R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Bachelor of Science (B.Sc.) Program
In Microbiology

F.Y.B.Sc. [Semester - I & II]

Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Name of Program	**B.Sc. [Microbiology]**
Level	UG
No of Semesters	06
Year of Implementation	**2023-24**
Program Specific Outcomes (PSO)	1] Learner shall know the various branches of Microbiology. 2] Learner shall know the role of microorganism in day to day life. 3] Learner shall able to Understand and identify the various Microorganisms. 4] Learner shall able to isolate and propagate various microorganisms. 5] Learner shall able to control microbial growth. 6] Learner shall know the fermentation of various fermented food products and industrial products by using microorganisms. 7] Learner should know the importance of microorganisms in infectious diseases.
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	Microorganism's role in nature is indispensable. They involved in biodegradation, Fermentation, Antibiotic production, etc. Likewise some are involved in disease generation too. Therefore the understanding of microorganisms becomes essential to propagate or to control its number. As microorganism is responsible for food spoilage, food borne diseases so the maintenance of quality standard high is important from local level to global level. With respect to this learner should know the branches of microbiology. As microorganisms are ubiquitous so learner should know the role of microorganism in day to day life. There are millions of different microbes present on earth so identification of those microbes is globally important. In addition to that such identification skills have great importance in an infectious diseases control. Industrial fermentation processes requires pure culture of microbes so the knowledge of isolation of pure culture and its propagation is essential. Contamination by unwanted microbes is a worldwide problem. Learners must know the methods of microbial growth control. The various decontamination methods is not only locally important but also it is globally essential. In a sterilized/controlled conditions only a good quality fermented food product can be prepared by specific microorganisms. Therefore learners should know skill and knowledge of such fermentation processes. Summarizing, graduates of B.Sc. Microbiology program will be informed citizens who can understand and apply basic microbiological technique at local to global level. It will be able to pursue wide range of careers including biological and life science research in higher educational institutions as well as careers in public health, clinical research, food, pharmaceutical and biotechnological industries.

B.Sc. Program

Under Choice Based Credit System (CBCS), Course Structure (Autonomous)

Department of Microbiology

(To be implemented from Academic Year-2023-24)

No. of Courses	Semester I	Credits	No. of Courses	Semester II	Credits
	Discipline Specific Course (DSC)			***Discipline Specific Course (DSC)***	
	Major			***Major***	
USMB101	Fundamentals Of Microbiology	**02**	USMB201	Basics of Microbiology	**02**
USMB102	Basic Techniques In Microbiology	**02**	USMB202	Exploring Microbiology	**02**
USMBP103	Microbiology Practical	**02**	USMBP203	Microbiology Practical	**02**
	Minor			***Minor***	
USCH101	Physical and Inorganic chemistry I	**02**	USCICH201	Physical and Inorganic chemistry II	**02**
USCH102	Organic and Inorganic Chemistry I	**02**	USCICH202	Organic and Inorganic Chemistry II	**02**
			USCICH203	Chemistry Practical II	**02**
	Generic / Open Elective			***Generic / Open Elective***	
USOE1	Google Workspace and Multimedia applications	**02**	USOE2	Introduction to Food Biotechnology	**02**
	Indian Knowledge System(IKS)				
USIKS	History of science and Technology in India	**02**			**---**
	Vocational Skill Course (VSC)			***Vocational Skill Course (VSC)***	
USCH104	Laboratory skills in Chemical science	**02**			**---**
	Skill Enhancement Course (SEC)			***Skill Enhancement Course (SEC)***	
		----	USCH204	Introduction to Separation Techniques	**02**
	Ability Enhancement Course (AEC)			***Ability Enhancement Course (AEC)***	
USAEC1	Communication Skills I	**02**	USAEC2	Communication Skills II	**02**
	Value Education Course (VEC)			***Value Education Course (VEC)***	
USVEC1	Environmental Studies - I	**02**	USVEC2	Environmental Studies - II	**02**
	Co-Curricular			***Co-Curricular***	
USCC1	Anyone course from the Table 2 given below	**02**	USCC2	Anyone course from the Table 2 given below	**02**
Total Credits		**22**	**Total Credits**		**22**

Table 2. Co curricular Activities

10. Co-Curricular (Any One)		*10. Co-Curricular (Any One)*	
1	*National Social Service (NSS)*	*1*	*National Social Service (NSS)*
2	*National Cadet Corps (NCC)*	*2*	*National Cadet Corps (NCC)*
3	*Sports*	*3*	*Sports*
4	*Cultural*	*4*	*Cultural*
5	*Yoga*	*5*	*Yoga*
6	*Life Long Learning*	*6*	*Life Long Learning*
7	*Shodhavedh / Avishkar*	*7*	*Shodhavedh*
8	*Publications*	*8*	*Publications*
9.	*Marathi Vidnyan Parishad*	*9.*	*Marathi VidnyanParishad*
10.	*Nature Club*	*10.*	*Nature Club*
11.	*Science Association*	*11.*	*Science Association*
12.	*Astronomy Club*	*12.*	*Astronomy Club*

Syllabus for F. Y. B. Sc. Microbiology Semester I

From the year 2023-24

Name of the Course	Fundamentals Of Microbiology
Course Code	USMB101
Class	F. Y. B. Sc.
Semester	I
No of Credits	02
Nature	Theory
Type	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Restructuring of syllabus has been done to ensure a smooth and logical flow of content throughout the curriculum. It also facilitates the logical progression of subjects which allows learners to build their understanding of subject progressively and systematically and to grasp contents more effectively. Microbiology related careers are found in a diverse range of employment sectors such as; healthcare organizations, environmental organizations, industry – food and drink, pharmaceuticals, toiletries, water and biotechnology companies, forensic science laboratories, publicly funded research organizations, higher education institutions etc.

Nomenclature: Fundamentals of Microbiology

Course Outcomes:

- The learner will understand the history and opportunities in microbiology.
- The learner will know the contribution of scientists in the field of microbiology.
- At the end of the course students will be able to understand the concept of prokaryotic and eukaryotic cell and know the structural features of the bacterial and human cell.
- The learner will come across with the knowledge related to laboratory safety techniques.
- The learner shall understand the structures of different biomolecules present in living system.

Curriculum:

USMB101 - Fundamentals Of Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	**History, Introduction& Scope Of Microbiology**	**1.1** a. Discovery of microorganisms b. Conflict over spontaneous generation c. Golden Age Of Microbiology-Koch Postulate, Medical Microbiology, Immunology **1.2 Prokaryotic Cell Structure and functions:** a. Cell wall b. Cell membrane c. Components external to cell wall-Capsule, Slime layer, Flagella, Pili, Fimbriae d. Cytoplasmic matrix-Inclusion bodies, magnetosomes, ribosomes, gas vesicles e. Nucleoid, Plasmids f. Bacterial endospores and their formation	**10**
2	**Eukaryotic Cell Structure**	**2.1** a.Overview of Eukaryotic cell structure b.The plasma membrane and membrane Structure c.Cytoplasmic matrix, microfilaments, intermediate filaments, and microtubules d.Organelles of the Biosynthetic-secretory and endocytic pathways –Endoplasmic reticulum & Golgi apparatus. Definitions of Lysosome, Endocytosis, Phagocytosis, Autophagy, Proteasome e.Eukaryotic ribosomes f.Mitochondria g.Chloroplasts h.Nucleus –Nuclear Structure i.External Cell Coverings: Cilia And Flagella j.Comparison Of Prokaryotic And Eukaryotic Cells **2.2Biosafety In Microbiology:** a. Means of laboratory infection b. Potentially hazardous procedures c. Safety equipments d. Immunization and medical records e. Levels of Containment	**10**

3	**Macromolecules**	**3.1Chemical foundations**: a. Biomolecules as compounds of carbon with a variety of functional groups. b. Universal set of small molecules. c. Macromolecules as the major constituents of cells. d. Configuration and Conformation with definitions and suitable examples only. e. Types of Stereoisomers and importance of stereoisomerism in biology. f. Types of bonds and their importance: Electrovalence, covalent, ester, phosphodiester, thioester, peptide, glycosidic **3.2 Water- Structure, properties in brief.** **3.3Carbohydrates**: Definition, Classification, Biological role. Monosaccharides, oligosaccharides (maltose, cellobiose, lactose) and polysaccharide (starch, peptidoglycan) **3.4 Lipids:** Fatty acids as basic component of lipids and their classification, nomenclature, storage lipids and structural lipids. **3.5 Amino acids& proteins:** General structure and features of amino acids (emphasis on amphoteric nature)Classification by R-group Peptides and proteins- Definition and general features and examples with biological role. Primary, secondary, tertiary, quaternary structures of proteins- Brief outline. **3.6 Nucleic acids**: Nitrogenous bases- Purines , Pyrimidines Pentoses-Ribose, Deoxyribose, Nomenclature of Nucleosides and nucleotides, N-β-glycosidic bond, polynucleotide chain to show bonding between nucleotides (Phosphodiester bonds). Basic structure of RNA and DNA.	**10**

Learning Resources recommended:

1. Prescott, Hurley, Klein-Microbiology, 7thedition, International edition, McGraw Hill.
2. Kathleen Park Talaro& Arthur Talaro - Foundations in Microbiology International edition 2002,| McGraw Hill.

3. Michael T.Madigan & J.M.Martin, Brock, Biology of Microorganisms 12th Ed. International edition 2006, Pearson Prentice Hall.
4. A.J.Salle,Fundamental Principles of Bacteriology.
5. Stanier.Ingraham et al, General Microbiology 4th & 5th Ed. 1987, Macmillan Education Ltd
6. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan, Noel R. Krieg
7. BIS: 12035.1986: Code of Safety in Microbiological Laboratories

Evaluation Pattern

A. Continuous evaluation [40 Marks]

Method	Marks
Class Test: Unit Test (MCQ / Descriptive – Based on Theory - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each / 3 unit tests of 10 marks each and best two out of three will be considered)	20
Assignment	10
Attendance& Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern) [60 Marks – 2Hours]

Question No	Unit	Marks
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Guidelines for paper pattern for Semester End Evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, short notes, diagrammatically explain, Justify, brief descriptions etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, define, true or false, etc., type of questions will not contain internal options.

Name of the Course	Basic Techniques In Microbiology
Course Code	USMB102
Class	F.Y.B.Sc.
Semester	I
No of Credits	02
Nature	Theory
Type	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	As part of the curriculum, we explored first year undergraduate students' understanding of some basic concepts in biology—types of cells and their forms, growth and control of microorganisms, etc. The course will help the student for basic research and industrial applications the he learned in the theory. Indeed, the study of bacterial growth has long been considered an essential foundational concept in microbiology, one that all learners will become sharp both in theory and practice. The insights into alternative conceptions held by students may also be useful for building tools such as concept inventories.

Nomenclature: Basic Techniques in Microbiology

Course Outcomes:

- The learner will acquire the knowledge and importance of microscopy and its use its field of microbiology and will understand the staining techniques.
- The student shall understand the requirement of nutrients for the growth of microorganisms.
- At the end of the course students will be able to define the use of disinfectants and different sterilization techniques in control of microorganisms.

Curriculum:

USMB102 - Basic Techniques in Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	**Microscopy & Staining**	**1.1 Microscopy:** History of microscopy, Optical spectrum, Lenses and mirrors: Simple and compound light microscope, Dark field Microscopy, Phase contrast **1.2 Staining procedures** a. Dyes and stains: Types, Physicochemical basis Fixatives, Mordants, Decolorizers b. Simple and differential staining (Monochrome staining & Gram staining) c. Special staining (Cell wall, Lipid granules & Flagella)	**10**
2	**Control Of Microorganisms**	**2.1 Definition** of frequently used terms & Rate of microbial death, Factors affecting the effectiveness of antimicrobial agents & Properties of an ideal disinfectant **2.2 Evaluation of disinfectant** –Phenol coefficient **2.3 Physical methods of microbial control** a. Dry & moist heat – mechanisms, instruments used and their operations b. Electromagnetic radiations – Ionizing radiations, mechanisms –advantages & disadvantages c. Bacteria proof filters d. Osmotic pressure e. Desiccation **2.4 Chemical methods of microbial control -** mechanism & advantages & disadvantages (if any) applications. a. Phenolics b. Alcohols c. Halogens d. Quaternary ammonium compounds e. Dyes f. Surfaces active agents/Detergents g. Sterilizing gases **2.5 Chemotherapeutic agents -** List types of agents active against various groups & mention the site of action (Detailed mode of action not to be done)	**10**

3	**Microbial Nutrition, Cultivation, Isolation and Preservation**	**3.1** Nutritional requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur and growth factors. **3.2** Nutritional types of microorganisms **3.3** Types of Culture media with examples **3.4** Isolation of microorganisms **3.5** Preservation of microorganisms	**10**

Learning Resources recommended:

1. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan,Noel R. Krieg
2. A.J.Salle, Fundamental Principles of Bacteriology, McGraw Hill Book Company Inc.1984
3. Cruikshank, Medical Microbiology, Volume -II
4. Prescott, Hurley, Klein-Microbiology, 5th & 6th edition, International edition 2002 & 2006, McGraw Hill.
5. Michael T.Madigan & J.M.Martin,Brock, Biology of Microorganisms 11th Ed. International edition, 2006, Pearson Prentice Hall.

Evaluation Pattern

A. Continuous evaluation [40 Marks]

Method	Marks
Class Test: Unit Test (MCQ / Descriptive – Based on Theory - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each / 3 unit tests of 10 marks each and best two out of three will be considered)	20
Assignment	10
Attendance & Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern) [60 Marks – 2Hours]

Question No	Unit	Marks
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Guidelines for paper pattern for Semester End Evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, short notes, diagrammatically explain, Justify, brief descriptions etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, define, true or false, etc., type of questions will not contain internal options.

Name of the Course	Microbiology Practical
Course Code	USMBP1
Class	F.Y.B.Sc.
Semester	I
No of Credits	01
Nature	Practical
Type	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	The course will inculcate the importance of microbiology lab skills and is reflected in the requirement for a microbiology lab course for admission to some professional programs, and hands-on skills are expected for graduate studies or laboratory-based jobs in microbiology-related fields. The course ensuring that students possess essential technical competencies, including safe working practices in the lab, is critical to ensure that our programs provide the skills employers expect and meet the educational goals of our learners. We strongly stress that while innovative and valuable new tools and approaches will be developed during this time, these resources should be viewed as important alternatives to traditional resource intensive laboratories supporting fundamental skill development. Microbiology is a necessarily sensory discipline, and we must be able to deliver this essential, hands-on experience to our students when it is again safe to do so.

Nomenclature: Microbiology Practical

Course Outcomes:

- At the end of the course students will be able handle the microbial samples aseptically.
- At the end of the course students will be able to handle instruments like microscope and centrifuge.
- The learner will understand the protocols of different staining techniques.
- The student shall know the handling of instruments.

Curriculum:

USMBP1 - Microbiology Practical		
Paper	**Learning points**	**No. of Clock Hours**
I and II	1. Cell wall staining 2. Metachromatic granules staining 3. Demonstrate presence of microbes in Air, cough, table surfaces, and finger tips. 4. Qualitative tests for carbohydrate 5. Qualitative tests for protein 6. Qualitative tests for amino acid 7. Qualitative tests for nucleic acid 8. Spores staining 9. Use of micropipettes 10. Disposal of highly pathogenic samples 11. Determination of capsules 12. Lipid staining 13. Safety inoculation hood and laminar air flow 14. Measure to be taken on accidental spillage or breakage of culture container 15. Assignments 16. Negative staining 17. Differential staining 18. Physical methods of control of microorganisms 19. Effect of UV rays 20. Effect of osmotic pressure 21. Oligodynamic methods of action of heavy metals 22. Chemical methods of control of microorganisms 23. Microbiological culture media preparation 24. Inoculation technique and study of growth pattern 25. Colony characteristics of microorganisms 26. Use of differential and selective media 27. Parts of compound microscope 28. Simple staining 29. Introduction to safety measures in laboratory 30. Methods of preparation and sterilization of glassware and other materials	**60**

Learning Resources recommended:

1. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan,Noel R. Krieg
2. Prescott, Hurley, Klein-Microbiology, 5th & 6th edition, International edition 2002 & 2006, McGraw Hill.

