14

C-11: Microbial Ecology Practical

PRACTICAL	Subject Code: BSMBP511CO
Total Marks for Evaluation: 100	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1-Identify bacteria from air, water and soil

CO.2- Demonstrate nitrifiers in soil

CO.3- Demonstrate denitrifiers in soil

CO.4-Identify rhizobia in root nodules

CO.5-Identify and enumerate phosphate solubilising organisms

CO.6-Analyse the quality of water

S.no	List of Experiments	Contact hours
1.	Isolation, cultivation of bacteria from, air, water and soil	6
2	Enumeration of Nitrifiers	6
3	Enumeration of denitrifiers	4
4	Isolation of Rhizobia from root nodules	4
5	Isolation and enumeration of phosphate solubilizing organisms	4
6	Sanitary quality of water	6

Recommended Books:

- Microbial Ecology: Fundamentals & Applications,Atlas RM and Bartha R., .Benjamin/Cummings Science Publishing, USA, 4th Edition,2000.
- Microbiology: Fundamentals and Applications,Atlas RM., MacMillan Publishing Company, New York.2nd Edition, 1989.
- Brock Biology of Microorganisms, Madigan MT, Martinko JM and Parker J, Pearson/ Benjamin Cummings,12th Edition 2009.
- Microbial Ecology,Campbell RE, Blackwell Scientific Publication, Oxford, England.1983.
- Soil Microbiology: An Exploratory Approach, Coyne MS, Delmar Thomson Learning,2001.
- Microorganisms in Action: Concepts & Application in Microbial Ecology,Lynch JM & Hobbie JE, Blackwell Scientific Publication, U.K, 1988.
- Environmental Microbiology, Maier RM, Pepper IL and Gerba CP., Academic Press.2nd Edition, 2009.
- An Introduction to Soil Microbiology,Martin A., John Wiley & Sons Inc. New York & London, 2nd Edition, 1977.
- Microbial Ecology: Organisms Habitats Activities,Stolp H, Cambridge University Press, Cambridge, England,1988.
- Soil Microbiology,Subba Rao NS, Oxford& IBH Publishing Co. New Delhi, 4th Edition, 1999.

C-12: Immunology I

Semester –V

THEORY	Subject Code: BSMBT512CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective:This module is a general introduction to the human immune system.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Distinguish between innate and adaptive immunity / humoral and cell mediated immunity.
CO.2 – Describe about all the cells and organs of the immune system.
CO.3 – Describe about the properties of antigens and adjuvants.
CO.4 – Distinguish between the structure of MHC and antigen presenting mechanisms of our immune system.
CO.5 – Distinguish between the pathways of the complement system and its consequences on eliminating pathogens from our body.

Unit	Topic/ Sub -Topic	Contact hours
1	Introduction Concept of Innate and Adaptive immunity, Immune dysfunction and its consequences. Immune Cells and Organs Structure,Functions and Properties of Immune Cells -T cell,B cell, NK cell, Macrophage,Neutrophil, Eosinophil, Basophil, Dendritic cell. Structure and Functions of Immune Organs–BoneMarrow, Thymus, Lymph Node, Spleen, GALT.	10
2	Antigens Antigenicity versus Immunogenicity. Haptens, Characteristics of an antigen - Foreignness, Molecular size and Heterogeneity. T-dependent and T- independent antigens, Adjuvants.	10
3	Antibodies and Humoral Immune Response-Basic structure of antibody- CDRs,Framework region, Hinge. Primary and secondary immune response. Antibody mediated effector function. Types and properties of antibodies Monoclonal antibodies- preparation and applications. Antigen-antibody interaction–Precipitation,Agglutination,Immunoelectrophoresis, Immunofluoresence, ELISA.	13
4	Major Histocompatibility Complex and Cell Mediated Immunity Organization and inheritance of MHC locus in humans.Structure and functions of MHC I & II molecules Cellular expression of M ADCC ADCC ADCC ADCC ADCC HC molecules Antigen processing and presentation - Cytosolic and Endocytic pathways.Killing mechanisms by CTL, NK cells and ADCC	12
5	Complement System Components of the complement system. Activation pathways- Classical, Alternative and Lectin pathway. Biological consequences of complement activation.	15

C-12: Immunology I Practical

PRACTICAL	Subject Code: BSMBP512CO
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:

CO.1- Demonstrate WIDAL test
CO.2- Demonstrate Immunodiffusion
CO.3- Analyze WBC and erythrocyte count
CO.4- Demonstrate HBsAG, HIV, HCV & other serological test
CO.5- Demonstrate Bacterial Agglutination
CO.6- Demonstrate Latex Agglutination
CO.7- Demonstrate serum separation

S.no	List of Experiments	Contact hours
1.	WIDAL	4
2.	Immunodiffusion	4
3.	WBC & erythrocytes count	4
4.	HBsAG, HIV, HCV & other serological test	6
5.	Bacterial Agglutination	4
6.	Latex Agglutination	4
7.	Separate serum from the blood sample (demonstration).	4

Recommended Books:

- Roitt's Essential Immunology, Delves P, Martin S, Burton D, Roitt IM, Wiley-Blackwell Scientific Publication, Oxford11th edition, 2006.
- Kuby's Immunology, Goldsby RA, Kindt TJ, Osborne BA., W.H. Freeman and Company, New York, 6th Edition, 2007.
- Janeway's Immunobiology, Murphy K, Travers P, Walport M, Garland Science Publishers, New York, 7th Edition, 2008.
- Manual of Molecular and clinical lab immunology, Detricj, Schmitz and Hamilton 8th Edition.
- Immunology Lab biology 477, Lab manual, Julie Jameson, 2016

C-13: Recombinant DNA Technology

Semester –VI

THEORY	BSMBT613CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the advanced techniques in DNA Technology, its importance in pathology body functioning.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Recall the basic techniques, enzymes and milestones of Genetic Engineering.
CO.2 – Recognize the relevance of the different kinds of vectors in genetic Engineering.
CO.3 – Explain the principle and procedures of DNA amplification and sequencing.
CO.4 – Outline the construction and screening of genomic and cDNA libraries.
CO.5 – List the methods of gene delivery and applications of DNA technology.

Unit	Topic/ Sub- Topic	Contact hours
1	Introduction to Genetic Engineering Milestones in genetic engineering and biotechnology. Modification systems: types i, ii and iii. Mode of action, nomenclature, applications of type ii restriction enzymes in genetic engineering.Analysis of restricted DNA: agarose gel electrophoresis and southern blotting. DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and ligases. Cloning: use of linkers and adaptors. Transformation of DNA: By chemical method.	12
2	Vectors, Cloning vectors:, definition and properties,Plasmid vectors: pbr and puc series. Bacteriophage lambda and m13 based vectors. Cosmids, bacs, yacs Expression vectors: e.coli lac and t7 promoter-based vectors, yeast yip, yep and ycp vectors, baculovirus based vectors mammalian sv40-based expression vectors.	14
3	DNA Amplification And DNA Sequencing PCR: basics of pcr, rt-pcr, real-time PCR, Sanger's method of DNA sequencing: traditional and automated sequencing, Primer walking and shotgun sequencing.	10
4	Construction and screening of genomic and cDNA libraries. Genomic and cDNA libraries: preparation and uses. Screening of libraries: colony hybridization and colony PCR. Chromosome walking and chromosome jumping.	12
5	Applications of DNA Technology Gene delivery: microinjection, electroporation, biolistic method (gene gun),liposome and viral-mediated delivery,Products of recombinant DNA technology: products of human therapeutic interest - insulin, hgh.	12

C-13: Recombinant DNA Technology Practical

PRACTICAL	Subject Code: BSMBP613CO
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Demonstrate competent cell preparation
CO.2- Demonstrate Bacterial Transformation and calculation of transformation efficiency.
CO.3- Demonstrate Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
CO.4- Demonstrate Ligation of DNA fragments
CO.5- Demonstrate Cloning of DNA insert
CO.6- Interpret DNA sequencing electropherograms

CO.7- Predict primer designs

S.no	List of Experiments	Contact hours
1.	Preparation of competent cells for transformation	4
2.	Demonstration of Bacterial Transformation and calculate transformation efficiency.	4
3.	Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis	4
4.	Ligation of DNA fragments	6
5.	Cloning of DNA insert	4
6.	Interpretation of sequencing gel electropherograms	4
7.	Designing of primers for DNA amplification	4

Recommended Books:

- Gene cloning and DNA analysis Brown TA, Blackwell publishing, oxford, UK.6th Edition, 2010.
- Biotechnology: applying the genetic revolution, Clark DP and Pazdernik NJ., Elsevier academic press, USA, 2009.
- Principles of gene manipulation and genomics,Primrose SB and Twyman RM, Blackwell publishing, oxford, UK.7th Edition, 2006
- Molecular cloning-a laboratory manual Sambrook J and Russell D., Cold spring harbor laboratory press, 3rd Edition, 2001.
- Prescott, Harley and Klein's microbiology Wiley JM, Sherwood lm and Woolverton CJ., Mcgraw hill higher education, 2008.
- Genomes-3, Brown TA., Garland science publishers, 2007.
- Genomics: applications in human biology, Primrose SB and Twyman RM., Blackwell publishing, Oxford, UK, 2008.
- Biotechnology, Kumaresan.
- Introduction to Molecular Biology and Genetic Engineering, Brandenberg.

C-14: Basic concepts of Genetics & Genomics

Semester –VI

THEORY	Subject Code: BSMBT614CO
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course objective:This course is designed to teach the students the basics of genetics, laws of inheritance and to educate them about genetic disorders

Course Outcomes (COs)

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

CO.1 – Explain the basics of classical, molecular and evolutionary genetics as well as model organisms used in genetic analysis and experimentation.

CO.2 – Explain Mendelian analysis with all the laws of Mendel's as well as Chromosome theory of inheritance and extensions Mendelian genetics.