3. Michael T.Madigan & J.M.Martin,Brock,Biology of Microorganisms 11th Ed. International edition, 2006, Pearson Prentice Hall.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Syllabus for F. Y. B. Sc. Microbiology Semester II

From the year 2023-24

Name of the Course	Basics of Microbiology
Course Code	USMB201
Class	F.Y.B.Sc.
Semester	II
No of Credits	02
Nature	Theory
Type	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	A key aim of undergraduate microbiology course is to train scientific literacy in the subject of microbiology where the students gain an ability to evaluate the quality of basic scientific study and apply it in real-world situations. This course will help the students to improve understanding of the subject and extend the knowledge in research related to all microbe types. The students will have a clear understanding on the general features of different group of microorganisms, their size, shape, host range, symmetry and basis for classification. The same knowledge can be applied in microbial understanding for its research.

Nomenclature: Basics of Microbiology

Course Outcomes:

- At the end of the course students will be able understand different groups of microbes.
- The student shall understand the growth pattern of microorganisms.
- The learner will understand the economic use of different groups of microbes. And also learn the pathogenic effects on the different groups of microorganisms.

Curriculum:

USMB201 – Basics of Microbiology			
Unit	**Title**	**Learning points**	**No. of lectures**
I	**Study Of Different Groups Of Microbes-I:**	**1.1Viruses**: a) Historical highlights, General properties of viruses, Prions, Viroids b) Structure of viruses-capsids, envelopes, genomes, d) Bacteriophages: Lytic cycle, Lysogeny, Structure of T4 phage. **1.2 Ricketssia, Coxiella, Chlamydia, Mycoplasma:** general features, medical significance **1.3Actinomycetes**: General features of Streptomyces Importance: ecological, commercial and medical **1.4 Archaea**: Archaeal lipids and membranes, Ecological importance	**10**
II	**Study Of Different Groups Of Microbes-II:**	Classification, Morphological characteristics, cultivation, reproduction and significance **2.1 Protozoa**- Major Categories of Protozoa Based on motility, reproduction. **2.2 Algae –**Characteristicsof algae: morphology, Pigments, reproduction Cultivation of algae. Economic importance of Algae. Differences between Algae and Cyanobacteria **2.3 Fungi and Yeast-**Characteristics: Structure, Reproduction, Cultivation of fungi and yeasts. Life cycle of yeast. **2.4 Slime molds and Myxomycetes**	**10**
III	**Microbial Growth:**	**3.1** a. Definition of growth, Mathematical Expression, Growth curve b. Measurement of growth c. Direct microscopic count – Breed's count, Petroff – Haussercounting chamber-Haemocytometer. d. Measurements of cell constituents. e. Turbidity measurements – Nephelometer and spectrophotometer techniques f. Synchronous growth, Continuous growth (Chemostat and Turbidostat) g. Influence of environmental factors on growth. h. Quorum sensing (Definition)	**10**

Learning Resources recommended:

1. Prescott, Hurley, Klein-Microbiology, 7th edition, International edition, McGraw Hill.
2. Kathleen Park Talaro& Arthur Talaro - Foundations in Microbiology International edition 2002,| McGraw Hill.
3. Michael T.Madigan & J.M.Martin, Brock Biology of Microorganisms 12th Ed. Internationaledition 2006, Pearson Prentice Hall.
4. A.J.Salle,Fundamental Principles of Bacteriology.
5. Stanier. Ingraham et al,General Microbiology 4th & 5th Ed. 1987, Macmillan Education Ltd
6. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan,Noel R. Krieg
7. BIS: 12035.1986: Code of Safety in Microbiological Laboratories.
8. Outlines of Biochemistry 5/E, Conn P. Stumpf, G. Bruening and R. Doi. John Wiley & Sons. New York 1995
9. Microbiology an Introduction. 6th Edition. Tortora, Funke and Case. Adisson Wesley Longman Inc. 1998.

Evaluation Pattern

A. Continuous evaluation [40 Marks]

Method	Marks
Class Test: Unit Test (MCQ / Descriptive – Based on Theory - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each / 3 unit tests of 10 marks each and best two out of three will be considered)	20
Assignment	10
Attendance & Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern) [60 Marks – 2Hours]

Question No	Unit	Marks
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Guidelines for paper pattern for Semester End Evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, short notes, diagrammatically explain, Justify, brief descriptions etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, define, true or false, etc., type of questions will not contain internal options.

Name of the Course	Exploring Microbiology
Course Code	USMB202
Class	F. Y. B. Sc.
Semester	II
No of Credits	02
Nature	Theory
Type	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	The course will offer diverse range of employment sectors such as; healthcare organizations, environmental organizations, industry like food and drink, pharmaceuticals, water and forensic science laboratories, publicly funded research organizations, higher education institutions etc. The learner will understand host-pathogen interactions in this course which will make them its use in microbiology laboratories. Study of microorganisms with respect to their etiology, pathogenesis and prophylactic measures will help the student to extend their learning in the field of medical microbiology. Learning importance of Clinical samples; Performing Microscopy, Culturing are valuable tools which will make the student to enable them to work in medical sectors.

Nomenclature: Exploring Microbiology

Course Outcomes:

- At the end of the course students will be able understand the use of advance instruments in the study of microbes.
- The student will know the concept of microbial interactions among different groups of organisms.

Curriculum:

USMB202 – Exploring Microbiology			
Unit	**Title**	**Learning points**	**No. of Lectures**
I	**Microbial interaction**	**1.1 Types of Microbial Interactions :**Mutualism, Cooperation, Commensalisms, Predation Parasitism, Amensalism, Competition **1.2 Human Microbe Interactions.** a) Normal flora of the human body : Skin, Nose &Nasopharynx, Oropharynx, Respiratory tract, Eye, External ear, Mouth, Stomach, Small intestine, Large intestine, Genitourinary tract. b) Relationship between microbiota & the host. **1.3 Microbial associations with vascular plants** a) Phyllosphere b) Rhizosphere & Rhizoplane c) Mycorrhizae d) Nitrogen fixation : Rhizobia, Actinorhizae e) Fungal & Bacterial endophytes f) Plant pathogen- Agrobacterium	**10**
II	**Microbes & Human Health:**	**2.1 Difference between infection & disease.** Important terminology: Primary infection, secondary infection, Contagious infection, occupational disorder, clinical infection, subclinical infection, Zoonoses, genetic disorder, vector borne infection. **2.2 Factors affecting infection:** Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization & its effects. **2.3 Individual resistance**: Factors influencing individual resistance: Age, nutrition, personal hygiene, stress, hormones, Addiction to drugs/ alcohol. **2.4 Host defense against infection: Overview** i) First line of Defense: for skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes. ii) Second line of defense: Biological barriers: Phagocytosis, Inflammation iii) Third line of defense: Brief introduction to antibody mediated & cell mediated immunity.	**10**
III	**Advance Techniques In Microbiology**	**3.1**Electron Microscope: TEM, SEM **3.3**Fluorescent Microscope, Confocal Microscope	**10**

	&Instrumentation:	**3.4**pH meter **3.5**Colorimeter **3.6**Autoclave & Hot air Oven **3.7**Concepts: Laminar air flow systems, Biosafety cabinets, Walk in Incubators, Industrial autoclaves, Cold Room.	

Learning Resources recommended:

1. Microbiology TMH 5th Edition by Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg
2. A. J. Salle, Fundamental Principles of Bacteriology, McGraw Hill Book Company Inc.1984
3. Cruikshank, Medical Microbiology, Vol -II
4. Prescott, Hurley, Klein-Microbiology, 5th & 6th edition, International edition 2002 & 2006, McGraw Hill.
5. Michael T. Madigan & J. M. Martin, Brock Biology of Microorganisms 11th Ed. International edition, 2006, Pearson Prentice Hall.

Evaluation Pattern

A. Continuous evaluation [40 Marks]

Method	Marks
Class Test: Unit Test (MCQ / Descriptive – Based on Theory - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each / 3 unit tests of 10 marks each and best two out of three will be considered)	20
Assignment	10
Attendance & Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern) [60 Marks – 2Hours]

Question No	Unit	Marks
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Guidelines for paper pattern for Semester End Evaluation:

1. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, short notes, diagrammatically explain, Justify, brief descriptions etc., will contain internal options.
3. MCQs, fill in the blanks, answer in one or two lines, match the following, define, true or false, etc., type of questions will not contain internal options.

Name of the Course	Microbiology Practical
Course Code	USMBP2
Class	F. Y. B. Sc.
Semester	II
No of Credits	01
Nature	Practical
Type	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Skill enhancement related to good laboratory practices will ensure employability in microbiology laboratories. Microbiology has many practical applications that can benefit society. Student microbiologists will learn a critical role in developing vaccines, producing antibiotics, and testing food and water for harmful bacteria. Studying microbiology can give students the skills and knowledge needed to make a real difference in the world. Learning hands on training will make students to build a career in research and non-research fields. The practical knowledge will make the students trained in; microbiological laboratory and safe practices, determining microbes in food/pharmaceutical samples.

Nomenclature: Microbiology Practical

Course Outcomes:

- At the end of the course students will be able to understand the detection of virulence factor.
- The student will understand the use of haemocytometer, pH meter and other instruments.
- The learner will get trained to do cultivation of various microorganisms.

Curriculum:

USMBP2 - Microbiology Practical		
Paper	**Learning points**	**No. of Clock Hours**
I and II	1. Study of Bacteriophages 2. Study of Actinomycetes 3. Cultivation of Yeast and Fungi 4. Fungal wet mount and study of morphological characteristics 5. Growth of microorganism under static and shaker culture 6. Growth curve 7. Breed count method 8. Haemocytometer method 9. Viable count method 10. Opacity tube method 11. Effect of temperature and pH on growth of microorganisms 12. Micrometry – Demonstration 13. Dark field microscopy 14. Phase contrast light microscope 15. Bacteria proof filtration 16. Normal flora of Skin 17. Study of Lichen- Demonstration 18. Study of Rhizobia 19. Study of Azotobacter 20. Detection of virulence factor: Coagulase 21. Detection of virulence factor: Haemolysin 22. Detection of virulence factor: Lecithinase 23. Study and preparation of buffers 24. Study of pH meter 25. Verification of Beer-Lamberts law 26. Autoclave and Hot air oven 27. Evaluation of disinfectant 28. Determination of efficacy of a disinfectant 29. Assignment 30. Visit to a microbiological laboratory in research institute	**60**

Learning Resources recommended:

1. Prescott, Hurley, Klein-Microbiology, 5th & 6th edition, International edition 2002 & 2006, McGraw Hill.
2. Michael T. Madigan & J. M. Martin, Brock Biology of Microorganisms 11th Ed. International edition, 2006, Pearson Prentice Hall.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Bachelor of Science (B.Sc.) Programme In Microbiology

S. Y. B. Sc. [Sem-III & IV]

Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Name of Programme	**B.Sc. [Microbiology]**
Level	UG
No of Semesters	06
Year of Implementation	**2023-24**
Programme Specific Outcomes (PSO)	1] Learner shall know the various branches of Microbiology. 2] Learner shall know the role of microorganism in day to day life. 3] Learner shall able to Understand and identify the various Microorganisms. 4] Learner shall able to isolate and propagate various microorganisms. 5] Learner shall able to control microbial growth. 6] Learner shall know the fermentation of various fermented food products and industrial products by using microorganisms. 7] Learner should know the importance of microorganisms in infectious diseases.
Relevance of PSOs to the local, regional, national, and global developmental needs	Microorganism's role in nature is indispensable. They involved in biodegradation, Fermentation, Antibiotic production, etc. Likewise some are involved in disease generation too. Therefore the understanding of microorganisms becomes essential to propagate or to control its number. As microorganism is responsible for food spoilage, food borne diseases so the maintenance of quality standard high is important from local level to global level. With respect to this learner should know the branches of microbiology. As microorganisms are ubiquitous so learner should know the role of microorganism in day to day life. There are millions of different microbes present on earth so identification of those microbes is globally important. In addition to that such identification skills have great importance in an infectious diseases control. Industrial fermentation processes requires pure culture of microbes so the knowledge of isolation of pure culture and its propagation is essential. Contamination by unwanted microbes is a worldwide problem. Learners must know the methods of microbial growth control. The various decontamination methods are not only locally important but also it is globally essential. In sterilized/controlled conditions only a good quality fermented food product can be prepared by specific microorganisms. Therefore learners should know skill and knowledge of such fermentation processes. Summarizing, graduates of B.Sc. Microbiology program will be informed citizens who can understand and apply basic microbiological technique at local to global level. It will be able to pursue wide range of careers including biological and life science research in higher educational institutions as well as careers in public health, clinical research, food, pharmaceutical and biotechnological industries.

S.Y.B.Sc. Microbiology Syllabus (General Outline)

	SEMESTER III		
Course Code	Title	Credits	Lectures / week
USMB-301 Theory	Biomolecules and Microbial taxonomy	2 Credits (45 lectures)	3
Unit-I	Estimation of Biomolecules	15 lectures.	1
Unit-II	Nucleic acid structure and chemistry	15 lectures.	1
Unit-III	Microbial Taxonomy	15 lectures.	1
USMB-302 Theory	Environmental Microbiology	2 Credits (45 lectures)	3
Unit-I	Air Microbiology	15 lectures.	1
Unit-II	Fresh Water & Sewage Microbiology	15 lectures.	1
Unit-III	Soil and Geo Microbiology	15 lectures.	1
USMB-303 Theory	Introduction to Clinical Microbiology	2 Credits (45 lectures)	3
Unit-I	Basic Microbiology	15 lectures.	1
Unit-II	Common infectious diseases, Epidemiology and public health awareness	15 lectures.	1
Unit-III	Control of Microorganisms & Safety in Clinical Microbiology	15 lectures.	1

USMBP-3	PRACTICALS	3 Credits	9
SECTION-1	Biomolecules and Microbial taxonomy (Practicals Based On Unit-I,II & III Of USMB-301	1 Credit (45 lectures)	3
SECTION-2	Environmental Microbiology (Practicals Based On Unit-I,II & III Of USMB-302	1 Credit (45 lectures)	3
SECTION-3 Any One	Introduction to Clinical Microbiology (Practicals Based On Unit-I,II & III Of USMB-303	1 Credit (45 lectures)	3

	SEMESTER IV		
Course Code	Title	Credits	Lectures / week
USMB-401 Theory	Metabolism & Basic Analytical Techniques	2 Credits (45 Lectures)	3
Unit-I	Introduction To Metabolism & Bioenergetics	15 lectures.	1
Unit-II	Enzyme Kinetics	15 lectures.	1
Unit-III	Analytical techniques	15 lectures.	1
USMB-402 Theory	Applied Microbiology	2 Credits (45 Lectures)	3
Unit-I	Host defence and public health (Epidemiology of infectious diseases)	15 lectures.	1
Unit-II	Food Microbiology	15 lectures.	1
Unit-III	Dairy Microbiology	15 lectures.	1
USMB-403 Option A Theory	Fermented Foods, Food Sanitation and Microbial Ecology	2 Credits (45 lectures)	3
Unit-I	Fermented Foods	15 lectures.	1
Unit-II	Food Sanitation	15 lectures.	1
Unit-III	Microbial evolution and ecology	15 lectures.	1

USMBP-4	PRACTICALS	3 Credits	9
SECTION-1	**Metabolism & Basic Analytical Techniques** (Practicals Based On Unit-I,II & III Of USMB-401	1 Credit (45 lectures)	3
SECTION-2	**Applied Microbiology** (Practicals Based On Unit-I,II & III Of USMB-402	1 Credit (45 Lectures)	3
SECTION-3	**Option A Fermented Foods, Food Sanitation and Microbial Ecology** (Practicals Based On Unit-I,II & III Of USMB-403	1 Credit (45 Lectures)	3

Syllabus for S. Y. B. Sc. Microbiology Semester III

From the year 2023-24

Name of the Course	Biomolecules and Microbial taxonomy
Course Code	USMB301
Class	S. Y. B. Sc.
Semester	III
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The course inculcate the knowledge and skills like estimation of proteins, amino acids, carbohydrates, lipids and nucleic acids which is applicable in microbiological and analytical industries. Understanding of nucleic acid structure and chemistry is very important in fields like drug discovery, genomics etc. Apart from this the knowledge of microbial taxonomy, genetic analysis, phylogenetic analysis and genome sequencing will be helpful for higher studies as well as for getting jobs in fields like molecular microbiology, biotechnology and genetics.

Nomenclature: Biomolecules and Microbial taxonomy

Course Outcomes:

At the end of the course students will be able

1. To understand and perform estimation of proteins, carbohydrates, lipids and nucleic acids.
2. To know nucleic acid structure and chemistry.
3. To explain microbial identification systems.

Curriculum:

USMB301 - Biomolecules and Microbial taxonomy			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Estimation Of Biomolecules	1a. Macromolecular composition of a microbial cell 1b. Methods of elemental analysis: Carbon, Nitrogen and Phosphorus 1c. Estimation of Proteins and amino acids Proteins by Biuret method(Direct and indirect Amino acids by Ninhydrin method 1d. Estimation of Carbohydrates Total carbohydrates by Anthrone method Reducing Sugars (maltose) by DNSA method Reducing sugar Felhing's method 1e. Extraction of Lipids by Soxhlet method 1f. Estimation of Nucleic acids General principles and extraction of nucleic acids DNA by DPA method RNA by Orcinol method	15
2	Nucleic acid structure and chemistry	2a. Nucleic Acid Structure DNA stores genetic information DNA molecules have distinctive base composition DNA is a double helix DNA can occur in different 3D forms DNA sequences adopt unusual structures Many RNAs complex 3Dstructures 2b. Nucleic acid chemistry Denaturation of double helical DNA and RNA Nucleic acid from different species can form hybrids Nucleotides and nucleic acids undergo non enzymatic transformations DNA methylation 2c. Other Functions of nucleotides 2d. Structures of chromosomes of eukaryotic cell	15
3	Microbial Taxonomy	3a. Introduction to microbial taxonomy Systems of classification(Cavalier Smith 6 kingdom) Bergey's manual The three domain concept based on phylogeny Nomenclature Taxonomic ranks Numerical Taxonomy 3b. Methods of analysis used in classification: Phenotypic analysis (Morphological characteristics, Physiological and metabolic characteristics, Biochemical characteristics, Ecological characteristics, Fatty acid analysis) 3c. Genetic analysis DNA-DNA hybridization DNA profiling Multilocus sequence analysis G+C ratio Genetic finger printing 3d. Amino acid sequencing 3e. Phylogenetic analysis Nucleic Acid sequencing Analysis of individual genes Multilocus gene sequence analysis Whole genome sequence analysis 3f. Phylogenetic tree: Types	15

Learning Resources recommended:

1. Methods in Microbiology, Vol.5B, Ed. Norris & Ribbon, Academic Press
2. A handbook book of Organic analysis: qualitative and quantitative 4th edition, Hans Thacher Clarke, CBS publishers & distributors, New Delhi.
3. Laboratory Manual in Biochemistry, J. Jayaraman, (2003) New Age International 11 Publishers
4. Lehninger: Principles of Biochemistry, 4th Ed., D. Nelson & M. Cox, W. H. Freeman & Co., (LPE)
5. Prescott's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, (2011) 8th edition, McGraw-Hill International edition
6. Prescott, Harley and Klein's Microbiology, Willey, Sherwood, Woolverton (2008) 7th edition, McGraw-Hill International edition
7. Brock Biology of Microorganisms, Madigan, Martinko, Dunlap and Clark (2009) 12th edition, Pearson Education
8. Peter J. Russell (2006), "Genetics-A molecular approach", 2nd ed. 2

Additional references
1. General Microbiology / Stanier R.Y. And Other, MacMillan (1989) 5th editon
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology / Glick, Bernard; Pasternak, Jack 2003
3. An Introduction to Practical Biochemistry / Plummer David (1979) TMH

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Name of the Course	Environmental Microbiology
Course Code	USMB302
Class	S. Y. B. Sc.
Semester	III
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The course will be primarily oriented towards imparting skills and knowledge on environmental microbiology. Air, Water and Soil sampling, sample preparation, processing and analysis. The course aims at providing hands on training on various instrumental methods according to specified protocols. Students will improve skills in handling microorganisms and studying their morphological, physiological and biochemical characteristics. The expertise in analysis of air, water and soil samples will be beneficial to students to get placed in pollution control board, water testing agency and environmental monitoring industries. Skills like understanding of sewage treatment processes and soil bioremediation are useful for industries related to waste water treatment and bioremediation.

Nomenclature: Environmental Microbiology

Course Outcomes:

At the end of the course students will be able

1. To understand the aeromicrobiology and its implications in human life.
2. To understand microbiology of water and explain modern waste water treatment.
3. To explain the role of soil microorganisms in bioremediation and biogeochemical cycles and its impact on environment.

Curriculum:

USMB302 - Environmental Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Air Microbiology	1a. Aeromicrobiology: Important airborne pathogens and toxins, Aerosols, nature of bioaerosols, aeromicrobiological pathway, microbial survival in the air, extramural aeromicrobiology, intramural aeromicrobiology 1b. Sampling Devices for the Collection of Air Samples, Detection of microorganisms on fomites 1c. Air Sanitation 1d. Air Quality Standards	15
2	Fresh Water and Sewage Microbiology	2a. Fresh water environments and micro-organisms found in Springs, rivers and streams, Lakes, marshes and bogs 2b. Potable water: Definition, water purification, water quality standards and pathogens transmitted through water 2c. Microbiological analysis of water: Indicator organisms and their detection in water Total Coliforms, Fecal Coliforms and *E. coli*, Fecal *Streptococci*, *Clostridium perfringens* 2d. Modern Waste Water treatment: Primary, Secondary and Tertiary Treatment. 2e. The nature of wastewater and Monitoring of waste water treatment processes (BOD,COD) 2f. Removal of Pathogens by Sewage treatment Processes 2g.Oxidation Ponds and Septic tanks 2h. Sludge Processing 2i. Disposal of treated waste water and biosolids	15
3	Soil and Geo Microbiology	3a. Terrestrial Environment Soil- Definition, Composition, function, Textural triangle Types of soil microorganisms and their activities 3b. Methods of studying soil microorganisms: Sampling, Cultural methods, Physiological methods, Immunological methods, Nucleic acid based methods, Radioisotope techniques 3c. Biogeochemical Cycles: Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus Cycle, Iron cycle 3d. Soil Bioremediation	15

Learning Resources recommended:

1. Environmental Microbiology, 2nd Edition; Raina M. Maier, Ian L. Pepper, Charles P.Gerba, 2010 Academic Press
2. Fundamental Principles of Bacteriology, 7th Editon; A.J. Salle, Tata Mc Graw Hill Publishing Company
3. Air Quality Standards- NAAQS Manual, Volume I
4. Prescott's Microbiology, 8th Edition; Joanne M. Willey, Linda M. Sherwood, Christopher J.Woolverton, 2011, Mc Graw Hill International Edition
5. Fundamentals of Microbiology, 9th Edition, Frobisher, Hinsdill, Crabtree, Goodheart, 1974, Saunders College Publishing
6. Introduction to Environmental Microbiology – Barbara Kolwzan, Waldemar Adamiak (E Book)
7. Soil Microbiology-4th Edition, N.S Subba Rao, 2000, Oxford and IBH Publishing Co. Pvt Ltd

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Name of the Course	Introduction to Clinical Microbiology
Course Code	USMB303
Class	S. Y .B. Sc.
Semester	III
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The course gives knowledge and skill required for becoming a competent medical clinical laboratory scientist through lectures and hands on work experience. The course will train the students in all sections of clinical laboratory to the point of being able to do the job independently in hospitals and pathology laboratories. Typical tasks of this course will include identifying fungal, parasitic, viral and bacterial infections. Testing the strength and virulence of microbes. Using a variety of biochemical and molecular methods to determine organisms that cause infection. Undertaking work aimed at helping to prevent the spread of infections within hospitals. Safety in clinical microbiology and control of microorganisms is important task in order to prevent the spread of infection. The knowledge about common infectious diseases, epidemiology and public health awareness along with safety in clinical microbiology enhance the employability in medical, paramedical and diagnostic industries.

Nomenclature: Introduction to Clinical Microbiology

Course Outcomes:

At the end of the course students will be able

1. To know physiology of bacteria and their cultivation methods.
2. To explain different infectious diseases and their epidemiology.
3. To know and apply knowledge of sterilization and disinfection in clinical microbiology.

Curriculum:

USMB303 - Introduction to Clinical Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Basic Microbiology	1a. Microbial World & you: Microbes in our lives Types of Microorganisms 1b. Morphology and Physiology of Bacteria: Microscopy Staining - monochrome, differential and cytological Shape of Bacteria Bacterial Anatomy- Structure & function Growth and Multiplication of Bacteria Bacterial Growth Curve 1c. Culture Methods of Isolating Pure Cultures Anaerobic Culture Methods(Anaerobic blood agar, Cooked meat media, Thioglycollate medium) 1d. Culture Media and Bacterial Growth Types of Media and examples of media like Nutrient agar, Sabouraud agar, MacConkeys agar. Study of morphological & cultural characteristics. 1e. Bacterial Taxonomy Nomenclature Type Cultures	15
2	Common infectious diseases, Epidemiology and public health awareness	2a. Skin Infections: Study of structure and functions of skin Study of skin infections caused by Pseudomonas, Acne & Measles 2b. Infections of Nervous system Study of structure and functions of nervous system Study of Tetanus & Rabies 2c. Infections of Respiratory systems Study of structure and function of respiratory system Study of pharyngitis, laryngitis, Sinusitis, Diphtheria and common cold 2d. Infections of Digestive system Study of structure and function of Digestive system Study of Typhoid fever, E. coli gastroenteritis, Hepatitis A, Rotavirus and Amoebiasis 2e. The Epidemiology of Infectious Diseases and Their Control Epidemiological terminology: Epidemiology, sporadic diseases, endemic diseases, Hyper endemic Diseases, epidemic Diseases, Index Case, Pandemic Disease, Outbreak 2f. The Spread of Infection: Reservoirs of infection – Human reservoir, Animal reservoir, non-living reservoir Transmission of Disease- Contact transmission, Vehicle Transmission and vectors 2g. Public Health Measures for Control of Disease: Control directed against reservoir, Transmission of	15

		the pathogens. Immunisation, Quarantine, Surveillance and pathogen eradication	
3	Control of Microorganisms & Safety in Clinical Microbiology	3a. Sterilization and disinfection Methods of sterilization: Dry heat: Hot air sterilizers Moist heat: Steaming at 100°C, Autoclave. Gas Sterilization: Ethylene oxide sterilizer, Gasplasma Sterilizing filters Sterilization by radiation 3b.Disinfectants: Disinfection of surfaces and spillages Disinfection of safety cabinets Discard jars Disinfection of rooms Disinfection of skin Testing of disinfectants 3c. Safety in Clinical Microbiology Chemical safety Fire safety Electrical safety Handling of compressed gases: Exposure control plan: Employee education and orientation, Disposal of hazardous waste, Standard precautions, Engineering controls: Laboratory Environment, Biological safety cabinet, Personal protective equipment, Post exposure control Classification of biologic agents based on hazard	15

Learning Resources recommended:

1. Microbiology, An Introduction by Tortora, Funke & Case 9th and 11th edition, Pearson education.
2. Bailey and Scott's Diagnostic Microbiology, 11th edition Publ: Mosby
3. Anantnarayan & Paniker's Textbook of Microbiology, 8th Ed.
4. Mackie and McCartney Practical medical microbiology 14th edition.
5. Brock biology of microorganism by Michael T Madigan. & John M Martinco.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

C.

Question No	**Unit**	**Marks**
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Name of the Course	Microbiology Practical
Course Code	USMBP03
Class	S. Y. B. Sc.
Semester	III
No of Credits	03
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The course inculcate the knowledge and skills like estimation of proteins, amino acids, carbohydrates, lipids and nucleic acids which is applicable in microbiological and analytical industries. Understanding of nucleic acid structure and chemistry is very important in fields like drug discovery, genomics etc. The course will be primarily oriented towards imparting skills and knowledge on environmental microbiology. Air, Water and Soil sampling, sample preparation, processing and analysis. The course aims at providing hands on training on various instrumental methods according to specified protocols. Students will improve skills in handling microorganisms and studying their morphological, physiological and biochemical characteristics. The expertise in analysis of air, water and soil samples will be beneficial to students to get placed in pollution control board, water testing agency and environmental monitoring industries. The course gives knowledge and skill required for becoming a competent medical clinical laboratory scientist through lectures and hands on work experience. The course will train the students in all sections of clinical laboratory to the point of being able to do the job independently in hospitals and pathology laboratories. Typical tasks of this course will include identifying fungal, parasitic, viral and bacterial infections. Using a variety of biochemical and molecular methods to determine organisms that cause infection. Undertaking work aimed at helping to prevent the spread of infections within hospitals. The knowledge about common infectious diseases, epidemiology and public health awareness along with safety in clinical microbiology enhance the employability in medical, paramedical and diagnostic industries.

Nomenclature: Microbiology practical

Course Outcomes:

At the end of the course learner will be able

1. To estimate various biomolecules such as protein, lipid, carbohydrate, nucleic acids.
2. To perform routine analysis of water and waste water.
3. To understand and perform laboratory techniques related to clinical microbiology.

Curriculum:

USMBP03 - Microbiology Practical			
Paper	**Title**	**Learning Points**	**No of Lectures**
1	Biomolecules and Microbial taxonomy	1. Estimation of total sugar by Anthrone Method(Demo) 2.Estimation of reducing sugar by DNSA method 3. Estimation of reducing method by Felhing's method 4. Estimation of protein Biuret method (indirect and direct)	45
		6. Isolation and detection of DNA from onion / *E.coli* 7. Estimation of DNA by DPA method 8. Estimation of RNA by Orcinol method	
2	Environmental Microbiology	1. Enumeration of microorganisms in air and study of its load after fumigation 2. Study of air microflora and determination of sedimentation rate	45
		3. Routine analysis of water: a. Standard Plate Count b. Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test 4. Waste water analysis: a. Study of microbial flora in raw and treated sewage b. Determination of total solids in wastewater c.Determination of BOD and COD of wastewater	
		5. Total viable count of soil microflora 6.Isolation of bacteria, Actinomycetes and fungi from soil 7.Enrichment and isolation of, Cellulose	

		degraders and Phosphate solubilisers from soil 8. Winogradskys column 9. Visit to a sewage treatment plant or water purification plant	
3	Introduction to Clinical Microbiology	1. Study of different parts of a compound Microscope. 2. Monochrome staining of bacterial smear. 3. Gram staining of bacterial smear. 4. To study the growth of yeast on the Sabouraud agar 5. To study the growth of lactose fermentor and nonlactose fermentors on the MacConkey's agar	15
		5. Isolation of Pseudomonas, Escherichia coli and S. typhi 6. Permanent slides of *Entamoeba histolytica* 7. Assignment on: i. Normal flora of - skin/ respiratory system/ nervous system / digestive system, ii. ii. Immunization programmes in India (role of CDC, WHO, ICMR, NICD, NAARI)	
		8. Determination of MIC of a chemical disinfectant 9. AST-Kirby method 10 Effect of UV	

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Syllabus for S. Y. B. Sc. Microbiology Semester IV

From the year 2023-24

Name of the Course	Metabolism & Basic Analytical Techniques
Course Code	USMB401
Class	S. Y. B. Sc.
Semester	IV
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	This course introduces students to metabolism: the collection of chemical processes by which the cells drive energy from their surroundings and use this energy to make the building blocks of life. The major metabolic pathways involved in the synthesis and breakdown of important biological molecules are explored, along with the mechanisms of regulating these pathways in the body. The skills developed during the course are paper chromatography, thin layer chromatography, HPTLC, column chromatography, preparative centrifugation, analytical centrifugation and electrophoresis. These skills will enhance the employability of students in various industries- pharmaceutical, chemical and cosmetic industries.