CO.3 – Explain Mendelian analysis, Linkage, Crossing Over and recombination of genes.

CO.4 – Explain Extra-Chromosomal Inheritance, Rules of extra nuclear inheritance and Organelle heredity.

CO.5 – Explain the detail about the structural organization of chromosome, Packaging, chromosome banding, chromosomal abnormalities as well as special types of chromosome.

Unit	Topic/ Sub-Topic	Contact hours
1	Introduction to Genetics, Historical developments, Model organisms in genetic, analyses and experimentation: Escherichia coli, Saccharomyces cerevisiae, Neurospora crassa, Caenorhabditis, Drosophila elegans melanogaster, Arabidopsis thaliana.	12
2	Mendelian Analysis, Mendel's Laws, Rediscovery of Mendel's principles, Chromosome theory of inheritance. Extensions Mendelian genetics: Allelic interactions, concept of dominance,recessiveness. Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity.	14
3	Mendelian Analysis Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over	10
4	Extra-Chromosomal Inheritance, 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.	10
5	Characteristics of Chromosomes, Structural organization of chromosomes- centromeres, telomeres and repititive 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. Variation in chromosomal number and structural abnormalities,-Turner syndrome Klinefelter syndrome, Down syndrome.	14

C-14: Basic concepts of Genetics & Genomics Practical

PRACTICAL	Subject Code: BSMBP614CO
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Demonstrate dihybrid crosses

CO.2- Identify Barr body

CO.3- Explain karyotyping

CO.4- Identify the structure of polytene chromosomes

CO.5- Illustrate pedigree analysis

CO.6- Analyze representative quantitative trait
CO.7- Demonstrate chi square analysis

S.no	List of Experiments	Contact hours
1.	Mendelian deviations in dihybrid crosses	4
2.	Studying Barr Body with the temporary mount of human cheek cells	4
3.	Karyotyping with the help of photographs	4
4.	Study of polytene chromosomes using temporary mounts of salivary glands of Chiromonas / Drosophila larvae	6
5.	Study of pedigree analysis	4
6.	Analysis of a representative quantitative trait	4
7.	Chi-Square Analysis	4

Recommended Books:

- Principles of Genetics, Gardner EJ, Simmons MJ, Snustad DP, Wiley-India, 8th Edition, 2008.
- Principles of Genetics,Snustad DP, Simmons MJ, John Wiley and Sons Inc 6th Edition, 2011.
- Genetics, Weaver RF, Hedrick PW, McGraw-Hill Education, 3rd Edition, 1997.
- Concepts of Genetics, Klug WS, Cummings MR, Spencer CA, Palladino M, Benjamin Cummings, 10th Edition, 2012.
- Introduction to Genetic Analysis Griffith AJF, Wessler SR, Lewontin RC, Carroll SB., W.H.Freeman and Co., New York, 9th Edition, 2007.
- Genetics: Analysis of Genes and Genomes,Hartl DL, Jones EW, Jones and Bartlett Publishers, 7th Edition, 2009
- Genetics - A Molecular Approach, Russell PJ., Benjamin Cummings3rd Edition, 2009.

DSE-1: Phycology &Mycology

Semester –V

THEORY	Subject Code: BSMBT501DE
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: The course is designed to provide an introduction Phycology and Mycology, with understanding of their mode of reproduction.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Describe the characters, morphology, life cycle and significance of algae and fungi.
CO.2 – Classify the algae and fungi.
CO.3 – Classify the characters, morphology and reproduction in various genera of algae.
CO.4 – Discuss about the fungal diseases, their causative agents, mode of infection, epidemiology and their control measures.
CO.5- Classify based on characters, morphology and reproduction in various genera of fungi.

Unit	Topic/ Sub -Topic	Contact hours
1	Phycology Introduction General characteristics of algae including occurrence, thallus organization, algal cell ultra-structure,Algal pigments, flagella, eyespot food reserves, Vegetative, asexual and sexual reproduction . Different types of life cycles in algae: Haplobiontic, Haplontic,Diplontic, Diplobiontic and Diplohaplontic life cycles	12
2	Classification of algae and Classification of Fungi - basic to current	9
3	Study of the following classes with reference to genera listed below Cyanophyta (BGA): General characteristics – Nostoc Chlorophyta:General characteristics, Chlamydomonas,Bacillariophyta: General account – Diatoms Phaeophyta: General characteristics with importance -Ectocarpus Rhodophyta: Generalcharacteristics with importance	14
4	Mycology Introduction General characteristics of fungi including habitat, distribution, nutritional requirements ,Fungal cell ultra - structure, thallus organization and aggregation, fungal wall structure ,Asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism	10
5	Study of the following classes (occurrence, somatic structure, reproduction and fruiting bodies).Oomycota – General characteristics. Life cycle of Achyla,Phytophthora, Peronospora Ascomycota - General characteristics. Life cycle of Saccharomyces, Penicillium, Neurospora. Asexual Ascomycota – General characteristics – Candida & Alternaria. Basidiomycota – General characteristics. Life cycle of Puccinia, Ustilago Asexual Basidiomycetes – Cryptococcusneoformans (Teleomorph: Filobasidiella neoformans)	15

DSE-1: Phycology &Mycology Practical

PRACTICAL	Subject Code: BSMBP501DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Identify of fungi from spoiled foods
CO.2-Demonstrate the isolation of phyllosphere & Rhizosphere fungi
CO.3- Identify algae in slides
CO.4- Identify of fungi in slides
CO.5- Demonstrate the preparation of culture for fungus

S.no.	List of Experiments	Contact hours

1	Identification of fungi from spoiled foods	5
2	Isolation of phyllosphere & Rhizosphere fungi	5
3	Algal slides	6
4	Fungal slides	6
5	Preparation & culture of Fungus	8

References Books :

- Introductory Phycology, Kumar HD., Affiliated East Western Press, 2nd Edition,2007(Reprint).
- Textbook of Algae, Sharma OP, Tata McGraw Hill Publishing Co. Ltd., 2011.
- Chapter 1, Introductory Mycology by Alexopoulos CJ, Mims CW and Blackwell M., John Wiley and Sons,3rd Edition, 2012(Reprint).
- Fungi, Sumbali and Geeta, Naros Publishing House ND, 2nd Edition.
- The Mycota, Karl Esser, Springer 2nd Edition.

DSE-2: Plant Pathology

Semester –V

THEORY	Subject Code: BSMBT502DE
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course is intended to educate the students about micro-organisms and their relation to plant diseases.

Course Outcomes (COs)

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

CO.1 – Describe the fundamental concepts of plant pathology and plant diseases.

CO.2 – Discuss the different stages of disease development in plants.

CO.3 – (a) Discuss about the physiology of infected plants and host-pathogen interaction, virulence and pathogenicity.

CO.3 – (b) Describe genetics and the interaction of plant with pathogens, specifically, the gene for gene concept and concepts of defence mechanisms in plant.

CO.4 – Analyse the economically important plant diseases and their control and prevention.

CO.5 – Illustrate the life cycles of plant pathogenic viruses, bacteria, fungi and phytoplasmas in relation to their interaction with host plants.

Unit	Topic/ Sub -Topic	Contact hours
1	Introduction and History of plant pathology,Concept of plant disease- definitions of disease, disease cycle & 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 De Bary, 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.	7
2	Stages in development of a disease,Infection, invasion, colonization, dissemination of pathogens and perennation.Plant disease epidemiology. Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.	6
3	Host Pathogen Interaction A. Microbial Pathogenicity Virulence factors of pathogens: enzymes, toxins (host specific and nonspecific) 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). B. Genetics of Plant Diseases Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance. C. Defense Mechanisms in Plants Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].	17
4	Control of Plant Diseases Principles & 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	10

5	Specific Plant diseases Study of some important plant diseases giving emphasis on its etiological agent, symptoms,epidemiology and control A. Important diseases caused by fungi,White rust of crucifers - Albugo candida,Downy mildew of onion - Peronospora destructor,Late blight of potato - Phytophthora infestans Powdery mildew of wheat - Erysiphe graminis,Ergot of rye - Claviceps purpurea,Black stem rust of wheat - Puccinia graminis tritici Loose smut of wheat - Ustilago nuda B. Important diseases caused by phytopathogenic bacteria Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus C. Important diseases caused by phytoplasmas Aster yellow, citrus stubborn D. Important diseases caused by viruses Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro E. Important diseases caused by viroids, Potato spindle tuber, coconut cadang cadang	20

DSE-2: Plant Pathology Practical

PRACTICAL	Subject Code: BSMBP502DE
Total Marks for Evaluation:100	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Demonstrate of Koch's postulates in fungal, bacterial and viral plant pathogens

CO.2- Describe important diseases of crop plants by cutting sections of infected plant material- Albugo, Ustilago, Puccinia, Fusarium, Colletotrichum

S.No.	List of Experiments	Contact hours
1	Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens	15
2	Study of important diseases of crop plants by cutting sections of infected plant material- Albugo, Ustilago, Puccinia, Fusarium, Colletotrichum	15

Recommended Books:

- Plant Pathology, Agrios GN, Academic press, San Diego,5th Edition, 2006.
- Plant Pathology and Plant Pathogens,Lucas JA., Blackwell Science, Oxford.3rd Edition 1998.
- Plant Pathology,Mehrotra R,. Tata McGraw-Hill Limited,1994.
- Diseases of Crop Plants in India, Rangaswami G., Prentice Hall of India Pvt.Ltd., New Delhi., 4th Edition 2005.
- Plant Diseases Management,Singh RS, Oxford & IBH, New Delhi, 7th Edition 1998.

DSE-3: Molecular Biology II

Semester –V

THEORY	Subject Code: BSMBT503DE
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course objective: This module is a general introduction to molecular biology, transcription & protein synthesis.

Course Outcomes (COs)

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

CO.1 – Predict the level of RNA formation, modification and splicing targeted to specific protein.

CO.2 – Compute the process of translation in different species and production of the protein.

CO.3 – Prepare a platform at genetic level where the gene of a specific bacterial species could be regulated and controlled according to the industrial application.

CO.4 – Solve the problem related to gene expression of eukaryotic organisms.

CO.5 – Identify the utilization of different RNA such as riboswitches and micro RNA in the area of gene regulation.

Unit	Topic/ Sub -Topic	Contact hours
1	Mechanism of Transcription RNA Polymerase and the transcription unit, Transcription in Prokaryotes, Transcription in Eukaryotes, RNA Modifications, Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport	12
2	Translation (Prokaryotes and Eukaryotes) Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination. of polypeptides. Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation Translation-dependent regulation of mRNA and Protein Stability.	12
3	Transcription Regulation in Prokaryotes Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, regulation of transcription termination.	12
4	Transcription Regulation in Eukaryotes Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing	12
5	Regulatory RNAs Transcription Regulation in Eukaryotes & Regulatory RNAs: Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and Xinactivation	12

DSE-3: Molecular Biology II Practical

PRACTICAL	Subject Code: BSMBP503DE
Total Marks for Evaluation:50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1-Demonstrate PCR

CO.2-Demonstrate procedures for Restriction digestion and cloning

CO.3-Analyze proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE)

CO.4-Analyze the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells

CO.5- Analyze the survival curve of bacteria after exposure to ultraviolet (UV) light

S.No.	List of Experiments	Contact hours

1	PCR	5
2	Restriction digestion and cloning	6
3	Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).	6
4	Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells	5
5	Study survival curve of bacteria after exposure to ultraviolet (UV) light	8

Recommended Books:

- Cell and Molecular Biology: Concepts and Experiments, Karp, G., John Wiley & Sons. Inc.,6th Edition, 2010.
- Cell and Molecular Biology, De Robertis, E.D.P. and De Robertis, E.M.F., Lippincott Williams and Wilkins, Philadelphia, 8th Edition, 2006.
- The World of the Cell Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P., Pearson Benjamin Cummings Publishing, San Francisco.7th Edition, 2009.
- Molecular Biology of the Gene, Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., Cold Spring Harbour Lab. Press, Pearson Pub,6th Edition, 2008.

DSE-4: Microbial Biotechnology

Semester –V

THEORY	Subject Code: BSMBT504DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course objective: This module is an introduction to the role of micro-organisms in biotechnology and an understanding of the various metabolic processed involved.

Course Outcomes (COs)

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

CO.1 – Explain the role of micro-organisms and its scope in the diverse processes of Microbial Biotechnology.

CO.2 – Summarize processes for small scale production of substances that are extracted from or produced by micro-organisms.

CO.3 – Recognize the role and relevance of enzymes at the industrial level of production.

CO.4 – (a) Describe methods that can be employed for the purification and recovery of industrially important products.

CO.4 – (b) Illustrate whole cell Immobilization methods.

CO.5 – Define the role of micro-organisms in environment management.

CO.6 – Estimate the importance of RNA interference mechanism and its applications in the field of medicine.

Unit	Topic/ Sub Topic	Contact hours
1	Microbial Biotechnology and its Applications, Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology .Use of prokaryotic and eukaryotic microorganisms in biotechnological applications. Genetically engineered microbes for industrial application: Bacteria and yeast	12
2	Therapeutic and Industrial Biotechnology, Recombinant microbial production processes in pharmaceutical industries -Streptokinase, recombinant vaccines (Hepatitis B vaccine), Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics, Microbial biosensors	10
3	Microbial based transformation of steroids and sterols. Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute	8
4	Microbial product purification: filtration, ion exchange & affinity chromatography techniques.Immobilization methods and their application: Whole cell immobilization	8
5	Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture.Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents	14
6	RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions.	8

DSE-4: Microbial Biotechnology Practical

PRACTICAL	Subject Code: BSMBP504DE
Total Marks for Evaluation: 100	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Demonstrate Pigment production from fungi

CO.2- Describe enzyme immobilization by sodium alginate method

CO.3- Demonstrate enzyme immobilization by sodium alginate method

CO.4- Identify SCP

CO.5- Demonstrate Yeast cell immobilization in calcium alginate gels

S.No.	List of Experiments	Contact hours
1	Pigment production from fungi (Trichoderma/Aspergillus/Penicillium)	5
2	Study enzyme immobilization by sodium alginate method	6
3	Isolation of xylanase or lipase producing bacteria	6
4	Study of algal Single Cell Proteins	5
5	Study Yeast cell immobilization in calcium alginate gels	8

Recommended Books:

- Basic Biotechnology, Ratledge, C and Kristiansen, B, Cambridge University Press,2nd Edition, 2001.
- Manual of Industrial Microbiology and Biotechnology, Demain, A. L and Davies, J. E., ASM Press, 2nd Edition,1999.
- Advances in Escherichia coli production of therapeutic proteins, Swartz, J. R., Current Opinion in Biotechnology, 12, 195–201, 2001
- Prescott, Harley and Klein's Microbiology, Willey JM, Sherwood LM, Woolverton CJ, , Mc Graw Hill Publishers, 9th Edition, 2014.
- Elements of Biotechnology, Gupta PK, Rastogi Publications,2nd Edition, 2009.
- Microbial Biotechnology,Glazer AN and Nikaido H, Cambridge UniversityPress, 2nd Edition, 2007.
- Molecular Biotechnology, Glick BR, Pasternak JJ, and Patten CL, ASM Press,4th Edition,2010.
- Principles of Fermentation Technology, Stanbury PF, Whitaker A, Hall SJ, Elsevier Science, 2nd Edition, 1995
- Biotechnology: A text Book of Industrial Microbiology,Crueger W, Crueger A, Sinauer associates, Inc., 2nd Edition 1990.

DSE-5: Immunology II

Semester –VI

THEORY	Subject Code: BSMBT505DE
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: Clinically diagnose, investigate and manage a whole spectrum of immune-mediated disorders. Practically perform and interpret the common laboratory techniques used in the Immunology Laboratory.Plan and undertake research in Clinical Immunology in the clinic, laboratory and community.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Classify the types of autoimmune disorders and discuss their diagnostic and treatment methods.
CO.2 – Classify the types of hypersensitivity reactions and discuss their diagnostic and treatment methods.
CO.3 – Interpret the immunodiagnostic methods used in the diagnosis of diseases and disorders.
CO.4 – Classify the types of immunodeficiency diseases and discuss their diagnostic and treatment methods.
CO.5 – Predict the method of choice to be used in order to treat any immunological problems.

Unit	Topic/ Sub -Topic	Contact hours
1	Auto immunity & auto immune disorders	8
2	Hypersensitivity : Reactions and types	11
3	Immunodiagnostics Evaluating immunological functions. Detection of specific antibodies Flowcytometry HLA typing and matching Lymphoproliferation assays Molecular methods	15
4	Immunodeficiency Approach to evaluation of the immunodeficient host,Primary immunodeficiency disorders, HIV/AIDS, HIV vaccine development, Ageing and immune system, Secondary immunodeficiency (excluding AIDS).	14
5	Treatment of immunological diseases Bone-marrow transplantation, IVIG therapy, Cancer vaccines, Therapeutic antibodies, Gene therapy. Anti-inflammatory medications: steroids, NSAIDs and antihistamines.	12

DSE-5: Immunology II Practical

PRACTICAL	Subject Code: BSMBP505DE
Total Marks for Evaluation:100	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Demonstrate immunodiffusion by Ouchterlony method
CO.2- Demonstrate immunoelectrophoresis

CO.3- Identify blood groups

CO.4- Demonstrate Differential Leukocyte Count of the given blood sample.

S.No.	List of Experiments	Contact hours
1	Perform immunodiffusion by Ouchterlony method	5
2	Perform immunoelectrophoresis	9
3	Identification of human blood groups	5
4	Perform Differential Leukocyte Count of the given blood sample.	8

Recommended Books:

- Roitt's Essential Immunology, Delves P, Martin S, Burton D, Roitt IM., Wiley-Blackwell Scientific Publication, Oxford, 11th Edition, 2006.
- Kuby's Immunology, Goldsby RA, Kindt TJ, Osborne BA, W.H. Freeman and Company, New York, 6th Edition, 2007.
- Janeway's Immunobiology, Murphy K, Travers P, Walport M, Garland Science Publishers, New York, 7th Edition, 2008.
- Cellular and Molecular Immunology Abbas AK, Lichtman AH, Pillai S, Saunders Publication, Philadelphia, 6th Edition, 2007.
- Basic and Clinical Immunology, Peakman M, and Vergani D, Churchill Livingstone Publishers, Edinberg, 2nd Edition, 2009.
- Immunology, Richard C and Geiffrey S, Wiley Blackwell Publication, 6th Edition, 2009

DSE-6: Scientific Methodology & Technical writing

Semester –VI

THEORY	Subject Code: BSMBT606DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: The student will learn about all the techniques involved in the formulation of a research project and writing of a scientific paper.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Distinguish between types of research methodologies.
CO.2 – Describe the process of research design.
CO.3 – Describe the process of formulating a hypothesis.
CO.4 – Distinguish between types of report and its layout.

Unit	Topic/ Sub -Topic	Contact hours
1	Research Methodology, Introduction & types. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Literature survey Importance & Primary and secondary sources	15
2	Research Design, Basic principles, Characteristics of a good design.	15
3	Formulation of hypothesis, Meaning, Techniques and Precautions of Interpretation.	15
4	Research Report Writing, Structure and components of scientific reports, Types of report,Different steps in the preparation –Layout, structure and Language of typical reports –Illustrations and tables , Bibliography,referencing and footnotes. Research paper writing- Main components and structure.	15

DSE-6: Scientific Methodology & Technical Writing Practical

PRACTICAL	Subject Code: BSMBP606DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Demonstrate review writing skills
CO.2- Demonstrate report writing skills
CO.3- Demonstrate abstract writing skills
CO.4- Demonstrate scientific proposal writing skills

S.No.	List of experiments	Contact hours
1	Review writing	8
2	Report writing	8
3	Abstract writing	6
4	Scientific proposal writing	8

Recommended Books:

- Research Methodology Logic methods and cases, Sameer Phanse, Oxford University Press.
- Successful Scientific writing , Janice Mathews, Robert Mathews and John M Bowen, Cambridge University Press, Second Edition.