Nomenclature: Metabolism & Basic Analytical Techniques

Course Outcomes:

At the end of the course students will be able

1. To understand metabolic pathways and thermodynamics of life.
2. To explain properties of enzymes and enzyme kinetics.
3. To learn instrumentation and analytical techniques, this will help them in their professional career.

Curriculum:

USMB401 - Metabolism & Basic Analytical Techniques			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Introduction To Metabolism & Bioenergetics	1a. Introduction to metabolism, Metabolic pathways 1b. Organic reaction mechanism 1c. Experimental approaches to study metabolism 1d. Thermodynamics of Phosphate compounds 1e. Oxidation-reduction reactions 1f. Thermodynamics of life	15
2	Enzyme Kinetics	2a. Introduction of Enzymes: General properties of enzymes, How do enzymes accelerate reaction Rate law for a simple catalyzed reaction, Michaelis-Menten equation and it's derivation Lineweaver Burke plot. Classification of enzymes 2b. Overview of Coenzyme: Coenzymes: Different types and reactions catalyzed by coenzymes (in tabular form) Nicotinic acid: structure, occurrence & biochemical function 2c. Enzyme Kinetics: Saturation +kinetics Effect of temperature and pH Effect of Inhibitors- Reversible and irreversible, competitive, Non competitive and uncompetitive inhibitors Multisubstrate reactions-Ordered, Random and ping pong reactions Allosteric effects in enzyme catalyzed reactions Koshland-Nemethy and Filmer model & Monod, Wyman and Changeux model	15
3	Analytical techniques	3a.Chromatography Introduction to chromatography, types of chromatography Paper chromatography: Principle, circular, ascending and descending Paper Chromatography, Separation of amino acids and monosaccharides by Paper Chromatography. Thin layer chromatography: principle, preparation of TLC plates, procedure for TLC, preparative TLC, 2D TLC [one paragraph], HPTLC-Separation of amino acids and sugars by TLC. Column chromatography: Introduction & principle Exclusion chromatography, gel chromatography 3b. Centrifugation Introduction: basic principles of sedimentation Types, care and safety aspects of centrifuges, types of rotors, care and maintenance, safety & centrifugation Preparative centrifugation, Analytical centrifugation and its application 3c. Electrophoresis General principles, support media – agarose gels, polyacrylamide gels	15

Learning Resources recommended:

1. Principles of Biochemistry- G. Zubay, W.W. Parson, D. E. Vance. C. Brown Publishers
2. Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley plus Edition 5th.
3. Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. 4th edition W.H. Freeman & Company[Low price edition- for sale in India, Pakistan, Sri Lanka, Bangladesh, Nepal & Bhutan]
4. Instrumental Methods of chemical analysis, V.K. Ahluwalia, Ane Books Pvt.Ltd; 2015.
5. Principles & techniques of Biochemistry & Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006
6. Laboratory manual in Biochemistry- J. Jayaraman

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Name of the Course	Applied Microbiology
Course Code	USMB402
Class	S. Y. B. Sc.
Semester	IV
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The course will train the students conducting microbiological analyses on samples collected from food processing facilities to determine potential causes of contamination. Students will be able to consult food manufacturers to determine the bacteria that may present in their food product and the microorganisms may affect the product's shelf life. During the course the student will understand and practices different types of tests of milk and practice to test microbiological quality of milk by MBRT and SFC test. The skills related to public health & epidemiology of infectious diseases will be useful in diagnostic & medical microbiology industries. Understanding of food microbiology, food spoilage, principles of food preservation microbial examinations of foods and dairy microbiology is required to work in food processing and dairy industries.

Nomenclature: Applied Microbiology

Course Outcomes:

At the end of the course students will be able

1. To understand immune system components and their role in control of infection.
2. To understand and apply basic knowledge of food microbiology, food preservation, food analysis and food safety.
3. To analyze quality of milk and milk product

Curriculum:

USMB402 - Applied Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Host defense and public health (Epidemiology of infectious diseases)	1a. Classification of immune system (innate immunity & acquired immunity) 1b. Physical barriers in nonspecific innate resistance revision. Chemical barriers (Complement: principle & significance (no pathway), Cytokines: interferon, antimicrobial peptides, bacteriocins 1c. Cells of Immune system: Haematopoiesis, lymphocyctes, monocytes & macrophages, granulocytes, mast cells, dendritic cells & NK cells 1d.Phagocytosis & Inflammation 1e.Tools of epidemiology, recognition of an infectious disease in population 1f. Spread of infection: Reservoirs and transmissions. Nosocomial infections: Microorganism in hospital, compromised host, chain of transmission, control of nosocomial infection.	15
2	Food Microbiology	2a. Introduction, Food as a substrate for microorganism a. pH, aw, O-R potential b. Nutrient Content 2b. Food Control Enforcement & Control Agency: International agencies, Federal agencies (FDA, USDA), FSSAI[website], Introduction to HACCP 2c. Important Microorganisms in Food Microbiology: A. Spoilage -causing microorganisms a. Yeast & Molds: *Saccharomyces, Aspergillus* & *Penicillium* b. Bacteria: *Bacillus, Clostridium, Flavobacterium, Pseudomonas* B. Food-borne Illness associated Microorganisms: Classification of Food-borne diseases (Schematic). Bacteria responsible for food -borne intoxication and infections-overview/tabulation. Examples of nonbacterial food-borne pathogens Details of: a) Staphylococcus food intoxication (organism, enterotoxin, incidence, foods involved, prevention of outbreaks) b) Salmonellosis (organism, source, incidence, foods involved, outbreak conditions & prevention) 2d. Food Spoilage, General Principles of spoilage of: a. Fruits and vegetables b. Meat (including spoilage under	15

		aerobic & anaerobic conditions- exclude spoilage of different kinds of meats) c. Canned foods 2e. General Principles of Food Preservation: a. Preservation using High temperature (including TDT, D, F, Z values, 12D concept), principle of canning b. Low temperature c. Drying d. Food preservatives (organic acids & their salts, Sugar & salt) e. Ionizing radiations 2f. Methods of microbial examination of foods: a. Homogenization of food samples b. Methods- SPC, spiral plater, membrane filters, dry films, surface examination-swab rinse & contact plate methods. c. Enlist the following methods giving their application only- Impedance, microcalometry, thermostable nuclease, LAL test, PCR, ATP, whole animal assay, Ligate loop technique	
3	Dairy Microbiology	3a. Raw and fluid milk products Pasteurization & Ultra-pasteurization 3b. Concentrated and dry milk, whey 3c. Microbiology of butter 3d. Fermented milk: Yogurt, cultured buttermilk and fermented milk in India 3e. Cheese: Cheddar, Cottage, Processed Cheese, Cheese Defects. Enlist other cheese and associated microorganisms 3f. Microbiological Quality of Milk & Milk Products: SPC, coliform count, LPC, thermophilic, psychrophilic counts and RPT (RRT, MBRT, DMC)	15

Learning Resources recommended:

1. Prescott, Harley Klein. Mc Graw international edition, 7th Ed
2. Anantnarayan & Paniker's ed 8th. University press
3. Food Microbiology by Frazier 5th ed
4. Modern Food Microbiology by James Jay 6th ed
5. Applied Dairy Microbiology by Martha & Steele
6. BIS standards, FSSAI
7. Outlines of Biochemistry. E.E. Conn & P.K.Stumpf ,G. Bruening, R.N. 5th Edition, John Wiley and sons

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Name of the Course	Fermented Foods, Food Sanitation and Microbial Ecology
Course Code	USMB403
Class	S. Y. B. Sc.
Semester	IV
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The course will guide the students to study the harmful organisms to understand how to prevent their growth in food. It may also be useful in work in technologies and innovations to enhance food safety for human consumption. The course typically aims to understand the use of microorganisms in fermented foods. These microbiologists may work in quality control & quality assurance industries or product development for food manufacturers, research institutes or the government bodies. The course encompasses skills required for jobs like sanitary inspector, food inspectors etc.

Nomenclature: Fermented Foods, Food Sanitation and Microbial Ecology

Course Outcomes:

At the end of the course students will be able

1. To explain food fermentation techniques and microbiology of fermented food
2. To know and apply food sanitation and hygiene measures.
3. To understand how life has evolved on earth.

Curriculum:

USMB403 - Fermented Foods, Food Sanitation and Microbial Ecology			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Fermented Foods	1a. Microorganisms used in food fermentations: yeasts, molds and lactic acid bacteria 1b. Microbiology of fermented food: bread, cheese, idli butter, yogurt, soy products, tea, coffee and cocoa 1c. Fermented beverages: beer, wine 1d.Food ingredients of microbial origin: SCP, amino acids, vitamins, colors, nutraceuticals and flavors 1e. Probiotics and intestinal bacteria	**15**
2	Food Sanitation	2a. Food Sanitation & Hygiene: Water, potable water, Sources of contamination of water, treatment of water, pesticide residue 2b.Food, Food Handling, Food contamination, equipment, Control of insects & Rodents, Practical rules for good sanitation. 2c. Food borne diseases 2d. Toxins from plants, toxins from animals, Mycotoxins, Toxic Agricultural Residues, Poisoning by chemicals, Food poisoning by bacteria, Food infections, other infection. 2e. Food laws and food adulteration 2f. Consumer protection & consumer guidance society	15
3	Microbial evolution and ecology	3a. Microbial evolution: formation and early history of earth, origin of cellular life, microbial diversification, endosymbiotic origin of eukaryotes 3b. Microbial ecosystems: Principles of Microbial ecology, the microbial habitats, fresh water, soil and plant microbial ecosystems, marine microbial ecosystems 3c. Microbial Ecology and its Methods - An Overview	15

Learning Resources recommended:

1. Fundamental Food Microbiology by Bibek Ray, Arun Bhunia (2007),4th edition CRC Press
2. Food Microbiology – An Introduction by Montville and Mathews,(2008), ASM Press
3. Industrial Microbiology by Waites and Morgan, Blackwell Science
4. Modern Industrial Microbiology and Biotechnology by Nduka Okafor, (2007), Science Publishers.

5. Food Science by Sumati R. Mudambi, Shalini Rao, M.V. Rajagopal, revised 2nd edition, (2006), New Age international publications.
6. Prescott's Microbiology by J.M. Willey, L.M. Sherwood, C.J. Woolverton, (2011) 8th edition, McGraw-Hill International edition
7. Prescott, Harley and Klein's Microbiology by Willey, Sherwood, Woolverton, (2008) 7th edition, McGraw-Hill International edition
8. Brock Biology of Microorganisms by Madigan, Martinko, Dunlap and Clark (2009) 12th edition, Pearson Education.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3	15
2	Unit 1	15
3	Unit 2	15
4	Unit 3	15
Total		**60**

Name of the Course	Microbiology Practical
Course Code	USMBP404
Class	S. Y. B. Sc.
Semester	IV
No of Credits	03
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	This course introduces students to metabolism: the collection of chemical processes by which the cells drive energy from their surroundings and use this energy to make the building blocks of life. The major metabolic pathways involved in the synthesis and breakdown of important biological molecules are explored, along with the mechanisms of regulating these pathways in the body. The skills developed during the course are paper chromatography, thin layer chromatography, HPTLC, column chromatography, preparative centrifugation, analytical centrifugation and electrophoresis. The course will train the students conducting microbiological analyses on samples collected from food processing facilities to determine potential causes of contamination. During the course the student will understand and practices different types of tests of milk and practice to test microbiological quality of milk by MBRT and SFC test. The skills related to public health & epidemiology of infectious diseases will be useful in diagnostic & medical microbiology industries. It may also be useful in work in technologies and innovations to enhance food safety for human consumption. The course typically aims to understand the use of microorganisms in fermented foods. These microbiologists may work in quality control & quality assurance industries or product development for food manufacturers, research institutes or the government bodies. The course encompasses skills required for jobs like sanitary inspector, food inspectors etc.

Nomenclature: Microbiology Practical

Course Outcomes:

At the end of the course learner will be able

1. To perform practical of enzymology
2. To perform techniques related to food and dairy microbiology.
3. To prepare and analyze fermented food.

Curriculum:

USMBP404 - Microbiology Practical				
Paper	**Title**	**Unit**	**Learning Points**	**No of Lectures**
1	Metabolism & Basic Analytical Techniques	**I, II and III**	1. Isolation of amylase, protease, lipase producers. 2. Extracellular production of invertase from yeast. 3. Effect of pH, Temp, substrate and enzyme concentration on activity of invertase.	45
			4. Separation and identification of amino acids and sugars by ascending paper chromatography. 5. Sizing Yeast cells 6. Electrophoresis & centrifuge machine	
2	Applied Microbiology	**I**	1. Differential staining: Blood staining 2. Isolation of organism from fomites. 3. Selective isolation of Staphylococcus & Pseudomonas sp.	45
		II	4. Isolation of food spoilage agent: a) Fruit/Vegetable- Physical & Microscopic & Pectinolytic agent b) Meat - Proteolytic, lipolytic, sacchrolytic 5. Determination of TDT and TDP 6. Determination of Salt and sugar tolerance 7. Determination of MIC of a Chemical preservative	
		III	11. RPT of Milk– RRT, MBRT, DMC 12. Microbiological Quality Control of Milk as per BIS/FSSSAI 13. Analysis of Cheese, Paneer, Butter, Yogurt/curd as 19 per BIS/FSSAI (Group experiment)	
3	Fermented Foods, Food Sanitation and Microbial Ecology	**I**	1. Wine and Bread making 2. Isolation of lactic acid bacteria from fermented food-e.g. Idli, curd	45
		II	3. Isolation of *Staphylococcus aureus* from sweets and demonstrating its virulence. 4. Food adulteration	

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Bachelor of Science (B.Sc.) Programme In Microbiology

T.Y.B.Sc. [Sem-V & VI]

Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Name of Programme	**B.Sc. [Microbiology]**
Level	UG
No of Semesters	06
Year of Implementation	**2023-24**
ProgrammeSpecific Outcomes (PSO)	1] Learner shall know the various branches of Microbiology. 2] Learner shall know the role of microorganism in day to day life. 3] Learner shall able to Understand and identify the various Microorganisms. 4] Learner shall able to isolate and propagate various microorganisms. 5] Learner shall able to control microbial growth. 6] Learner shall know the fermentation of various fermented food products and industrial products by using microorganisms. 7] Learner should know the importance of microorganisms in infectious diseases.
Relevance of PSOs to the local, regional, national, and global developmental needs	Microorganism's role in nature is indispensable. They involved in biodegradation, Fermentation, Antibiotic production, etc. Likewise some are involved in disease generation too. Therefore the understanding of microorganisms becomes essential to propagate or to control its number. As microorganism is responsible for food spoilage, food borne diseases so the maintenance of quality standard high is important from local level to global level. With respect to this learner should know the branches of microbiology. As microorganisms are ubiquitous so learner should know the role of microorganism in day to day life. There are millions of different microbes present on earth so identification of those microbes is globally important. In addition to that such identification skills has great importance in an infectious diseases control. Industrial fermentation processes requires pure culture of microbes so the knowledge of isolation of pure culture and its propagation is essential. Contamination by unwanted microbes is a worldwide problem. Learners must know the methods of microbial growth control. The various decontamination methods is not only locally important but also it is globally essential. In a sterilized/controlled conditions only a good quality fermented food product can be prepared by specific microorganisms. Therefore learners should know skill and knowledge of such fermentation processes. Summarizing, graduates of B.Sc. Microbiology program will be informed citizens who can understand and apply basic microbiological technique at local to global level. It will be able to pursue wide range of careers including biological and life science research in higher educational institutions as well as careers in public health, clinical research, food, pharmaceutical and biotechnological industries.