DSE-7: Biostatistics

Semester –VI

THEORY	Subject Code: BSMBT607DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: The student will learn to collect, tabulate, & analyze data as a researcher.

Course Outcomes (COs)

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

CO.1 – Solve mean, mode, median, dispersion; skewness, kurtosis, elementary probability, discrete and continuous random variable problems

CO.2 – Compute curve fitting; correlation and regression

CO.3 – Solve mean and variance of discrete and continuous distributions.

CO.4 – Distinguish between sample and population; parametric and non-parametric statistics

CO.5 – Calculate standard error, t-test, Z-test and F test; Confidence Interval; Distribution-free test - Chi-square test.

Unit	Topic/ Sub –Topic	Contact hours
1	Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable,	14
2	Curve Fitting; Correlation and Regression	10
3	Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution	8
4	Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics	14
5	Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test;	14

DSE-7: Biostatistics Practical

PRACTICAL	Subject Code: BSMBP607DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Calculate Mean, Median, Mode from grouped and ungrouped Data set

CO.2- Calculate Standard Deviation and Coefficient of Variation

CO.3- Demonstrate Skewness and Kurtosis

CO.4- Apply curve fittings

CO.5- Calculate Correlation, Regression

CO.6- Apply and test hypothesis

S.No.	List of Experiments	Contact hours
1	Mean, Median, Mode from grouped and ungrouped Data set	5
2	Standard Deviation and Coefficient of Variation	5
3	Skewness and Kurtosis	5
4	Curve fitting	5
5	Correlation, Regression	5

6	Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test,Confidence Interval	5

Recommended Books:

- Fundamentals of Biostatistics,Bernard Rosner, Duxbury Thomson Learning, 5th Edition.
- Introduction to Biostatistics, Larry Winner
- Introductory Biostatistics, Chap T. Lee, Chap Lee
- Understanding Calculus, H. S. Bear John Wiley and Sons, Second Edition, 2003.
- E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, InternationalStudent Edition, Narosa Publishing House, New Delhi (1971, 1975)
- A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
- Biostatistics: A foundation for Analysis in Health Sciences, W. Daniel, John Wiley and Sons Inc;2004.

DSE-8: Biosafety and Intellectual Property Rights

Semester –VI

THEORY	Subject Code: BSMBT608DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: The students will gain insights into Copyrights, patents, and biosafety

Course Outcomes (COs)

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

CO.1- Describe the Biosafety and its levels

CO.2- Describe the Biosafety guidelines and regulations

CO.3- Discuss Intellectual property rights

CO.4- Describe patents, its types and stages of filing.

CO.5- Describe the various agreements and treaties related to patents

Unit	Topic/ Sub –Topic	Contact hours
1	Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types;Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms	12
2	Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM,GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; RiskAnalysis; Risk Assessment; Risk management and communication; Overview of InternationalAgreements - Cartagena Protocol. AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.	12
3	Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).	12
4	Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.	12
5	Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement;WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms;UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	12

DSE-8: Biosafety and Intellectual Property Rights Practical

PRACTICAL	Subject Code: BSMBP608DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Identify the components of a BSL-III laboratory

CO.2- Prepare applications for approval from biosafety committee

CO.3- Identify the components of a BSL-III laboratory

CO.4- Employ steps of a patenting process

CO.5- Prepare case studies

Unit	List of Experiments	Contact hours
1	Study of components and design of a BSL-III laboratory	5
2	Filing applications for approval from biosafety committee	6
3	Filing primary applications for patents	6
4	Study of steps of a patenting process	5
5	A case study	8

Recommended Books:

- Bare Act,.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt.Ltd., New Delhi,2007.
- Genetic Patent Law & Strategy, Kankanala C, , Manupatra Information Solution Pvt. Ltd. New Delhi,2007.
- Indian Patents Law, Mittal, D.P., Taxmann, Allied Services (p) Ltd.,1999.
- Biotechnology and Intelectual Property Rights: Legal and Social Implications, Singh K K., Springer India.,2015
- IPR, Biosafety and Bioethics,Goel D & Prashar S. Pearson, 2013.
- IPR, Biosafety and biotechnology Management, Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S., Jasen Publications, Tiruchirappalli, India, 2008.

DSE-9: Forensic Sciences

Semester –VI

THEORY	Subject Code: BSMBT609DE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course will give a brief introduction to Forensic science and its application.

Course Outcomes (COs)

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

CO.1 – Define Forensic Science, the role of the forensic laboratory, history and development of forensic science in India & abroad and Laws and Principles of Forensic Science.

CO.2 – Discuss about legal processes involving environmental forensic science, Geo-forensics global positioning system and biometrics in personal identification

CO.3 – Practice general forensic tools and techniques

CO.4 – Discuss the general principles of centrifugation, microscopy and its application in forensic sciences

CO.5 – Explain the history of DNA typing, molecular biology of DNA, variations, polymorphism, DNA extraction, RFLP analysis, PCR amplifications and sequence polymorphism

Unit	Topic/ Sub -Topic	Contact hours
1	Forensic Science: Definition of Forensic Science, The Role of the Forensic Laboratory, History and Development of Forensic Science in India & Abroad, Pioneers in Forensic Science, Multidisciplinary nature, Forensic Technology solving crimes with advanced technology, Forensic intelligence and Interviews. Forensic Evidences: Concise of Forensic Physical, Biological, Chemical and Psychological evidences, Medico-Legal Cases. Laws and Principles of Forensic Science: Law of Exchange (Locard), Law of Individuality, Law of Comparison, Law of Progressive Changes and Law of Probability, Branches of Forensic Science	12
2	Recent Trends in Forensic Science- Environmental Forensics: Definition, Legal processes involving environmental forensic science. Geo-forensics Global Positioning System; Basic principles and applications. Biometrics in Personal Identification: Introduction, Concepts of Biometric Authentication, Role in person Identification, Techniques and Technologies (Finger Print Technology, Face Recognition, IRIS, Retina Geometry, Hand Geometry, Speaker Recognition, Signature Verification and other forensic related techniques). Bioterrorism: Definition, Concepts of Biosecurity and microbial forensics, Weapons of mass destruction (WMD), mass-casualty weapons (MCW), NBC and CBRNE, Dirty Bombs.	12
3	General Forensic tools and Techniques- Qualitative and quantitative methods of analysis, Destructive and Non-Destructive Methods, Separatorarytechniques, Hyphenated techniques, Accuracy, Precision, Signal to noise ratio, Sensitivity and detection limit, sources of noise, Instrument calibration. Schematic analysis of Chemical, Biological and Physical samples, Preliminary and Confirmatory methods of analysis, Colour spot tests in Forensic Biological, Chemical and Physical analysis, Microcrystalline test.	12
4	General principles of Centrifugation, Microscopy and its application in Forensic sciences – Fluorescence and Electron Microscopey. Principles of chromatography and its application in Forensioc science- Partition, adsoprtion and thin layer chromatogrphy.	12
5	DNA Profiling: Introduction, History of DNA Typing, molecular biology of DNA, variations,polymorphism,DNA Extraction-Organic and Inorganic extraction, Comparison of Extraction methods, Commercial kits,DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism.	12

DSE-9: Forensic Sciences Practical

PRACTICAL	Subject Code: BSMBP609DE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

On successful completion of the course, the student shall be able to:
CO.1- Interpret blood groups from blood stains
CO.2- Analyze the chemistry and properties of blood
CO.3- Practice serological techniques
CO.4- Demonstrate DNA isolation and electrophoresis
CO.5- Prepare case studies

S.no.	List of Experiments	Contact hours
1	Blood grouping from stains of blood	5
2	Characterization of Blood: Chemistry and properties,	5
3	Serological Techniques: Primary binding assays (ELISA, Immunochromatographic assays), Secondary binding assays(Precipitation based assays- Immunodiffusion , Agglutination based assays- Direct agglutination assay, Passive agglutination assay)	9
4	Isolation of DNA, Electrophoresis, PCR, DNA Finger printing	6
5	A case study	5

Recommended Books:

- An Introduction to Scientific and Investigative Technique, S.H James and J.J Nordby, Forensic Science:CRC Press, Boca Raton, 2nd Edition,2005.
- Fundamentals of Analytical Chemistry, D.A. Skoog, d. M. West and F.J. Holler, Saunders College Publishing, Fort Worth,6th Edition, 1992.
- The practical Methodology of Forensic Photography, D.R. Redsicker, CRC Press, Boca Raton, 2nd Edition, 2000.

DSE-10: Project Work

Semester –VI

THEORY	Subject Code: BSMBP610DE
Total Marks for Evaluation: 100	No. of Contact Hours: 90, Credits: 6

UNIT WISE DETAILS	COURSE OUTCOME	BLOOM'S LEVEL	CONTACT HOURS
Project Work	CO1:Analyse the importance of doing a hands-on research project. CO2: Outline how to review literature and finalize a topic of research. CO3:Illustrate the process of compiling a thesis. CO4: Summarize the importance of hands-on training in research and development.	Analysis Analysis Analysis Synthesis	90

GE-1: History and Scope of Microbiology

Semester –I

THEORY	Subject Code: BSMBT101GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to the history and scope of Microbiology. The module also gives insight to importance of Microbiology to the society.

Course Outcomes (COs)

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

CO.1 – Memorize the contributions of renowned microbiologists to the field of microbiology.
CO.2 – Classify the diverse micro-organisms based on their characteristic features.
CO.3 – Discuss the relevance of microbiology in the field of environmental management and human health.
CO.4 – Recognize the role of micro-organisms for large scale industrial productions.
CO.5 – Describe the importance of micro-organisms as a high protein food and its role in the food and dairy industry.

Unit	Topic/ Sub-Topic	Contact hours
1	History of Development of Microbiology Development of microbiology as a discipline,Spontaneous generation vs.biogenesis. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming,Role of microorganisms in fermentation,Germ theory of disease,Development of variousmicrobiological techniques and golden era of microbiology,Development of the field of soil microbiology : Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman. Waksman,Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff,Edward Jenner.	16
2	Diversity of Microorganisms, Systems of classification: Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya:Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa)giving definitions and citing examples.	10
3	Relevance of Microbiology to Human Health & Environment, Medical microbiology and immunology: List of important human diseases and their causative agents (Tuberculosis, Anthrax, Cholera, Typhoid, Diphtheria, Tetanus, Plague,Syphilis,Amoebic dysentery,Giardiasis; AIDS, Polio, Measles,Mumps, Ringworm) Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types.Environmental microbiology :Definitions and examples of important microbial interactions– mutualism, commensalism, parasitism, mycorrhizal and actinorrhizal relationships; Definitions and microorganisms used as biopesticides, in biodegradation, biodeterioration and bioremediation (e.g. hydrocarbons in oil spills)	14
4	Industrial Microbiology: Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing ethanol, antibiotics,(penicillin and streptomycin), enzymes (amylase and lipase) and organic acids (citric acid and acetic acid)	10

5	Food and Dairy Microbiology- A brief description on production and importance of Single Cell Protein and probiotics, microorganisms involved in producing fermented foods such as bread, cheese and curd	10

GE-1: History and Scope of Microbiology Practical

PRACTICAL	Subject Code: BSMBP101GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Practice Microbiology Laboratory Management and Biosafety

CO.2- Employ the different instruments in the laboratory

CO.3- Prepare culture media for bacterial cultivation

CO.4- Practice Sterilization of medium using Autoclave and assessment for sterility

CO.5- Demonstrate the presence of microflora in the environment by exposing nutrient agar plates to air

CO.6- Identify different shapes of bacteria using permanent slides

CO.7- Identify Rhizopus and Penicillium, Spirogyra and Chlamydomonas.

Unit	Topic/ Sub-Topic	Contact hours
1	Microbiology Laboratory Management and Biosafety.	4
2	To study the principle and applications of important instruments (biological safety cabinets,autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory	5
3	Preparation of culture media for bacterial cultivation	4
4	Sterilization of medium using Autoclave and assessment for sterility	4
5	Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air	5
6	Study of different shapes of bacteria using permanent slides	4
7	Study of Rhizopus and Penicillium using permanent mounts, Study of Spirogyra and Chlamydomonas using permanent Mounts	4

Recommended Books:

- Microbiology: An Introduction, Tortora GJ, Funke BR and Case CL, PearsonEducation, 9th edition, 2008.
- Microbiology, Pelczar, Micheal J. ETC, McGraw-Hill Inc. USA, 5th Edition.
- Microbiology, Lansing M Prescott, , The McGraw Hill Companies,7th Edition.
- Applied Dairy and Food Microbiology, Rameshwar Singh, Agrotech Publishing Academy.
- General Microbiology, Stainer, Roger, Mac Milan India Limited, 5th Edition.
- Industrial Microbiology, Casida, New age, INT, 2nd Edition.

GE-2: Applied Microbiology

Semester–I

THEORY	Subject Code: BSMBT102GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This module is a general introduction to water, air, soil and food microbiology, and its industrial and environmental applications.

Course Outcomes (COs)

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

CO.1 – Explain in detail the water microbiology and microbiological analysis of water.

CO.2 – Describe water pollution, the techniques used in water analysis and waste water treatments.

CO.3 – Explain Air and Soil microbiology in detail like microbial analysis of air, biopesticides, bio fertilizers, and microbial leaching of copper and uranium.

CO.4 – Explain in detail about Food microbiology, spoilage, pasteurization, preservation, as well as Food borne diseases and food intoxication.

Unit	Topic/ Sub Topic	Contact hours
1	Water microbiology Significance of bacteriological analysis of water, collection and handling of water samples,indicators of excretal pollution, bacteriological analysis of water for coliforms and faecal streptococci (MTFT, MFT), water treatment using SSF and RSF,methods of chlorination, differences between fecal and non fecal organisms	15
2	Waste water treatment Sewage types, composition, physical, chemical and biological characteristics, BOD, COD, ThOD, trickling filter, activated sludge, RBC, sludge digester, oxidation pond, septic tank, imhoff tank	15
3	Air and Soil microbiology Microbial analysis of air , settling plate and Anderson technique, bacteria and fungi as biopesticides, biofertilizers, PSB, mycorrhiza, microbial leaching of copper and uranium	15
4	Food microbiology Food spoilage organisms, canning process, pasteurization, low temperature preservation, chemical preservation Food borne diseases and food intoxication	15

GE-2: Applied Microbiology Practical

PRACTICAL	Subject Code: BSMBP102GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Calculate DO and BOD of water

CO.2- Demonstrate the presence of enzymes in soil
CO.3- Analyze the quality of water
CO.4- Demonstrate the presence of Rhizobium in root nodule
CO.5- Analyze the quality of milk
CO.6- Calculate the microorganisms in milk
CO.7- Identify microorganisms in air

S.no.	Topic/ Sub-Topic	Contact hours
1	Determination of DO, BOD of waste water sample.	4
2	Study the presence of microbial activity by detecting (qualitatively) enzymes (Amylase) in soil	5
3	Assessment of microbiological quality of water.	4
4	Isolation of Rhizobium from root nodule	4
5	Quality of milk by MBRT	5
6	Enumeration of micro-organisms in milk	4
7	Isolation of micro-organisms from air	4

Recommended Books:

- Microbial Biotechnology: Fundamentals of Applied Microbiology,Glaze A.N. and Nikaido H. W.H. Freeman and Company, 1st edition, 1995.
- Water Microbiology, Kulkarni NS, Aithal CS, 2016.

GE-3 Microbial Metabolism

Semester-II

THEORY	Subject Code: BSMBT203GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course will help students understand the different metabolism patterns of bacteria.

Course Outcomes (COs)

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

CO.1 – Describe the microbial growth and the effect of environment on microbial growth and nutrient uptake and transport

CO.2 – Discuss the concept of aerobic respiration and fermentation and sugar degradation pathways

CO.3 – Discuss anaerobic respiration and fermentation

CO.4 – Explain the chemolithotrophic and phototrophic metabolism

CO.5 – Discuss nitrogen metabolism

Unit	Topic/ Sub-Topic	Contact hours
1	Microbial Growth and Effect of Environment on Microbial Growth-Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate Temperature and temperature ranges of growth,pH and pH ranges of growth, Effect of solute and water activity on growth,Effect of oxygen concentration on growth, Nutritional categories of microorganisms. Nutrient uptake and Transport- Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation Iron uptake	12
2	Chemoheterotrophic Metabolism - Aerobic Respiration-Concept of aerobic respiration, anaerobic respiration and fermentation, Sugar degradation pathways i.e. ,Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors	12
3	Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation- Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction), Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways	12
4	Chemolithotrophic and Phototrophic Metabolism- Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation, (definition and reaction) and methanogenesis (definition and reaction), Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria	12
5	Nitrogen Metabolism - an overview, Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction	12

GE-3 Microbial Metabolism Practical

PRACTICAL	Subject Code: BSMBP203GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Analyze the growth of bacteria by different techniques
CO.2- Calculate the generation time and specific growth rate of bacteria
CO.3- Demonstrate the Effect of temperature on growth of E. coli
CO.4- Demonstrate the Effect of pH on growth of E. coli
CO.5- Demonstrate the Effect of Nitrogen and Carbon sources on E. coli
CO.6- Demonstrate the Effect of salt on growth of E. coli
CO.7- Demonstrate alcohol fermentation

S.No.	List of Experiments	Contact hours
1	Study and plot the growth curve of E. coli by tubidiometric and standard plate count methods.	5
2	Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data	5
3	Effect of temperature on growth of E. Coli	4
4	Effect of pH on growth of E. Coli	4
5	Effect of Nitrogen and Carbon sources on E. Coli	4
6	Effect of salt on growth of E. Coli	4
7	Demonstration of alcoholic fermentation	4

Recommended Books:

- Biology of Microorganisms, Madigan MT, and Martinko JM. Brock, PrenticeHall International Inc., 14th Edition, 2014.
- Microbial Physiology, Moat AG and Foster JW, John Wiley & Sons, 4th Edition, 2002.
- Microbial Physiology,Reddy SR and Reddy SM, Scientific Publishers India, 2005.
- Bacterial Metabolism, Gottschalk G, Springer Verlag, 2nd Edition 1986.
- General Microbiology, Stanier RY, Ingrahm JI, Wheelis ML and Painter PR., McMillan Press,5th Edition,1987.

GE-4: Industrial and Food and Dairy Microbiology

Semester –II

THEORY	Subject Code: BSMBT204GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course will help students understand the basics of Industrial, Food and Dairy Microbiology, its industrial techniques and application.