T.Y.B.Sc. Microbiology Syllabus (General Outline)

(SEMESTER V)

COURSE CODE	TITLE	CREDITS AND LECTURES / SEM
USMB501	**Microbial Genetics**	**2.5 Credits (60 Lectures)**
Unit I	DNA Replication	15 Lectures
Unit II	Transcription, Genetic Code & Translation	15 Lectures
Unit III	Mutation and Repair	15 Lectures
Unit IV	Genetic Exchange & Homologous Recombination	15 Lectures
USMB502	**Medical Microbiology & Immunology: Part - I**	**2.5 Credits (60 Lectures)**
Unit I	Bacterial Strategies for Evasion and Study of a Few Diseases	15 Lectures
Unit II	Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological agent, Pathogenesis, Laboratory Diagnosis and Prevention.	15 Lectures
Unit III	General Immunology - I	15 Lectures
Unit IV	General Immunology - II	15 Lectures
USMB503	**Microbial Biochemistry: Part - I**	**2.5 Credits (60 Lectures)**
Unit I	Biological Membranes & Transport	15 Lectures
Unit II	Bioenergetics & Bioluminescence	15 Lectures
Unit III	Methods of Studying Metabolism & Catabolism of Carbohydrates	15 Lectures
Unit IV	Fermentative Pathway & Anabolism of Carbohydrates	15 Lectures

USMB504	**Bioprocess Technology: Part - I**	**2.5 Credits (60 Lectures)**
Unit I	Upstream Processing - I	15 Lectures
Unit II	Upstream Processing - II	15 Lectures
Unit III	Fermentation Modes, Equipments and Instruments	15 Lectures
Unit IV	Traditional Industrial Fermentations	15 Lectures

(SEMESTER VI)

COURSE CODE	TITLE	CREDITS AND LECTURES / SEM
USMB601	**rDNA Technology, Bioinformatics & Virology**	**2.5 Credits (60 Lectures)**
Unit I	Recombinant DNA Technology	15 Lectures
Unit II	Applications of rDNA Technology & Bioinformatics	15 Lectures
Unit III	Regulation & Basic Virology	15 Lectures
Unit IV	Advanced Virology	15 Lectures
USMB602	**Medical Microbiology & Immunology: Part - II**	**2.5 Credits (60 Lectures)**
Unit I	Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention.	15 Lectures
Unit II	Chemotherapy of Infectious Agents	15 Lectures
Unit III	Immunology - I	15 Lectures
Unit IV	Immunology – II	15 Lectures
USMB603	**Microbial Biochemistry: Part - II**	**2.5 Credits (60 Lectures)**
Unit I	Lipid Metabolism & Catabolism of Hydrocarbons	15 Lectures
Unit II	Metabolism of Proteins and Nucleic Acids.	15 Lectures
Unit III	Metabolic Regulation	15 Lectures
Unit IV	Prokaryotic Photosynthesis & Inorganic Metabolism	15 Lectures
USMB604	**Bioprocess Technology: Part - II**	**2.5 Credits (60 Lectures)**
Unit I	Downstream Processing	15 Lectures
Unit II	Advances in Bioprocess Technology	15 Lectures
Unit III	Quality Assurance, Quality Control, Instrumentation and Bioassay	15 Lectures
Unit IV	Industrial Fermentations	15 Lectures

Syllabus for T. Y. B. Sc. Microbiology Semester V

From the year 2023-24

Name of the Course	Microbial Genetics
Course Code	USMB501
Class	T.Y.B.Sc.
Semester	V
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Microbial genetics is a subject area within microbiology and genetic engineering. Microorganisms have been used to study many processes and have had applications in various areas of study in genetics The learning of microbial genetics provides technical expertise in micro or molecular biology techniques. Microbial genetics can identify microorganisms at species, strains or sub strains levels. Microbial genetics can also study unique microbial characteristics such as virulence, antibiotic resistance and various microbial metabolic pathways using genetic analysis.

Nomenclature: Microbial Genetics

Course Outcomes:

1- The learner will understand the sequence of events, mechanism, enzymes and proteins involved in replication of DNA in prokaryotes and eukaryotes.

2- The student will know the central dogma of biology its two-step transcription and translation, maturation of RNA.

3- The learner will know the concept of mutation, its types, causes and their effects. This module will also make them understand types of mutagens, damage to DNA due to mutagenesis, various mechanisms of DNA repair.

4- The student shall understand the various mechanisms of gene transfer in bacteria and genetic recombination

Curriculum:

USMB501 – Microbial Genetics			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	DNA Replication	1.1. Historical perspective - Conservative, dispersive, semi-conservative, bidirectional and semi-discontinuous, Theta model of replication 1.2. Prokaryotic DNA replication - Details of molecular mechanisms involved in Initiation, Elongation and Termination 1.3. Enzymes and proteins associated with DNA replication- Primase, Helicase, Topoisomerase, SSB, DNA polymerases, Ligases, 1.4. Eukaryotic DNA replication - Molecular details of DNA synthesis, replicating the ends of the chromosomes. 1.5. Rolling circle mode of DNA replication	15 (1)
2	Transcription, Genetic Code and Translation	2.1 Central Dogma: An Overview, Transcription process, Transcription in bacteria - Initiation of transcription at promoters, elongation of an RNA chain, termination of an RNA chain. 2.2 Transcription in Eukaryotes - Eukaryotic RNA polymerase, Transcription of protein- coding genes by RNA polymerase II, Transcription initiation, The structure and production of Eukaryotic mRNAs, Production of mature mRNA in Eukaryotes, Processing of Pre-mRNA to mature mRNA. Self-Splicing of Introns, 2.3 Genetic code - Nature of genetic code and characteristics of genetic code. 2.4 Translation process - Transfer RNA, structure of tRNA, Recognition of the tRNA anticodon by the mRNA codon, Adding of amino acid to tRNA , Ribosomal RNA and Ribosomes, Ribosomal RNA Genes, Initiation of translation, Initiation in Bacteria, Initiation in eukaryotes, Elongation of the polypeptide chain, termination of translation, protein sorting in the cell.	15 (1)
3	Mutation and Repair	3.1 Mutation 3.1.1 Terminology: alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes.	15 (1)

		3.1.2 Fluctuation test. 3.1.3 Types of mutations: Point mutation, reverse mutation, suppressor mutation, frameshift mutation, conditional lethal mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation, pleiotropic mutations. 3.1.4 Causes of mutation: Natural/spontaneous mutation-- replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for: 3.1.4.1 Chemical mutagens - base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents. 3.1.4.2 Physical mutagen 3.1.4.3 Biological mutagen (only examples) 3.1.5 Ames test 3.1.6 Detection of mutants 3.2 DNA Repair 3.2.1 Mismatch repair, 3.2.2 Light repair 3.2.3 Repair of alkylation damage 3.2.4 Base excision repair 3.2.5 Nucleotide excision repair 3.2.6 SOS repair	
4	Genetic Exchange & Homologous Recombination	4.1 Genetic analysis of Bacteria 4.2 Gene transfer mechanisms in bacteria 4.2.1 Transformation 4.2.1.1 Introduction and History 4.2.1.2 Types of transformation in prokaryotes-- Natural transformation in *Streptococcus pneumoniae*, *Haemophilusinfluenzae*, and *Bacillus subtilis*. 4.2.1.3 Mapping of bacterial genes using transformation. 4.2.1.4 Problems based on transformation. 4.2.2 Conjugation 4.2.2.1 Discovery of conjugation in bacteria 4.2.2.2 Properties of F plasmid/Sex factor 4.2.2.3 The conjugation machinery 4.2.2.4 Hfr strains, their formation and mechanism of conjugation 4.2.2.5 F' factor, origin and behavior of F' strains, Sexduction. 4.2.2.6 Mapping of bacterial genes using conjugation (Wolman and Jacob experiment).	15 (1)

		4.2.2.7 Problems based on conjugation 4.2.3 Transduction 4.2.3.1 Introduction and discovery 4.2.3.2 Generalized transduction 4.2.3.3 Use of Generalized transduction for mapping genes 4.2.3.4 Specialized transduction 4.2.3.5 Problems based on transduction	

Learning Resources recommended:

Text books:

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. M. Madigan, J. Martinko, J. Parkar, (2009), "Brock Biology of microorganisms", 12th edition, Pearson Education International.
5. Prescott, Harley and Klein, "Microbiology", 7 th edition McGraw Hill international edition.
6. Robert Weaver, "Molecular biology", 3 rd edition. McGraw Hill international edition.
7. Nancy Trun and Janine Trempy, (2004), "Fundamental bacterial genetics", Blackwell Publishing
8. Snustad, Simmons, "Principles of genetics", 3rd edition. John Wiley & sons, Inc.

Reference books:

1. Benjamin Lewin, "Genes IX", Jones and Bartlett publishers.
2. JD Watson, "Molecular biology of the gene", 5 th edition.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Medical Microbiology & Immunology: Part – I
Course Code	USMB502
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Medical microbiology and immunology conducts biochemical assays including biochemical identification of microorganisms. It performs testing for water samples including bacteria identification and specs limits monitoring for microorganism in water samples. Medical microbiology participates in the validation of sterility testing in compliance with FDA guidelines. Immunologists can work as scientists or clinicians across different areas of biomedical research and in diverse clinical specialties ranging from allergy to cancer.

Nomenclature: Medical Microbiology & Immunology: Part - I

Course Outcomes:

1- The learners will correlate these virulence factors with the pathogenesis and clinical features of the disease

2- The learners will study the mode of transmission, method of diagnosis and modes of prophylaxis of these diseases

3- The learners will understand the importance of cytokines, MHC, APCs, Cytokines, and the role in adaptive immunity.

4- The learners will understand the various antigen –antibody reactions

Curriculum:

USMB502 – Medical Microbiology & Immunology: Part - I			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Bacterial Strategies for Evasion and Study of a Few Diseases	1.1. Study of virulence mechanisms in bacteria 1.1.1. Pathogenicity islands 1.1.2. Bacterial virulence factors 1.1.2.1. Adherence factors 1.1.2.2. Invasion of host cells and tissues 1.1.3. Toxins 1.1.3.1. Exotoxins 1.1.3.2. Exotoxins associated with diarrheal diseases and food poisoning 1.1.3.3. LPS of gram negative bacteria 1.1.4. Enzymes 1.1.4.1. Tissue degrading enzymes 1.1.4.2. IgA1 proteases 1.1.5. Antiphagocytic factors 1.1.6. Intracellular pathogenicity 1.1.7. Antigenic heterogeneity 1.1.8. The requirement for iron 1.2. Study of A Few Infectious Diseases of the Respiratory Tract (wrt. Cultural Characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only) 1.2.1. *S. pyogenes* infections 1.2.2. Influenza 1.2.3. Pneumonia caused by *K .pneumoniae* 1.3. Study of urinary tract infections	15 (1)
2	Study of few diseases (w.r.t. Cultural characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only)	2.1 Study of skin infections 2.1.1 Pyogenic skin infections caused by *Pseudomonas* and *S. aureus* 2.1.2 Leprosy 2.1.3 Fungal infections- Candidiasis 2.1.4 Viral Infections- Herpes simplex 2.2 Study of gastrointestinal tract infections 2.2.1 Infections due to Enteropathogenic *E.coli* strains 2.2.2 Enteric fever- *Salmonella* 2.2.3 Shigellosis 2.2.4 Rotavirus diarrhoea	15 (1)
3	General Immunology – I	3.1. Organs and tissues of the immune system: 3.1.1 Primary lymphoid organs - structure and	15 (1)

		function of Thymus and Bone marrow 3.1.2 Secondary lymphoid organs – structure and function of Spleen, Lymph node, Mucosa associated lymphoid tissues, Bronchus associated lymphoid tissue, Gut associated lymphoid tissue, Cutaneous associated lymphoid tissue 3.2 Antigens 3.2.1 Immunogenicity versus antigenicity: Concepts - Immunogenicity, Immunogen, Antigencity, Antigen, Haptens. Haptens as valuable research and diagnostic tools 3.2.2 Factors that influence immunogenicity - Foreignness, Molecular size, Chemical composition, Heterogeneity, Susceptibility of antigen to be processed and presented, Contribution of the biological system to immunogenicity Genotype of the recipient, Immunogen dosage, Route of administration 3.2.3 Adjuvants 3.2.4 Epitopes / antigen determinants - General concept, Characteristic properties of B - cell epitopes, concepts of sequential and non-sequential epitopes (with only one example each). Properties of B - cell and T - cell epitopes. Comparison of antigen recognition by T cells and B cells 3.3 Immunoglobulins 3.3.1 Immunoglobulins – basic structure of Immunoglobulins, heterodimer; types of heavy and light chains; constant and variable regions, Immunoblobulin domains-hinge region. Basic concepts - hypervariable region. 3.3.2 Immunoglobulin classes and biological activities - Immunogloublin G, Immunogloublin M, Immunogloublin A, Immunogloublin E, Immunogloublin D, (including diagrams) 3.3.3 Antigenic determinants on immunoglobulins – isotypes, allotypes, idiotypes. (Only concept) 3.3.4 Immunoglobulin Superfamily	
4	General Immunology – II	4.1 Cytokines 4.1.1 Concepts - cytokines, lymphokines, monokines, interleukines, chemokines.	15 (1)

		4.1.2 Properties of cytokines 4.1.3 Attributes of cytokines 4.1.4 Biological functions of cytokines 4.2 Major histocompatibility complex 4.2.1 Introduction 4.2.2 Three major classes of MHC encoded molecules 4.2.3 The basic structure and functions of Class I and Class II MHC Molecules 4.2.4 Peptide binding by Class I and Class II MHC molecule 4.3 Antigen presenting cells 4.3.1 Types of APC's 4.3.2 Endogenous antigens: The cytosolic pathway (Diagram only) 4.3.3 Exogenous antigens: The endocytic pathway (Diagram only) 4.4 Antigen Antibody reactions 4.4.1 Precipitation reaction - Immunoelectrophoresis 4.4.2 Agglutination reactions - haeme-agglutination, bacterial agglutination, passive agglutination, agglutination inhibition. 4.4.3 Radioimmunoassay (RIA), 4.4.4 Enzyme Linked Immunosorbent Assay - indirect, competitive and sandwich ELISA 4.4.5 Immunofluorescence- Direct and indirect. 4.4.6 Western blotting.	

Learning Resources recommended:

Text books:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Kuby Immunology, 6th Edition, W H Freeman and Company
6. Pathak &Palan, Immunology: Essential & Fundamental, 1 st& 3rd edition, Capital Publishing Company
7. Fahim Khan, Elements of Immunology, Pearson Education

Reference books / Internet references:

1. Kuby Immunology, 7th edition, W H Freeman and Company
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition

3. Baron Samuel , Medical Microbiology, 4th edition
4. http://www.ncbi.nlm.nih.gov/books/NBK7627/
5. http://www.macmillanlearning.com/catalog/static/whf/kuby/

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Microbial Biochemistry: Part - I
Course Code	USMB503
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Microbial biochemistry gains the molecular knowledge in virology, pharmacology and toxicology. It also provides a knowledge of data analysis, marketing and scientific communication. The study helps you to observe things from a completely new perspective to get them translated into new opportunities.

Nomenclature: Microbial Biochemistry: Part – I

Course Outcomes:

1- The learner will understand the architecture of the membrane and how solute is transported inside the cell.

2- The learner will understand the electron transport chains in prokaryotes and mitochondria and the mechanism of ATP synthesis.

3- The learner will understand experimental aspect of studying catabolism, anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.

4- The learner will understand various other pathways that produce different end products.

Curriculum:

USMB503 – Microbial Biochemistry: Part – I			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Biological Membranes & Transport	1.1 Composition and architecture of membrane 1.1.1 Lipids and properties of phospholipid membranes 1.1.2 Integral & peripheral proteins & interactions with lipids 1.1.3 Permeability 1.1.4 Aquaporins 1.1.5 Mechanosensitive channels 1.2 Methods of studying solute transport 1.2.1 Use of whole cells 1.2.2 Liposomes 1.2.3 Proteoliposomes 1.3 Solute transport across membrane 1.3.1 Passive transport and facilitated diffusion by membrane proteins 1.3.2 Co-transport across plasma membrane - (Uniport, Antiport, Symport) 1.3.3 Active transport & electrochemical gradient 1.3.4 Ion gradient provides energy for secondary active transport 1.3.4.1 Lactose transport 1.3.5 ATPases and transport (only Na-K ATPase) 1.3.6 Shock sensitive system – Role of binding proteins 1.3.6.1 Maltose uptake (Diagram and description) 1.3.6.2 Histidine uptake (Diagram and description) 1.3.7 Phosphotransferase system 1.3.8 Schematic representation of various membrane transport systems in bacteria. 1.4 Other examples of solute transport: 1.4.1 Iron transport: A special problem 1.4.2 Assembly of proteins into membranes and protein export 1.4.3 Bacterial membrane fusion central to many biological processes	15 (1)
2	Bioenergetics & Bioluminescence	2.1 Biochemical mechanism of generating ATP: Substrate-Level Phosphorylation, Oxidative Phosphorylation & Photophosphorylation 2.2 Electron transport chain 2.2.1 Universal Electron acceptors that transfer	15 (1)

		electrons to E.T.C. 2.2.2 Carriers in E.T.C. 2.2.2.1 Hydrogen carriers – Flavoproteins, Quinones 2.2.2.2 Electron carriers – Iron Sulphur proteins, Cytochromes. 2.2.3 Mitochondrial ETC 2.2.3.1 Biochemical anatomy of mitochondria 2.2.3.2 Complexes in Mitochondrial ETC 2.2.3.3 Schematic representation of Mitochondrial ETC. 2.3 Prokaryotic ETC 2.3.1 Organization of electron carriers in bacteria 2.3.1.1 Generalized electron transport pathway in bacteria 2.3.1.2 Different terminal oxidases 2.3.2 Branched bacterial ETC 2.3.3 Pattern of electron flow in *E. coli* - aerobic and anaerobic 2.4 ATP synthesis 2.4.1 Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential) 2.4.2 Free energy released during electron transfer from NADH to O2 2.4.3 Chemiosmotic theory (only explanation) 2.4.4 Structure & function of Mitochondrial ATP synthase 2.4.5 Structure of bacterial ATP synthase 2.4.6 Mechanism by Rotational catalysis 2.4.7 Inhibitors of ETC, ATPase and uncouplers 2.5 Other modes of generation of electrochemical energy 2.5.1 ATP hydrolysis 2.5.2 Oxalate formate exchange 2.5.3 End product efflux, Definition, Lactate efflux 2.5.4 Bacteriorhodopsin: - Definition, function as proton pump and significance	
3	Methods of Studying Metabolism & Catabolism of Carbohydrates	3.1 Experimental Analysis of metabolism 3.1.1 Goals of the study 3.1.2 Levels of organization at which metabolism is studied 3.1.3 Metabolic probes. 3.1.4 Use of radioisotopes in biochemistry	15 (1)

		3.1.4.1 Pulse labeling 3.1.4.2 Assay and study of radiorespirometry to differentiate EMP & ED 3.1.5 Use of biochemical mutants 3.2 Catabolism of Carbohydrates 3.2.1 Breakdown of polysaccharides - Glycogen, Starch, Cellulose 3.2.2 Breakdown of oligosaccharides - Lactose, Maltose. 3.2.3 Utilization of monosaccharides - Fructose, Galactose 3.2.4 Major pathways – (with structure and enzymes) 3.2.4.1 Glycolysis (EMP) 3.2.4.2 HMP Pathway - Significance of the pathway 3.2.4.3 ED pathway 3.2.4.4 TCA cycle - Action of PDH, Significance of TCA 3.2.4.5 Incomplete TCA in anaerobic bacteria 3.2.4.6 Anaplerotic reactions 3.2.4.7 Glyoxylate bypass 3.3 Amphibolic role of EMP; Amphibolic role of TCA cycle 3.4 Energetics of Glycolysis, TCA and ED pathway – Balance sheet only. Format as in Lehninger (2.5 ATP/NADH and 1.5 ATP / FADH2) (Based on this format make balance sheet for Glycolysis - Lactic acid and Alcohol fermentation and for ED pathway.	
4	Fermentative Pathway & Anabolism of Carbohydrates	4.1 Fermentative pathways (with structures and enzymes) 4.1.1 Lactic acid fermentation 4.1.1.1 Homofermentation 4.1.1.2 Heterofermentation 4.1.2 Bifidum pathway 4.1.3 Alcohol fermentation 4.1.3.1 By ED pathway in bacteria 4.1.3.2 By EMP in yeasts 4.2 Other modes of fermentation in microorganisms 4.2.1 Mixed acid 4.2.2 Butanediol 4.2.3 Butyric acid 4.2.4 Acetone-Butanol 4.2.5 Propionic acid (Acrylate and succinate	15 (1)

		propionate pathway) 4.3 Anabolism of Carbohydrates 4.3.1 General pattern of metabolism leading to synthesis of a cell from glucose. 4.3.2 Sugar nucleotides 4.3.3 Gluconeogenesis (only bacterial) 4.3.4 Biosynthesis of glycogen 4.3.5 Biosynthesis of Peptidoglycan	

Learning Resources recommended:

Text books:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
2. Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5 th edition, 1987. John Wiley &Sons. New York.
3. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
5. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry. 4th edition, W. H. Freeman and Company
6. Rose, A.H. (1976) Chemical Microbiology, 3rd edition. Butterworth-Heinemann
7. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
8. Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill (2012) Biochemistry, 4th edition. Pearson
9. Wilson and Walker, 4th edition Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University press.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Bioprocess Technology: Part – I
Course Code	USMB504
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Bioprocess technology is a part of industrial microbiology, which conducts environmental monitoring on manufacturing facility. Industrial microbiologists study and solve problems related to industrial production processes. Industrial microbiologists may responsible for research, product testing, quality control, product development and genetic engineering. It also supports and prepared protocol for startup and annual environmental monitoring for new facilities, environmental testing and disposition of microbial samples. It participates in the internal audits on microbiology test methods and activities to identify improvement opportunities.

Nomenclature: Bioprocess Technology: Part - I

Course Outcomes:

1- The learner shall study the applications of microbes and its strain improvement in Industrial Microbiology.

2- The learner shall understand design media, growth conditions and techniques for producing and recovering different types of products of commercial value.

3- The learner shall study the design of bioreactors for different applications and its process parameters.

4- Learner will be well-versed with the containment and levels of containment.

Curriculum:

USMB504 – Bioprocess Technology: Part – I			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Upstream Processing – I	1.1 Introduction 1.1.1 An introduction to fermentation processes 1.1.2 The range of fermentation processes 1.1.3 The Component parts of a fermentation process 1.2 Screening methods 1.2.1 Primary and secondary screening 1.2.2 High throughput screening methods 1.3 Strain improvement 1.3.1 The improvement of industrial microorganisms 1.3.2 The selection of induced mutants synthesizing improved levels of primary metabolites 1.3.3 The isolation of induced mutants producing improved yields of secondary metabolites. 1.4 Preservation of cultures 1.4.1 Preservation of industrially important organisms 1.4.2 Quality control of preserved stock 1.4.2.1. Development of a master culture bank (MCB)	15 (1)
2	Upstream Processing – II	2.1 Fermentation media formulation and raw materials 2.1.1 Media formulation 2.1.2 Raw materials for fermentation media 2.2 The development of inocula for industrial fermentations 2.2.1 Introduction 2.2.2 Development of inocula for unicellular bacterial process 2.2.3 Development of inocula for mycelial process 2.3 Sterilization and achievement of aseptic conditions 2.3.1 Introduction 2.3.2 Methods of batch sterilization 2.3.3 The design of continuous sterilization process 2.3.4 Sterilization of the Fermenter 2.3.5 Sterilization of the Feeds 2.3.6 Sterilization of the liquid wastes 2.3.7 Filter Sterilization 2.3.8.1 Filter sterilization of fermentation media, 2.3.8.2 Filter sterilization of air 2.4 Scale up and scale down of fermentation	15 (1)
3	Fermentation Modes, Equipments and Instruments	3.1 Modes of fermentation 3.1.1 Batch, continuous and fed batch fermentation 3.1.2 Solid substrate fermentation 3.2 Design of fermenter	15 (1)

		3.2.1 Basic functions 3.2.2 Aseptic operation & Containment 3.2.3 Body construction 3.2.4 Agitator (impeller) – function, types, mechanical seal and magnetic drive 3.2.5 Baffles 3.2.6 The aeration system (sparger) - function and types 3.2.7 Valves (Globe, piston & needle) 3.2.8 Examples of fermenters - Stirred Tank Reactor, Air Lift, Deep Jet, Photobioreactor 3.3 Instrumentation and control 3.3.1 Introduction to sensors and its types 3.3.2 Measurement and control of: pH, temperature, pressure, foam sensing, dissolved oxygen, inlet and exit gas analysis.	
4	Traditional Industrial Fermentations	4.1 Wine – Red, White, Champagne and Sherry: Alcoholic fermentation, composition of grape juice, Sulphur dioxide addition, factors affecting wine fermentation, examples and role of yeasts involved in fermentation, malolactic fermentation, technological aspects of wine making- red, white, champagne, sherry, examples of aroma compounds of wine, types and examples of wine 4.2 Beer – Ale and Lager: Elements of brewing process, process details, use of cylindro-conical vessel, primary fermentation, continuous fermentation, aging and finishing, yeasts involved in fermentation. 4.3 Alcohol from Molasses: Introduction, biosynthesis of ethanol, production process- preparation of nutrient solution, fermentation, recovery by distillation. 4.4 Vinegar (acetic acid): Introduction, biosynthesis, production using generator, production using submerged fermenter, recovery. 4.5 Baker's yeast: Outline of production, yeast strains and their properties, factors important in production-oxygen requirement and aeration, concentration of sugar, pH, temperature, preparation of substrate, fermentation, harvesting of yeast cells, production of compressed and active dry yeast. 4.6 Fungal amylase production: $\propto$ amylase- production from bacteria and fungi, β amylase and glucoamylase, concentration and purification.	15 (1)

Learning Resources recommended:

Text books:

1. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.
3. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
4. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol. 1 & 2, Academic Press
5. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India.
6. OkaforNduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
7. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology.
8. Microbiology", 2nd edition, Panima Publishing Corporation, New Delhi.
9. Prescott and Dunn's ''Industrial Microbiology'' (1982) 4th edition, McMillan Publishers

Reference books:

1. R. C. Dubey, 2005 A Textbook of ''Biotechnology'' S. Chand and Company, New Delhi.
2. H. A. Modi, 2009. ''Fermentation Technology'' Vol: 1 & 2, Pointer Publications, India
3. Practical Fermentation Technology by Brian Mcneil& Linda M. Harvey (2008).

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Practical of USMB501 and USMB502
Course Code	USMBP05
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The microbial genetics and immunology practicals are based on the variety of knowledge related to replica plate technique, UV mutagenesis and identification of microorganisms. Replica plate methods allows each clone to be tested by a variety of methods while retaining a master plate form, which clones, can be picked. It performs testing for water samples including bacteria identification and specs limits monitoring for microorganism in water samples.

Nomenclature: Practical of USMB501 and USMB502

Course Outcomes:

1- The learner will acquire the practical skills of laboratory techniques based on UV mutagenesis and UV survival curve.

2- The learner will acquire the knowledge of identification of isolates obtained from pus, sputum, stool and urine.

Curriculum:

USMBP05 – Practical of USMB501 and USMB502		
Title	**Learning Points**	**No of Lectures**
Microbial Genetics	1. UV survival curve – determination of exposure time leading to 90% reduction 2. Isolation of mutants using UV mutagenesis 3. Gradient plate technique (dye resistant mutant) 4. Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant.	60(2)
Medical Microbiology & Immunology: Part - I	1. Acid fast staining. 2. Identification of Candida species using the germ tube test and growth on Chrom agar 3. Study of standard cultures *E. coli, Klebsiella spp., Proteus spp., Pseudomonas spp., Salmonallatyphi, S. paratyphi A, S. paratyphi B, Shigella spp., S .pyogenes, S. aureus* 4. Identification of isolates obtained from pus, sputum, stool and urine by morphological, cultural and biochemical properties. 5. Antigen Preparation: O & H antigen preparation of Salmonella. Confirmation by slide agglutination	60(2)

Learning Resources recommended:

Text books:

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. Robert Weaver, "Molecular biology", 3 rd edition. McGraw Hill international edition
4. Kuby Immunology, 6th Edition, W H Freeman and Company
5. Pathak &Palan, Immunology: Essential & Fundamental, 1 st& 3rd edition, Capital Publishing Company
6. Fahim Khan, Elements of Immunology, Pearson Education

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Practical of USMB503 and USMB504
Course Code	USMBP06
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Microbial biochemistry gains the molecular knowledge in virology, pharmacology and toxicology. Industrial microbiologists study and solve problems related to industrial production processes. Industrial microbiologists may responsible for research, product testing, quality control, product development and genetic engineering. It also supports and prepared protocol for startup and annual environmental monitoring for new facilities, environmental testing and disposition of microbial samples.

Nomenclature: Practical of USMB503 and USMB504

Course Outcomes:

1- The learner will acquire the practical skills of laboratory techniques based on qualitative and quantitative assay of phosphatase.

2- The learner will acquire the hands on skill of alcohol fermentation and screening methods.

Curriculum:

USMBP06 – Practical of USMB503 and USMB504		
Title	**Learning Points**	**No of Lectures**
Microbial Biochemistry: Part – I	1. Isolation and study of Bioluminescent organisms 2. Study of oxidative and fermentative metabolism 3. Qualitative and Quantitative assay of Phosphatase 4. Study of Homo–Heterofermentations 5. Glucose detection by GOD/POD	60(2)
Bioprocess Technology: Part – I	1. Alcohol Fermentation 1.1. Preparation and standardization of yeast inoculums for alcohol fermentation 1.2. Laboratory Alcohol fermentation using jaggery medium, calculation of efficiency of fermentation. 2. Determine the alcohol tolerance for yeast. 3. Determine the sugar tolerance for yeast. 4. Chemical estimation of sugar by Cole's ferricyanide method 5. Chemical estimation of alcohol 6. Production of amylase- detection, shake flask or solid substrate cultivation and detection (Qualitative). 7. Primary screening for antibiotic producers using Wilkin's agar overlay method. 8. Industrial Visit	60(2)

Learning Resources recommended:

Text books:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd.
2. Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5 th edition, 1987. John Wiley &Sons. New York.
3. Wilson and Walker, 4th edition Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University press.
4. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
5. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.
6. Crueger W. and Crueger A. (2000) "Biotechnology –"A Textbook of Industrial Microbiology.

Evaluation Pattern

C. Internal Evaluation

Method	Marks
Journal	20
Viva	10
Class performance	10
Total	**40**

D. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Syllabus for T. Y. B. Sc. Microbiology Semester VI

From the year 2023-24

Name of the Course	rDNA Technology, Bioinformatics & Virology
Course Code	USMB601
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Microbes are ideally suited for biochemical and genetics studies. The rDNA technology allows scientist to insert, delete or modify specific genes of an organism's DNA in a precise and controlled manner. Recombinant DNA is also used to produce food additives and enzymes for the production of various food products. The rDNA technology provides technical expertise in micro or molecular biology techniques including real-time PCR and data analysis. It performs PCR, RT-PCR, real time RT-PCR. It utilizes PCR denature, anneal, elongate and amplification of a DNA fragment. DNA fingerprinting utilized for the identification purpose. Bioinformatics helps the doctors to more accurately diagnose and treat diseases.

Nomenclature: rDNA Technology, Bioinformatics & Virology

Course Outcomes:

1- This module will make the student to understand the methods to construct recombinant DNA molecules, also know the tools required like vectors, restriction enzymes etc.

2- The learner will know about applications of rDNA technology, through bioinformatics the student will understand the use of databases and software tools for understanding biological data.