Course Outcomes (COs)

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

CO.1 – Define the fermentation process and types of fermenters

CO.2 – Describe methods of isolation of industrial strains and fermentation; preservation and maintenance of industrial strains and ingredients used in the fermentation medium

CO.3 – Discuss about the production of various industrial products like citric acid, ethanol and penicillin and enzymes - amylases, proteases, lipases and cellulases

CO.4 – Explain intrinsic and extrinsic parameters that affect microbial growth in food

CO.5 – Discuss dairy products, probiotics and food-borne diseases

Unit	Topic/ Sub-Topic	Contact hours
1	Introduction to Industrial microbiology-Brief history and developments in industrial microbiology. Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous. Types of fermenters – laboratory, pilot-scale and production fermenters	12
2	Isolation of Industrial Strains and Fermentation Medium-Primary and secondary screening,Preservation and maintenance of industrial strains, Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract	12
3	Downstream processing - filtration, centrifugation, cell disruption, solvent extraction.Microbial production of industrial products - citric acid, ethanol and penicillin.Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases	12
4	Food as a substrate for microbial growth Intrinsic and extrinsic parameters that affect microbial growth in food.Microbial spoilage of food - milk, egg, bread and canned foods. Physical methods - high temperature, low temperature, irradiation, aseptic packaging.Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite.Food sanitation and control – HACCP	12
5	Dairy products, probiotics and Food-borne Diseases-Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese,Probiotics definition, examples and benefits,Food intoxication by Clostridium botulinum and Staphylococcus aureus, Food infection by Salmonella and E.coli	12

GE-4: Industrial and Food and Dairy Microbiology Practical

PRACTICAL	Subject Code: BSMBP204GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1-Prepare wine
CO.2-Demonstrate the isolation of amylase enzymes from soil
CO.3-Illustrate microbial fermentation for the production and estimation of ethanol
CO.4- Analyze the quality of milk
CO.5-Demonstrate isolation of fungi from spoiled foods
CO.6-Prepare yogurt

S.No.	List of Experiments	Contact hours
1	Preparation of wine	5
2	Isolation of amylase producing enzymes from soil	5
3	Microbial fermentation for the production and estimation of ethanol	5
4	Determination of the microbiological quality of milk sample by MBRT	5
5	Isolation of fungi from spoilt bread/fruits/vegetables	5
6	Preparation of Yogurt/Dahi	5

Recommended Books:

- Applied Dairy and Food Microbiology, Rameshwar Singh Agrotech, Publishing Academy.
- Industrial Microbiology,Patel A.H., Macmillan India Limited, 1st Edition, 1996.
- Industrial Microbiology, Casida, New age, Int , 2nd Edition.
- Industrial Microbiology: An Introduction, Waites M.J., Morgan N.L., Rockey J.S. and Higton G., Wiley – Blackwell, 1st Edition, 2001.
- Food Microbiology,Frazier WC and Westhoff DC, Tata McGraw-Hill Publishing Company Ltd, New Delhi, India, 4th Edition, 2008
- Food Microbiology: An introduction,Montville, TJ and Matthews, KR,ASM Press, Washington DC USA, 2nd Edition, 2008.

GE:5 Genetic Engineering and Biotechnology

Semester - III

THEORY	Subject Code:BSMBT305GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course will give us a detailed understanding of the basics, methodologies and state-of- art techniques involved in designing genetically modified organisms.

Course Outcomes (COs)

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

CO.1 – Describe restriction modification systems, cloning, transformation of DNA, and various methods to isolate DNA, RNA and protein

CO.2 – Describe the properties of various cloning and expression vectors

CO.3 – Discuss about different methods for DNA amplification and sequencing

CO.4 – Explain various modes of gene delivery, gene therapy, recombinant vaccine and protein engineering

CO.5 – Discuss about IPR, patents, copyrights and trademarks

Unit	Topic/ Sub-Topic	Contact hours
1	Milestones in genetic engineering and biotechnology Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering, DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl, transferase, kinases and phosphatases, and DNA ligases, Cloning: Use of linkers and adaptors, Transformation of DNA: Chemical method, Electroporation, Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting	12
2	Cloning Vectors: Definition and Properties-Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs, Expression vectors: E.coli lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors,Baculovirus based vectors, mammalian SV40-based expression vectors	12
3	DNA Amplification and DNA sequencing- PCR: Basics of PCR, RT-PCR, Real-Time PCR, Genomic and cDNA libraries: Preparation and uses, Genome sequencing, Sanger's method of DNA Sequencing: traditional and automated sequencing	12
4	Application of Genetic Engineering and Biotechnology- Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral- mediated delivery, Agrobacterium - mediated delivery, Products of recombinant DNA technology: Products of human therapeutic interest - insulin, Hgh, antisense molecules. Bt transgenic - cotton, brinjal, flavo savo tomato, Gene therapy, recombinant vaccine, protein engineering	14
5	Intellectual Property Rights Patents, Copyrights, Trademarks	10

GE-5 Genetics Engineering and Biotechnology Practical

PRACTICAL	Subject Code: BSMBP305GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Demonstrate the isolation of plasmid DNA
CO.2- Demonstrate DNA digestion with restriction enzymes
CO.3- Demonstrate Ligation of DNA fragments
CO.4- Design primers
CO.5- Demonstrate DNA amplification

S.No.	List of Experiments	Contact hours
1	Isolation of Plasmid DNA from plant and bacteria	6
2	Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis	6
3	Ligation of DNA fragments	6
4	Designing of primers for DNA amplification	6
5	Amplification of DNA by PCR	6

Recommended Books:

- Gene cloning and DNA analysis, Brown TA, Blackwell publishing, oxford, UK.6th Edition 2010.
- Biotechnology: applying the genetic revolution,Clark DP and Pazdernik NJ, Elsevier academic press, USA, 2009.
- Principles of gene manipulation and genomics, Primrose SB and Twyman RM... Blackwell publishing, oxford, UK.7th Edition, 2006.
- Molecular cloning-A laboratory manual,Sambrook J and Russell D,Cold spring harbourlaboratoryPress, 3rd Edition, 2001.

GE-6 Immunology and Medical Microbiology

Semester- III

THEORY	Subject Code: BSMBT306GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course will enable students to understand the concepts of immune response generation, Immunodiagnosis and the basics of Medical Microbiology.

Course Outcomes (COs)

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

CO.1 – Describe cells and organs of the immune system

CO.2 – Discuss the characteristics of antigens, structure and functions of antibodies; primary and secondary immune response

CO.3 – Discuss various immunological disorders, types of autoimmunity, hypersensitivity and immunological techniques

CO.4 – Explain microflora of the human body and host-pathogen interaction

CO.5 – Discuss the Important bacteria, fungal, viral and protozoan diseases and their causative agents and mode of action of antibacterial agents

Unit	Topic/ Sub-Topic	Contact hours
1	Immune Cells and Organs-Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell,Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – BoneMarrow, Thymus, Lymph Node, Spleen	12
2	Antigens and Antibodies-Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T& B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies. Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response	12
3	Immunological Disorders and Tumor Immunity-Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models,(Nude and SCID mice).Immunological Techniques-Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA,ELISPOT.	12
4	Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract,Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Collection, transport and culturing of clinical samples and their identification characteristics.	12
5	Important bacteria, fungal, viral and protozoan diseases and their causative agents. Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis;Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis;Inhibitor of metabolism,Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin,Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine	12

GE-6 Immunology and Medical Microbiology Practical

PRACTICAL	Subject Code: BSMBP306GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Perform IMViC tests
CO.2- Perform IMViC tests
CO.3- Identify bacteria by IMViC tests
CO.4- Analyze antibacterial sensitivity tests
CO.5- Identify blood groups
CO.6- Identify Total Leukocyte Count of the given blood sample.
CO.7- Demonstrate serum separation
CO.8- Illustrate immunodiffusion by Ouchterlony method

S.No.	List of Experiments	Contact hours
1	IMViC	4
2	important differential media for identification of bacteria: EMB,Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS	4
3	Study of bacterial flora of skin by swab method	4
4	Perform antibacterial sensitivity by Kirby-Bauer method	4
5	Identification of human blood groups.	3
6	To perform Total Leukocyte Count of the given blood sample.	4
7	To separate serum from the blood sample (demonstration)	3
8	To perform immunodiffusion by Ouchterlony method.	4

Recommended Books:

- Textbook of Microbiology, Ananthanarayan R. and Paniker C.K.J., UniversityPress Publication, 8th Edition, 2009.
- Jawetz, Melnick and Adelberg's Medical Microbiology, Lange Medical Books,26th Edition.
- Mims Medical Microbiology, Goering R., Dockrell H., Zuckerman M. and Wakelin D,Elsevier, 4th Edition,2007
- Prescott, Harley and Klein's Microbiology, Willey JM, Sherwood LM, and Woolverton CJ., McGraw Hill Higher Education, 9th Edition, 2013.
- Cellular and Molecular Immunology, Abbas AK, Lichtman AH, Pillai S., Saunders Publication, Philadelphia, 6th Edition,2007.
- Roitt's Essential Immunology, Delves P, Martin S, Burton D, Roitt IM., Wiley- Blackwell Scientific Publication, Oxford,11th Edition, 2006.
- Kuby's Immunology, Goldsby RA, Kindt TJ, Osborne BA.,W.H. Freeman and Company, New York, 6th Edition, 2007.
- Immunology,Richard C and Geiffrey S, Wiley Blackwell Publication, 6th Edition, 2009.

GE-7: Biophysics

Semester –IV

THEORY	Subject Code: BSMBT407GE
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course will introduce to the students the basics of physics that drive the mechanics of life.

Course Outcomes (COs)

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

CO.1 – Describe the conservation of energy in living systems, entropy, Gibbs and standard free energy, equilibrium constant, coupled reactions

CO.2 – Explain protein folding and pathways, prediction of protein structures and oxygen binding mechanism

CO.3 – Discuss diffusion, laws of diffusion, active transport, facilitated diffusion, osmosis, osmotic pressure and osmoregulation

CO.4 – Discuss about X-ray diffraction, light and neutron scattering, nuclear magnetic resonance, fluorescence, DNA microarrays

CO.5 – Explain pattern formation and diffusion

Unit	Topic/ Sub-Topic	Contact hours
1	Thermodynamics of living systems: Conservation of energy in living systems, Entropy and Life, Gibbs and Standard free energy, Equilibrium constant, Coupled reactions.	12
2	Co-operative transitions -Protein folding: Forces for protein stability, Protein denaturation and renaturation, Protein folding pathways, Levinthal's paradox, Molten globule, Folding accessory proteins, Prediction of protein structures, Protein Function: Structure of heme, Structure of Myoglobin and hemoglobin, Oxygen binding mechanism, Oxygen binding co-operativity, Hill equation, Hill coefficient, Allostery in hemoglobin, Bohr effect. Unzipping of DNA	12
3	Dynamics of biomolecules: Diffusion, Laws of diffusion, Active transport, Facilitated diffusion, Osmosis, Osmotic pressure, Osmoregulation, Viscosity and biological importance, Surface tension, Factors influencing surface tension, Biological importance.	12
4	Physical Techniques and related biology-X-ray diffraction, light and neutron scattering, Nuclear magnetic Resonance, Fluorescence', DNA Microarrays, Manipulation of bio-molecules using optical tweezers. Tomography, Patch clamps.	12
5	Pattern formation and diffusion- How nonlinear partial differential equations produce patterns-Cheetah stripes on the tail and and spots on the body. Instability patterns.	12

GE-7: Biophysics Practical

PRACTICAL	Subject Code: BSMBP407GE
Total Marks for Evaluation: 50	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Apply the concepts of microscopy to view samples
CO.2- Estimate the percent purities of dyes and inorganic compounds.
CO.3- Describe the characteristics of UV absorption spectra of Aromatic Amino Acids or nucleic acids or proteins
CO.4- Analyze of Oil-Iodine number, saponification number
CO.5- Estimate the DNA molecules
CO.6- Estimate the protein by Biuret assay and Folin's-Lowry method.
CO.7- Demonstrate Chemo taxis
CO.8- Interpret growth curves and generation time

S.No.	List of Experiments	Contact hours
1	To familarize with bright field, phase contrast, fluorescence & polarizing Microscopes.	4
2	To estimate the percent purities of dyes and inorganic compounds.	3
3	To study the characteristics of UV absorption spectra of Aromatic Amino Acids or nucliec acids or proteins	4
4	To analyze of Oil-Iodine number, saponification number	3
5	To estimate the DNA molecules.	4
6	To estimate proteins by Biuret assay and Folin's-Lowry method.	4
7	Demonstration of Chemo taxis.	4
8	To establish the cell growth curve & determination of generation time.	4

Recommended Books:

- Biochemistry, Voet and Voet.
- Biological Thermodynamics, Donald T. Haynie.
- Introductory Biophysics, J. R. Claycomb and J.Q.P. Tran.
- Molecular and Cellular Biophysics, Meyer B., Jackson.S.

GE-8 Bioinformatics

Semester-IV

THEORY	Subject Code: BSMBT408GE
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objectives: This module will enable students to understand the basics of Bioinformatics and its application and also teach them about the available software for data analysis.

Course Outcomes (COs)

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

CO.1- Define the basic concepts and applications of bioinformatics

CO.2- Describe the different databases available for analysis of biological data

CO.3- Practice sequence alignment with different bioinformatics tools

CO.4- Analyze phylogenetic data with bioinformatics tools

CO.5- Practice protein structure prediction by employing bioinformatics tools

Unit	Topic/Sub-Topic	Contact hours
I.	Bioinformatics: Definition, history of bioinformatics, Basic terminology used, Applications of Bioinformatics, introduction to NCBI, basic tools of NCBI, database searching and database retrieving from NCBI, Human Genome project.	12
2	Biological Data bases: Definition, types of database, overview of primary and secondary database, Nucleic acid sequence , data bases (NCBI, EMBL and DDJB), Protein sequence data base-SWISS-PORT, database searching: BLAST and FASTA.	12
3	Sequence alignment: Local and global Alignments, pair wise alignment, substitution scoring and gap penalties, Statistical significance of alignment, multiple sequences alignment: progressive alignment methods, motife and patterns,	12
4	Phylogenetic analysis : Element of phylogenetic model, data analysis, tree building and tree evaluation, building methods, searching for a tree, phylogenetic software, CLUSTAL, PHYLIP & UPGMA. Gene finding and gene scan.	12
5	Protein structure prediction : Physical properties, secondary structure, alpha & beta structure, motifs, tertiary structures, specialized structure and function, protein conformation and visualization tool-RASMOL, role of bioinformatics in drug discovery, docking and prediction of drug quality.	12

GE-8 Bioinformatics Practical

PRACTICAL	Subject Code: BSMBT408GE
Total Marks for Evaluation:100	No. of Contact Hours: 30, Credits: 2

Course Outcomes (COs)

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

CO.1- Practice with the different organism specific databases

CO.2- Employ molecular databases for analysis

CO.3- Employ marker databases

CO.4- Employ genome maps and tools

CO.5- Demonstrate search with different literature data bases

S.No.	List of Experiments	Contact hours
I.	Organism specific databases, BLAST, FASTA, Phylip, Pymol, Prosite.	6
2	Moleculardatabases (sequence databases - nucleotides, proteins, structures, genes, expression, taxonomy	6
3	Marker databases – dbSNP, dbSTS, dbEST, Unigene	6
4	genomes and maps, tools (Entrez, BLAST, nucleotide sequence analysis, protein sequence analysis, 3-D structure display and similarity searching	6
5	Literature Databases (PubMed, PubMedCentral, OMIM, Books, Citation Matcher), research at NCBI, education, FTP site	6

Recommended Books:

- Introduction to Bioinformation, T.Attawood.
- Bioinformatics – Managing Scientific Data, Zoe' Lacroix and Terence Critchlow.
- Bioinformatics – Sequence, Structure and Databanks, Des Higgins & Willie Taylor.
- Structural Bioinformatics, Philip E. Bourne, Helge Weissig, 2003.

SC-1 Biofertilizers and Biopesticides

Semester-III

THEORY	Subject Code: BSMBT301SC
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course objective: This course will enhance the skills of students by teaching them the basics and application of Biopesticides and biofertilizers.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1 – Apply the knowledge of isolation, characterization and production of symbiotic nitrogen fixers to enhance the crop production directly in the field
CO.2 – Apply the knowledge of isolation, characterization and production of non-symbiotic nitrogen fixers to enhance the crop production directly in the field
CO.3 – Apply the knowledge of isolation, characterization and production of phosphate solubilizers to enhance the crop yield directly in the field
CO.4 – Demonstrate the application of mycorrhizal biofertilizers to enhance the crop production directly in the field
CO.5 – Demonstrate the application of bioinsecticides to enhance the crop production directly in the field

Unit	Topic/Sub-Topic	Contact hours
I.	Biofertilizers-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, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, Azolla - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.	12
2	Non - Symbiotic Nitrogen Fixers-Free living Azospirillum, Azotobacter - free isolation, characteristics, mass inoculums, production and field application	12
3	Phosphate Solubilizers-Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application	12
4	Mycorrhizal Biofertilizers-Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.	12
5	Bioinsecticides-General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, Bacillus thuringiensis, production, Field applications, Viruses – cultivation and field applications.	12

Recommended Books:

- Biotechnology of Bio fertilizers,Kannaiyan, S., CHIPS, Texas, 2003.
- Hand book of Microbial biofertilizers, Mahendra K. Rai, The Haworth Press, Inc. New York,2005.
- Bioinoculants for sustainable agriculture and forestry,Reddy, S.M. et. al., Scientific Publishers,2002.
- Soil microorganisms and plant growth, Subba Rao N.S, Oxford and IBH publishing co. Pvt. Ltd. New Delhi, 1995.
- Development of Bioinsecticide,Saleem F and Shakoori AR, Lap Lambert Academic Publishing GmbH KG, 2012.

- Advanced Environmental Biotechnology,Aggarwal SK, APH publication, 2005.

SC-2 Food Fermentation Techniques

Semester - III

THEORY	Subject Code: BSMBT302SC
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course objective: This module will teach the students the applications of Fermented Food Microbiology.

Course Outcomes (COs)

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

CO.1 – Define fermented foods and their health benefits

CO.2 – Prepare milk based fermented foods

CO.3 – Demonstrate the production of grain based fermented foods

CO.4 – Prepare vegetable based fermented foods

CO.5 – Define probiotics and its health benefits

Unit	Topic/Sub-Topic	Contact hours
1	Fermented Foods-Definition, types, advantages and health benefits	12
2	Milk Based Fermented Foods-Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process	12
3	Grain Based Fermented Foods-Soy sauce, Bread, Idli and Dosa: Microorganisms and production process	12
4	Vegetable Based Fermented Foods-Pickels, Saeurkraut: Microorganisms and production process	14
5	Probiotic Foods-Definition, types, microorganisms and health benefits	10

Recommended Books:

- Handbook of food and fermentation technology, Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS, CRC Press, 2004.
- Advances in Fermented Foods and Beverages, Holzapfel W, Woodhead Publishing, 2014.
- A comprehensive dairy microbiology, Yadav JS, Grover, S and Batish VK, Metropolitan, 1993.
- Modern Food Microbiology,Jay JM, Loessner MJ, Golden DA, Springer, 7th Edition, 2005.

SC-3 Microbial Diagnosis in Healthcare

Semester - IV

THEORY	Subject Code: BSMBT403SC
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course will enhance the knowledge and skills of students in understanding the role of Microbiology in healthcare.

Course Outcomes (COs)

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

CO.1 – Explain the importance disease diagnosis and the relevance of clinical samples in diagnosis

CO.2 – Demonstrate the collection and transport of clinical samples

CO.3 – Demonstrate the skills of microscopic identification and culture of clinical samples

CO.4 – Apply the basic serological and molecular tools for disease diagnosis

CO.5 – Employ rapid diagnostic kits for detection of pathogens

Unit	Topic/Sub-Topic	Contact hours
I.	Importance of Diagnosis of Diseases-Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis	12
2	Collection of Clinical Samples-How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.	12
3	Direct Microscopic Examination and Culture-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.	12
4	Serological and Molecular Methods-Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes	12
5	Kits for Rapid Detection of Pathogens-Typhoid, Dengue and HIV, Swine flu Testing for Antibiotic Sensitivity in Bacteria-Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method,Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution Method	12

Recommended Books:

- Textbook of Microbiology, Ananthanarayan R and Paniker CKJ, UniversitiesPress Private Ltd.,8th Edition, 2009.
- Jawetz, Melnick andAdelberg's Medical Microbiology, Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A., McGraw Hill Publication 26th Edition, 2013
- Practicals and Viva in Medical Microbiology, Randhawa, VS, Mehta G and Sharma KB Elsevier India Pvt Ltd, 2nd edition, 2009.
- Bailey's and Scott's Diagnostic Microbiology,Tille P, Elsevier, 13th Edition, 2013.
- Mackie and McCartney Practical MedicalMicrobiology, Collee JG, Fraser, AG, Marmion, BP, Simmons A, , Elsevier, 14th Edition, 2007.