3- The student will know about gene expression in prokaryotes, operon as a unit of gene regulation, regulation of gene expression in prokaryotes and bacteriophages. The student will also understand about general structure, life cycle and classification of viruses.

4- The learner will understand the basic structure and life cycle of different viruses and their cultivation. The student will get basic knowledge on Prions, Viroid and viruses causing cancer.

Curriculum:

USMB601 – rDNA Technology, Bioinformatics & Virology			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Recombinant DNA Technology	1.1 Branches of Genetics 1.1.1 Transmission genetics 1.1.2 Molecular genetics 1.1.3 Population genetics 1.1.4 Quantitative genetics 1.2 Model Organisms 1.2.1 Characteristics of a model organism 1.2.2 Examples of model organisms used in study 1.2.3 Examples of studies undertaken using prokaryotic and eukaryotic model organisms 1.3 Plasmids 1.3.1 Physical nature 1.3.2 Detection and isolation of plasmids 1.3.3 Plasmid incompatibility and Plasmid curing 1.3.4 Cell to cell transfer of plasmids 1.3.5 Types of plasmids 1.3.6 Resistance Plasmids, Plasmids encoding Toxins and other Virulence characteristics, Colfactor, Degradative plasmids 1.4 Transposable Elements in Prokaryotes 1.4.1 Insertion sequences 1.4.2 Transposons: Types, Structure and properties, Mechanism of transposition, Integrons 1.5 Basic steps in Gene Cloning. 1.6 Cutting and joining DNA molecules - Restriction and modification systems, restriction endonucleases, DNA ligases 1.7 Vectors 1.7.1 Plasmids as cloning vectors. plasmid vectors, pBR322 vector 1.7.2 Cloning genes into pBR322 1.7.3 Phage as cloning vectors, cloning genes into phage vector 1.7.4 Cosmids 1.7.5 Shuttle vectors 1.7.6 YAC 1.7.7 BAC 1.8 Methods of transformation	15 (1)
2	Applications of rDNA Technology & Bioinformatics	2.1 PCR- basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR)	15 (1)

		2.2 Basic techniques 2.2.1 Southern, Northern and Western blotting. 2.2.2 Autoradiography (explain the term 2.3 Screening and selection methods for identification and isolation of recombinant cells 2.4 Applications of recombinant DNA technology: Site specific mutagenesis of DNA, Uses of DNA polymorphism, STRS and VNTRS, DNA molecular testing for human genetic diseases (Only RFLP), DNA typing, gene therapy, Genetic engineering of plants and animals. 2.5 Bioinformatics 2.5.1 Introduction 2.5.2 Definition, aims, tasks and applications of Bioinformatics. 2.5.3 Database, tools and their uses – 2.5.3.1 Importance, Types and classification of databases 2.5.3.2 Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. 2.5.3.3 Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D.Protein structure databases SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG. 2.5.4 Explain the terms: Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, Genomics- structural, functional and comparative genomics, Proteomics - structural and functional proteomics, Sequence alignment - global v/s local alignment, FASTA, BLAST (Different types of BLAST)	
3	Regulation & Basic Virology	3.1 A) Lac operon and problems on Lac operon B) Trp operon 3.2 Regulation of lytic and lysogenic pathway of lambda phage 3.3 Viral architecture - Capsid, viral genome and envelope 3.4 Viral classification (Baltimore classification) 3.5 Viral replication cycle - Attachment, penetration, uncoating, types of viral genome, their replication, assembly, maturation & release.	15 (1)
4	Advanced Virology	4.1 Structure of TMV, T4, Influenza virus, HIV. Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail.	15 (1)

		4.2 Cultivation of viruses- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue 4.3 Visualization and enumeration of virus particles 4.3.1 Measurement of infectious units 4.3.1.1 Plaque assay 4.3.1.2 Fluorescent focus assay 4.3.1.3 Infectious center assay 4.3.1.4 Transformation assay 4.3.1.5 Endpoint dilution assay. 4.3.2 Measurement of virus particles and their components 4.3.2.1 Electron microscopy 4.3.2.2 Atomic force microscopy 4.3.2.3 Haemagglutination 4.3.2.4 Measurement of viral enzyme activity. 4.4 Role of viruses in cancer: Important definitions, characteristics of cancer cell, Human DNA tumor viruses- EBV, Kaposis sarcoma virus, Hepatitis B and C virus, Papiloma Virus. 4.5 Prions: Defination, Examples of diseases caused by prions, Kuru, PrP protein and protein only hypothesis 4.6 Viroids	

Learning Resources recommended:

Text books:

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. M. Madigan, J. Martinko, J. Parkar, (2009), "Brock Biology of microorganisms", 12th edition, Pearson Education International.
5. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
6. Prescott, Harley and Klein, "Microbiology", 7th edition McGraw Hill international edition.
7. Edward Wagner and Martinez Hewlett, (2005) "Basic Virology", 2nd edition, Blackwell Publishing
8. Teri Shors, (2009), "Understanding viruses", Jones and Bartlett publishers.
9. S.Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house.
10. Robert Weaver, (2008), "Molecular biology", 3rd edition, McGraw Hill international edition.

11. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6th edition, Blackwell Publishing
12. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd edition, Oxford University Press
13. Snustad, Simmons, "Principles of genetics", 3rd edition. John Wiley & sons, Inc.
14. A textbook of biotechnology R. C. Dubey 4 th edition. S. Chand.

Reference books:

1. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2 nd edition. ASM press.
2. T. K. Attwood & D. J. Parry-Smith, (2003), "Introduction to bioinformatics", Pearson education
3. Benjamin Lewin, (9th edition), "Genes IX", Jones and Bartlett publishers.
4. JD Watson, "Molecular biology of the gene", 5th edition.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Medical Microbiology & Immunology: Part - II
Course Code	USMB602
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Medical microbiology performs antimicrobial effectiveness testing and other traditional microbiological testing to identify organisms and interpret the results. Tested process equipment and production areas for contamination and environmental pathogens to monitor the effectiveness of sanitation measures throughout the facility. Research focuses on the identification and characterization of bacterial pathogens. Immunologists are actively involved in the drug discovery process in pharmaceutical sector especially for the development of antibodies and vaccines. Immunologists are employed in a varied range of organization across different areas in science and medicine.

Nomenclature: Medical Microbiology & Immunology: Part - II

Course Outcomes:

1- The learners shall understand the virulence factors, morphological and cultural features of the pathogen and correlate these virulence factors with the pathogenesis and clinical features of the disease.

2- The learners shall understand clinical features of pathogens and identify the causative agent.

3- The learners shall understand the structure and role of T and B cells in generating adaptive immunity and thereby study effector responses in both Humoral& Cell Mediated Immunity.

4- The learners shall understand the activation of complement system.

Curriculum:

USMB602 – Medical Microbiology & Immunology: Part - II			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention.	1.1 Study of vector-borne infections - Malaria 1.2 Study of sexually transmitted infectious diseases 1.2.1 Syphilis 1.2.2 AIDS 1.2.3 Gonorrhoea 1.3 Study of central nervous system infectious diseases 1.3.1 Tetanus 1.3.2 Polio 1.3.3 Meningococcal meningitis	15 (1)
2	Chemotherapy of Infectious Agents	2.1 Attributes of an ideal chemotherapeutic agent - Selective toxicity, Bioavailability of drug, routes of drug administration, LD50, MBC, etc. 2.2 Mode of action of antibiotics on 2.2.1 Cell wall (Beta-lactams- Penicillin and Cephalosporins, Carbapenems) 2.2.2 Cell Membrane (Polymyxin and Imidazole) 2.2.3 Protein Synthesis (Streptomycin, Tetracycline and Chloramphenicol) 2.2.4 Nucleic acid (Quinolones, Nalidixic acid, Rifamyicn) 2.2.5 Enzyme inhibitors (Sulfa drugs, Trimethoprim) 2.3 List of common antibiotics - used for treating viral, fungal and parasitic diseases. 2.4 Mechanisms of drug resistance - Its evolution, pathways and origin for ESBL, VRE, MRSA 2.5 (i) Selection and testing of antibiotics for bacterial isolates by Kirby Bauer method (ii) Methods that detect *S. aureus* resistance to methicillin, and determination of ESBL strains	15 (1)
3	Immunology - I	3.1 T cells 3.1.1 T Cell Receptor-structure (alpha-beta, gamma-delta TCR) 3.1.2 TCR-CD3 complex - structure and functions. Accessory molecules 3.1.3 T cell activation 3.1.3.1 TCR mediated signaling – Overview	15 (1)

		3.1.3.2 Costimulatory signals 3.1.3.3 Superantigens induced T cell activation 3.1.4 T cell differentiation (Memory and Effector cells) 3.2 Cell mediated effector response 3.2.1 General properties of effector T cells 3.2.2 Cytotoxic T cells and destruction of target cell by perforin/granzyme pathway and Fas pathway 3.2.3 Killing mechanism of NK cells 3.2.4 Antibody mediated cell cytotoxicity (ADCC) 3.3 B cells 3.3.1 B cell receptor and co-receptor-structure and function 3.3.2 B cell activation and Differentiation 3.3.2.1 Thymus dependant and independent antigens 3.3.2.2 Signal transduction pathway activated by BCR overview 3.4 Humoral Response 3.4.1 Primary and secondary responses 3.4.2 In vivo sites for induction of Humoral response 3.4.3 Germinal centers and antigen induced B cell Differentiation 3.4.3.1 Cellular events within germinal centers-Overview 3.4.3.2 Affinity maturation, somatic hyper-mutation and class switching (only concept) 3.4.3.3 Generation of plasma cells and memory cells	
4	Immunology – II	4.1 Vaccines 4.1.1 Active and passive immunization 4.1.2 Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines 4.1.3 Use of adjuvants in vaccine 4.1.4 New vaccine strategies 4.1.5 Ideal vaccine 4.1.6 Route of vaccine administration, Vaccination schedule 4.2 Immunohaematology 4.2.1 Human blood group systems, ABO, secretors and non secretors, Bombay Blood	15 (1)

		group. Rhesus system and list of other blood group systems 4.2.2 Haemolytic disease of new born, Coombs test. 4.3 Complement System 4.3.1 Functions and components of complement 4.3.2 Complement Activation—classical, alternative and lectin pathway 4.3.3 Biological consequences of complement activation.	

Learning Resources recommended:

Text books:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th edition, Lange publication
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition 2017
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Introduction to diagnostic microbiology for lab Science Maria DannessaDelost 2015
6. Prescott's microbiology 10th edition 2017
7. Kuby Immunology, 4th and 6th edition, W H Freeman and Company
8. Pathak &Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
9. Fahim Khan, Elements of Immunology, Pearson Education

Reference books:

1. Baron Samuel, Medical Microbiology, 4th edition http://www.ncbi.nlm.nih.gov/books/NBK7627/
2. Kuby Immunology, 7th edition, W H Freeman and Company http://www.macmillanlearning.com/catalog/static/whf/kuby/

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Microbial Biochemistry: Part – II
Course Code	USMB603
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	In biochemistry has working area like research lab, product development, healthcare and forensics. To successfully gain employment in biochemistry, problem solving, data analysis, process creation and project management are the key skills. In addition, you will develop a deeper understanding of the fundamental processes of life at molecular and cellular levels

Nomenclature: Microbial Biochemistry: Part - II

Course Outcomes:

1- The learner will have an understanding of metabolism of lipids, fatty acids, nucleotides and amino acids.
2- The learner will have an understanding of catabolism of protein and aliphatic hydrocarbons.
3- The learner will have an understanding of regulation of metabolic process at various levels.
4- The learner will have an understanding of photosynthesis and metabolism of inorganic molecules with special reference to nitrate and sulfate.

Curriculum:

USMB603 – Microbial Biochemistry: Part – II			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Lipid Metabolism & Catabolism of Hydrocarbons	1.1 Introduction to Lipids 1.1.1 Lipids –Definition, classification & functions 1.1.2 Types and role of fatty acids found in bacteria 1.1.3 Common phosphoglycerides in bacteria 1.1.4 Action of lipases on triglycerides /tripalmitate 1.2 Catabolism of Fatty Acids and PHB 1.2.1 Oxidation of saturated fatty acid by β oxidation pathway 1.2.2 Energetics of β oxidation of Palmitic acid 1.2.3 Oxidation of propionyl CoA by acrylyl-CoA pathway and methylcitrate pathway 1.2.4 PHB as a food reserve and its degradation 1.3 Anabolism of Fatty Acids & Lipids 1.3.1 Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) 1.3.2 Biosynthesis of phosphoglycerides in bacteria 1.3.3 Biosynthesis of PHB 1.4 Catabolism of aliphatic hydrocarbons 1.4.1 Organisms degrading aliphatic hydrocarbons 1.4.2 Hydrocarbon uptake mechanisms 1.4.3 Omega oxidation pathway 1.4.3.1 Pathway in *Corynebacterium* and yeast 1.4.3.2 Pathway in *Pseudomonas*	15 (1)
2	Metabolism of Proteins and Nucleic Acids.	2.1 Protein / amino acid catabolism 2.1.1 Enzymatic degradation of proteins 2.1.2 General reactions of amino acids catalyzed by 2.1.2.1 Amino acid decarboxylases 2.1.2.2 Amino acid deaminases 2.1.2.3 Amino acid transaminases 2.1.2.4 Amino acid racemases 2.1.3 Metabolic fate of amino acids - Glucogenic and ketogenic amino acids 2.1.4 Fermentation of single amino acid - Glutamic acid by *Clostridium tetanomorphum*	15 (1)

		2.1.5 Fermentation of pair of amino acids - Stickland reaction (include enzymes) 2.2 Anabolism of amino acids 2.2.1 Schematic representation of amino acid families 2.2.2 Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine) 2.3 Catabolism of Nucleotides 2.3.1 Degradation of purine nucleotides up to uric acid formation 2.3.2 Salvage pathway for purine and pyrimidine nucleotides 2.4 Biosynthesis of nucleotides 2.4.1 Nomenclature and structure of nucleotides 2.4.2 Role of nucleotides (high energy triphosphates) 2.4.3 Biosynthesis of pyrimidine nucleotides 2.4.4 Biosynthesis of purine nucleotides 2.4.5 Biosynthesis of deoxyribonucleotides	
3	Metabolic Regulation	3.1 Definition of terms and major modes of regulation 3.2 Regulation of enzyme activity 3.2.1 Noncovalent enzyme inhibition 3.2.1.1 Allosteric enzymes and feedback inhibition 3.2.1.2 Patterns of FBI, combined activation and inhibition 3.2.2 Covalent modification of enzymes 3.2.2.1 Monocyclic cascades 3.2.2.2 Examples of covalent modification(without structures) 3.2.2.3 Regulation of Glutamine synthetase 3.3 DNA binding proteins and regulation of transcription by positive & negative control 3.3.1 DNA binding proteins 3.3.2 Negative control of transcription: Repression and Induction 3.3.3 Positive control of transcription: Maltose catabolism in E. coli 3.4 Global regulatory mechanisms 3.4.1 Global control &catabolite repression 3.4.2 Stringent response 3.5 Regulation of EMP and TCA cycle - (Schematic and Regulation of Pryruvate dehydrogenase Complex)	15 (1)

4	Prokaryotic Photosynthesis &Inorganic Metabolism	4.1 Photosynthesis 4.1.1 Definition of terms in photosynthesis (light and dark reactions, Hill reaction & reagent, Photophosphorylation) 4.1.2 Photosynthetic pigments 4.1.3 Location of photochemical apparatus 4.1.4 Photochemical generation of reductant 4.2 Light reactions in: 4.2.1 Purple photosynthetic bacteria 4.2.2 Green sulphur bacteria 4.2.3 Cyanobacteria (with details) 4.3 Dark reaction 4.3.1 Calvin Benson cycle 4.3.2 Reductive TCA cycle 4.4 Inorganic Metabolism 4.4.1 Assimilatory pathways: 4.4.1.1 Assimilation of nitrate, 4.4.1.2 Ammonia fixation – Glutamate dehydrogenase, Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase 4.4.1.3 Biological nitrogen fixation (Mechanism for N2 fixation and protection of nitrogenase) 4.4.1.4 Assimilation of sulphate 4.4.2 Dissimilatory pathways: 4.4.2.1 Nitrate as an electron acceptor (Denitrification in *Paracoccusdenitrificans*) 4.4.2.2 Sulphate as an electron acceptor.	15 (1)

Learning Resources recommended:

Text books:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd.
2. Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5 th edition, 1987. John Wiley & Sons. New York.
3. Gottschalk, G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
5. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry, 4th edition, W. H. Freeman and Company.