SC-4 Microbial Quality Control in Food and Pharmaceutical Industries

Semester- IV

THEORY	Subject Code: BSMBT404SC
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course objective: This course will enhance the skill of students and help in analysing the quality of Food and Pharmaceuticals.

Course Outcomes (COs)

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

CO.1 – Employ safe and good laboratory practices while working in the laboratories

CO.2 – Demonstrate the microbiological analysis of food/pharmaceutical samples

CO.3 – Demonstrate the methods for the culture and detection of pathogenic microorganisms in food

CO.4 – Summarize safety and microbiological standards for food and drinking water

Unit	Topic/Sub-Topic	Contact hours
I.	Microbiological Laboratory and Safe 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	15
2	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, Molecular methods - Nucleic acid probes, PCR based detection, biosensors.	15
3	Pathogenic Microorganisms of Importance in Food & Water-Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, MacConkey Agar, Saboraud Agar, Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)	15
4	HACCP for Food Safety and 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	15

Recommended Books:

- Laboratory Methods in Food Microbiology, Harrigan WF, Academic Press, 3rd Edition, 1998.
- Laboratory Manual of Food Microbiology I, Garg N, Garg KL and Mukerji KG, International Publishing House Pvt. Ltd.2010.
- Modern Food Microbiology Jay JM, Loessner MJ, Golden DA, Springer, 7th Edition, 2005.
- Handbook of Microbiological Quality control inPharmaceutical and Medical Devices, Baird RM, Hodges NA and Denyer SP, Taylor and Francis Inc.2005

SC-5 Microbiological Analysis of Air and Water

Semester - IV

THEORY	Subject Code: BSMBT405SC
Total Marks for Evaluation:100	No. of Contact Hours: 60, Credits: 4

Course Objective: This course is designed to help develop the skill of students in the Microbiological analysis of air and water.

Course Outcomes (COs)

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

CO.1 – Practice air sampling and its analysis

CO.2 – Apply control measures to inactivate harmful substances in bio aerosols

CO.3 – Discuss waterborne pathogens and the infection caused by them

CO.4 – Demonstrate the microbiological analysis of water

CO.5 – Apply measures for treatment or control of contamination in water

Unit	Topic/Sub-Topic	Contact hours
I.	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. Air Sample Collection and Analysis-Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics	12
2	Control Measures- Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration	12
3	Water Microbiology Water borne pathogens, water borne diseases	12
4	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	12
5	Control Measures-Precipitation, chemical disinfection, filtration, high temperature, UV light	12

Recommended Books:

- Microbiological Examination Methods of Food and WaterA Laboratory Manual, da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR, CRC Press, 2012.
- Microbial Ecology: Fundamentals & Applications,Atlas RM and Bartha R., Benjamin/Cummings Science Publishing, USA, 4th Edition, 2000.
- Environmental Microbiology, Maier RM, Pepper IL and Gerba CP.,Academic Press 2nd Edition, 2009.
- Manual of EnvironmentalMicrobiology, Hurst CJ, Crawford RL, Garland JL, Lipson DA , ASM press, 3rd Edition 2007.

AC-1: English

Semester –I/II

THEORY	Subject Code: BSMBT101AC/BSMBT201AC
Total Marks for Evaluation:50	No. of Contact Hours: 60, Credits: 4

Course Objective: To enable the students of management to speak and write with a fair degree of grammatical correctness.

Course Outcomes (COs)
On successful completion of the course, the student shall be able to:
CO.1- Apply tenses during their communication and writing
CO.2- Apply clauses for better communication
CO.3- Apply structural items to sentences
CO.4- Apply knowledge of reported speech for better communication skills
CO.5- Demonstrate writing kills in English

Unit	Topic/Sub-Topic	Contact hours
I.	Tense: Simple Present, Progressive and Present Perfect, Simple Past, Progressive and Past Perfect, Indication of Futurity. Modals: will, shall, should, would, ought to, and others, Verb Structures: Infinitives, Gerund and Participles. Linking Devices, Parts of speech.	12
2	Clauses: Co-ordinate Clause- with, but, either-or, neither-nor, otherwise, or else, Subordinate Clauses: Noun Clause- as subject, object and complement, Relative Clause: Restrictive and Non-Restrictive, Adverb Clauses: open a hypothetical conditionals, ((with because, though where, so that, as long as, as soon as) Comparative Clauses.	12
3	Structural Items: Simple, Compound and Complex Sentence.	12
4	Reported Speech: Declarative Sentences, Imperative Sentences, Interrogatives (wh-questions, yes/no questions, Exclamatory Sentences. Voice: Transformation of Sentences from Active to Passive and visa-versa.	12
5	Composition: Paragraph Writing, Essay and Letter Writing	12

Recommended Books:

- English Grammar in Use, R. Murphy, Cambridge University Publication, 4th Edition, 2012.
- English Made Easy, Chetan Anand Singh, BSC Publishers & Distributors,2nd Edition Reprint 2018.

AC-2: Environmental Sciences

Semester –I/II

THEORY	Subject Code: BSMBT102AC/BSMBT202AC
Total Marks for Evaluation:50	No. of Contact Hours: 60, Credits: 4

Course Objective: This module will inform the students about the facts of the Environment, its importance and about its protection.

Course Outcomes (COs)

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

CO.1 – Describe natural resources, food resources, land resources and energy resources

CO.2 – Classify various biodiversity and its conservation

CO.3 – Explain different types of pollution, their causes, effects and control measures

CO.4 – Discuss environmental issues, pollution, ethics, water conservation and global warming

Unit	Topic/Sub-Topic	Contact hours
I.	Natural Resources: Renewable and Non-renewable Resources Forest, Water and Mineral resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and their effects on forests and tribal people and relevant forest Act. Use and over-utilization of surface and ground water, floods drought, conflicts over water, dams benefits and problems and relevant Act. Use and exploitation, environmental effects of extracting and using mineral resources. Food resources and energy resources food, Energy and Land resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging , salinity. Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land as a resource, land degradation, man induced landslides soil erosion and desertification.	15
2	Biodiversity and its Conservation Introduction - Definition: genetic. species and ecosystem diversity, Bio-geographical classification of India, Value of biodiversity: Consumptive use. productive use, social ethics, aesthetic and option values, Biodiversity at global, National and local levels, India as mega-diversity nation, Hot spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wild life, conflict,dangered and endemic species of India, Conservation of biodiversity: In situ and Ex-situ conservation of biodiversity.	15
3	Causes, effect and control measures of Air water, soil, marine, noise, nuclear pollution and Human population, Solid waste management: Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Disaster Management: floods, earthquake, cyclone and landslides.	15
4	Social issues an environment: From Unsustainable to Sustainable development • Urban problems related to energy • Water conservation, rain water harvesting, watershed management • Environmental ethics : Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. • Wasteland reclamation.,• Consumerism and waste products.,• Environment Protection Act. • Air (Prevention and Control of Pollution) Act.,• Water (Prevention and control of Pollution) Act,• Wildlife Protection Act.• Forest Conservation Act,• Issues involved in enforcement of environmental legislation.,• Public awareness	15

Recommended Books:

- Textbook of environmental studies, Erach Bharucha, University Press.

ECC-1: Seminar

Name of the Programme/Semester: B.Sc. Hons (MB) /Sem –III, IV, V, VI	**Branch : Microbiology**
Name of the Subject: Seminar	**Subject Code:** BSMBTSE01EC

UNIT WISE DETAILS	COURSE OUTCOME	BLOOM'S LEVEL
Seminar	CO1:Practice scientific readings & presentation skills. CO2: Outline how to make a poster for seminar and conferences. CO3: Practice persuasive speech, present information in a compelling, well-structured, and logical sequence. CO4: Express oral and written communication skills.	Application Level Analysis Level Application Level Comprehension Level

ECC-2: MOOC

Name of the Programme/Semester: B.Sc. Hons (MB) /Sem –IV, V, VI	**Branch : Microbiology**
Name of the Subject: MOOC	**Subject Code:** BSMBMO01EC

UNIT WISE DETAILS	COURSE OUTCOME	BLOOM'S LEVEL
MOOC (SWAYAM)	CO 1: Demonstrate the ability to strictly follow the course information.	Application
	CO2: Develop participation and engagement by creating learner-centred communities using group projects.	Synthesis
	CO3: Solve the weekly assignments and assessments given based on critical thinking.	Application
	CO4: Develop time management, intrinsic motivation and commitment to the course.	Synthesis
	CO5: Develop self-directed learning environment and enhancement of computer and language.	Synthesis

ECC-3: Summer Internship

Name of the Programme/Semester: B.Sc. Hons (MB) /Sem –IV, V, VI	**Branch : Microbiology**
Name of the Subject: Summer Internship	**Subject Code:** BSMBSI401EC

UNIT WISE DETAILS	COURSE OUTCOME	BLOOM'S LEVEL
Summer Internship	CO1:Practice the latest techniques in research and development laboratories.	Application
	CO2: Apply the working principles of basic and high throughput instruments.	Application
	CO3:Practice persuasive speech, present information in a compelling, well-structured, and logical sequence.	Application
	CO4: Demonstrate hands on practical skills.	Application