6. G. Moat, J.W. Foster, M, P. Spector. (2002), Microbial Physiology, 4th edition, WILEY-LISS 7. Madigan, M.T. and J.M. Martinko2006. 11th edition, Brock Biology of Microorganisms. Pearson Prentice Hall.

Reference books:

1. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
2. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers
3. Principles of Biochemistry, Lehninger, 5th edition, W. H. Freeman and Company

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Bioprocess Technology: Part – II
Course Code	USMB604
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Industrial microbiology used for the production of important substances, such as antibiotics, food products, enzymes, amino acids, vaccines and fine chemicals. Industrial microbiology trains junior microbiologists on microbiology test methods and lab procedures. The demonstrated good laboratory documentation skills and documentation requirements. It performs preparatory testing and anti-microbial preservative effectiveness testing on pharmaceutical products.

Nomenclature: Bioprocess Technology: Part - II

Course Outcomes:

1- The learners shall understand the actual process involved in fermentations of important products.
2- The learners shall understand knowledge of applications of animal and plant tissue culture techniques.
3- The learners shall understand the working of important instruments used in biochemical analysis and bioassay.
4- The students will learn the silent features of quality management and regulatory procedures.

Curriculum:

USMB604 – Bioprocess Technology: Part – II			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Downstream Processing	1.1 Recovery and purification 1.1.1 Introduction 1.1.2 Methods of DSP: Precipitation, Filtration, Centrifugation, Cell Disruption, Liquid-Liquid Extraction, Solvent Recovery, Chromatography, Membrane Processes, Drying, Crystallization, Whole Broth Processing 1.2 Effluent treatment – Introduction, Treatment process (Physical, chemical and biological)	15 (1)
2	Advances in Bioprocess	2.1 Animal biotechnology 2.1.1 Primary cell culture and established cell lines	15 (1)

	Technology	2.1.2 Basic principles 2.1.3 Growth media 2.1.4 Cell viability 2.1.5 Applications of cell culture: Vaccines, somatic cell fusion, valuable products. 2.2 Plant tissue culture 2.2.1 Introduction 2.2.2 Requirements for in vitro culture, Methods of plant cell and tissue culture 2.2.3 Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micropropogation, suspension culture, protoplast culture, protoplast fusion and somatic hybridization. 2.2.4 Applications: production of disease resistant plants, production of virus free plant, In vitro selection of cell lines for disease resistance. 2.3 Immobilized enzyme and cells 2.3.1 Introduction and Definitions 2.3.2 Methods 2.3.3 Immobilized Enzyme Reactors 2.3.4 Applications	
3	Quality Assurance, Quality Control, and Bioassay	3.1 Quality assurance and quality control. 3.1.1 Definitions, Chemical and pharmaceutical products 3.1.2 Q.A and Q.C wrt.- Raw materials, method of manufacturing, in process items, finished products, label and labeling, packaging materials 3.1.3 Control of microbial contamination during manufacturing 3.2 Sterilization control and assurance. 3.3 Bioassay 3.3.1 Introduction 3.3.2 Types: Diffusion, End Point, Turbidometric, Metabolic Response, Enzymatic 3.4 Intellectual property rights 3.5.1 Genesis, Role of WTO and TRIPS 3.5.2 Overview of patent system 3.5.3 Requirements for patentability 3.5.4 Patent Categories 3.5.5 Preliminary steps for patent applications 3.5.6 Patent Procedures 3.5.7 For biotech and microbiological products	15 (1)
4	Industrial Fermentations	4.1 Penicillin and semisynthetic penicillins: Introduction, biosynthesis and regulation,	15 (1)

		strain development, production methods. Semisynthetic penicillins: Examples, production, advantages 4.2 Aminoglycoside: Streptomycin: Aminoglycoside antibiotics, biosynthesis, regulation of biosynthesis, strain development, production method, recovery. 4.3 Vitamin B 12: Occurrence and economic significance, structure, biosynthesis, production based on media containing carbohydrates by*Propionibacteria* and *Pseudomonas*, recovery. 4.4 Citric acid: Introduction, strains used for production, biosynthesis, nutrient media, production processes- surface and submerged, product recovery. 4.5 Glutamic acid: Production strains, biosynthesis, effect of permeability on production, conditions of manufacturing, production process and recovery.	

Learning Resources recommended:

Text books:

1. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
4. H. K. Das., "Text book of Biotechnology", 2nd and 3rd edition.
5. A textbook of biotechnology R. C. Dubey 4th edition. S. Chand.
6. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India
7. OkaforNduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
8. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology.
9. Microbiology", 2 nd edition, Panima Publishing Corporation, New Delhi.
10. Prescott and Dunn's ''Industrial Microbiology'' (1982) 4th edition, McMillan Publishers.
11. Veerakumari L. "Bioinstrumentation", MJP Publisher
12. Pharmaceutical Microbiology, Hugo and Russell, 7 th edition, Blackwell Science.

Reference books:

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 & 2, Academic Press.
2. Williams, Bryan L; Wilson, 2 nd edition." A Biologist's guide to principles and techniques of practical biochemistry" Baltimore: University Park Press, 1981.
3. Wilson, Keith, 1936-; Goulding, Kenneth H, 3 rd edition., A Biologist's guide to principles and techniques of practical biochemistry" London ; Baltimore : E. Arnold, 1986.
4. Wilson and Walker, "Principles and techniques of practical biochemistry" 5 th edition.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Practical of USMB601 and USMB602
Course Code	USMBP07
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The rDNA technology provides technical expertise in micro or molecular biology techniques including real-time PCR and data analysis. It performs PCR, RT-PCR, real time RT-PCR. It utilizes PCR denature, anneal, elongate and amplification of a DNA fragment. DNA fingerprinting utilized for the identification purpose. Research focuses on the identification and characterization of bacterial pathogens. Immunologists are actively involved in the drug discovery process in pharmaceutical sector especially for the development of antibodies and vaccines.

Nomenclature: Practical of USMB601 and USMB602

Course Outcomes:

1- The students will acquire skill to perform the laboratory techniques and experiments based on isolation of genomic DNA.

2- The students will understand computational biology and insilico analytical techniques.

3- The students will acquire skill to perform determination of MBC of an antibiotic and blood grouping.

Curriculum:

USMBP07 – Practical of USMB601 and USMB602		
Title	**Learning Points**	**No of Lectures**
rDNA Technology, Bioinformatics & Virology	1. Isolation of genomic DNA of E. coli and measurement of its concentration by UV-VIS. 2. Enrichment of coliphages, phage assay (pilot & proper). 3. Restriction digestion of lambda phage /any plasmid DNA (Demo) 4. Beta galactosidase assay 5. Bioinformatics practicals On Line Practical i. Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained ii. Visiting & exploring various databases mentioned in syllabus and a. Using BLAST and FASTA for sequence analysis	60(2)

	b. Fish out homologs for given specific sequences (by teacher – decide sequence of some relevance to their syllabus and related to some biological problem e.g. evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology) c. Six frame translation of given nucleotide sequence d. Restriction analysis of given nucleotide sequence e. Pair-wise alignment and multiple alignment of a given protein sequences f. Formation of phylogenetic tree 6. Animal cell culture (Demo)	
Medical Microbiology & Immunology: Part - II	1. Demonstration of malarial parasite in blood films (Demo) 2. Selection and testing of antibiotics using the Kirby-Bauer method 3. Determination of MBC of an antibiotic. 4. Blood grouping – Direct & Reverse typing 5. Coomb's Direct test 6.Determination of Isoagglutinin titer 7. Demonstration experiments - Widal, VDRL	60(2)

Learning Resources recommended:

Text books:

1. Prescott, Harley and Klein, "Microbiology",. 7th edition McGraw Hill international edition.
2. S.Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house.
3. Robert Weaver, (2008), "Molecular biology", 3rd edition, McGraw Hill international edition.
4. Kuby Immunology, 6th Edition, W H Freeman and Company
5. Pathak &Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
6. Fahim Khan, Elements of Immunology, Pearson Education.

Evaluation Pattern

E. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

F. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Practical of USMB603 and USMB604
Course Code	USMBP08
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	To successfully gain employment in biochemistry, problem solving, data analysis, process creation and project management are the key skills. Industrial microbiology used for the production of important substances, such as antibiotics, food products, enzymes, amino acids, vaccines and fine chemicals.

Nomenclature: Practical of USMB603 and USMB604

Course Outcomes:

1- The learner will acquire the practical skills of screening of microorganisms producing lipase, PHB and protease.

2- The students will acquire skill to perform detection of enzymes which play an important role in amino acid and nitrate metabolism.

3- The students will acquire skill to perform quantitative detection of important metabolic products such as protein and uric acid.

4-The learner will acquire the practical skills and techniques involved in running a bioassay, immobilization of cells & sterility testing.

Curriculum:

USMBP08 – Practical of USMB603 and USMB604		
Title	**Learning Points**	**No of Lectures**
Microbial Biochemistry: Part - II	1. Detection of PHB producing bacteria 2. To study catabolite repression by diauxic growth curve. 3. Protein estimation by Lowry's method 4. Estimation of uric acid 5. Qualitative and Quantitative assay of Protease 6. Qualitative detection of Lipase 7.Study of breakdown of amino acids – Lysine decarboxylase and Deaminase activity 8. Study of Lithotrophs – Nitrosification and Nitrification	60(2)
Bioprocess Technology: Part - II	1. Bioassay of an antibiotic (Ampicillin / Penicillin) 2. Bioassay of Cyanocobalamin. 3. Perform immobilization of yeast cells for invertase activity - making of beads, Determination of activity and count by haemocytometer and viable count. 4. Plant tissue culture – Callus culture (Demo). 5. Sterility testing of injectable. 6. Chemical estimation of Penicillin 7. Estimation of phenol. 8. Industrial Visit	60(2)

Learning Resources recommended:

Text books:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd.
2. Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5 th edition, 1987. John Wiley & Sons. New York.
3. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology.
4. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
5. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.

Evaluation Pattern

G. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

H. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Bachelor of Science (B.Sc.) Program
In Microbiology - Applied Component
[Medical Laboratory Technology]

T. Y. B. Sc. [Sem-V & VI]

Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year-2023-2024

Name of Programme	**B.Sc. Microbiology AC[Medical Laboratory Technology]**
Level	UG
No of Semesters	02
Year of Implementation	**2023-24**
ProgrammeSpecific Outcomes (PSO)	1] Learner shall know the various branches of MLT 2]Learner shall know the role of pathology tests in day to day life. 3] Learner shall able to carry out various laboratory tests.
Relevance of PSOs to the local, regional, national, and global developmental needs	In the era of modern technology, health care delivery system involves so many different personnel and specialties that the caregiver must have an understanding and working knowledge of other professional endeavours, including the role of diagnostic evaluation. Basically, laboratory and diagnostic tests are tools by and of themselves, they are not therapeutic. Medical Laboratory Technology is a basic course that equips the student with the most essential knowledge and skill pertaining to medical laboratories such as: Importance of laboratory services, Role of medical laboratory technologist, Use of laboratory wares, instruments and sterilization techniques, Prevention and control of laboratory accidents and, Institution of quality control system. This pathological services have made disease treatment is more targeted and more accurate due to their correct diagnosis nature. The students with this Medical Laboratory Technology knowledge shall able to perform various pathological tests to help in disease diagnosis.

T.Y.B.Sc. Microbiology Applied Component Syllabus

(General Outline)

SEMESTER V

Course Code	Unit	Topics	Credits	Lec / Week
USACMT501		**Techniques and Automation In MLT**	**2**	
	I	Introduction to diagnostic microbiology		1
	II	Automation and newer approaches in MLT		1
	III	Haematology		1
	IV	Clinical Biochemistry		1
USACMT5P1		**Practicals based on above course in theory**	**2**	**4**

SEMESTER VI

Course Code	Unit	Topics	Credits	Lec / Week
USACMT601		**Microbiology ,Clinical Pathology and Histopathology**	**2**	
	I	Bacteriology		1
	II	Mycology, Parasitology, and Virology		1
	III	Organ Function Tests		1
	IV	Clinical Pathology and Histopathology		1
USACMT6P1		**Practicals based on above course in theory**	**2**	**4**

Syllabus for T.Y.B.Sc. Microbiology Applied Component Semester V

from the year 2023-24

Name of the Course	Techniques and Automation in MLT
Course Code	USACMT501
Class	T.Y.B.Sc.
Semester	V
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Introduction to Medical Laboratory Technology is a basic course that equips the student with the most essential knowledge and skill pertaining to medical laboratories such as: Importance of laboratory services, Role of medical laboratory technologist, Use of laboratory wares, instruments and sterilization techniques, Prevention and control of laboratory accidents and, Institution of quality control system. Moreover, this course is extremely important for the student as it paves the ways to easily understand various professional courses such as Haematology, Bacteriology, Urinalysis, Parasitology, and others. Hence, great emphasis should be given to this subject matter so as to train qualified, competent and task oriented medical laboratory technologists.

Nomenclature: Techniques and Automation in MLT

Course Outcomes:

1. The learner will understand the safety and precautions in clinical microbiology.
2. The student will know the identification system for bacteria.
3. The student will understand the branch of hematology and will learn the process of blood collection.
4. The learner will know the concept in clinical biochemistry. This module will also make them understand the diagnostic tests.

Curriculum:

USACMT501 - Techniques and Automation in MLT			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Introduction to diagnostic microbiology**	**1.1** Safety and special precautions in clinical microbiologylab, Legislative and regulatory control, Infectious wastemanagement, Methods of sterilization, Classification ofbio hazardous agents. **1.2** Antimicrobial susceptibility testing: Selection of antimicrobial agents, Disc diffusion test, Dilutionantimicrobial susceptibility test, E test, commercial systems. **1.3** Serodiagnostic tests: a) Types of antigen antibody reactions used in diagnostic serology – precipitin reactions, CFT, Haemaglutination inhibition, agglutination reactions, flocculation. b) Solid phase immunoassay methods – Enzyme immunoassay for antibody and antigen detection. c) Immunofluorescent techniques for antibody and antigen detection.	**15L**
II	**Automation and newer approaches in MLT**	**2.1** Automation: Semiautomated and automated identification systems for Enterobacteriaceae, Non fermentors, Mycobacteria, Staphylococci, Anaerobes **2.2** Newer approaches: use of molecular techniques indiagnosis a) Signal amplification methods – Nucleic acid probes, in situ hybridization b) PCR and modifications of PCR c) Post amplification analysis – DNA sequencing, microarray analysis d) Strain typing – Pulse field gel electrophoresis, PCR-RFLP	**15L**
III	**Haematology**	**3.1** Introduction to haematology – composition of blood, serum and plasma, structure, function and life span of blood cells, Haematopoiesis and factors required for the same,hemoglobin: structure, types-normal &abnormal,glycosylatcdHb, HbCo, Hi, SHb, Hbs, HbC, HbD, lIbE,HbH. **3.2** Collection of blood- Capillary blood by skin puncture, Venous blood by venipuncture	**15L**

		3.3 Anticoagulants: types and mechanism of action. **3.4** Anemia: Types – Sickle cell anemia, thalassemia, iron deficiency, aplastic, hemolytic, megaloblastic (only a brief outline). **3.5** Abnormal forms of RBC: microcytes, macrocytes – hypochromic, spherocytes, target cell, stomatocytes, anisocytes, poikilocytes, sickle cells. Abnormalities of WBC's: toxic granulation, vacuoles, hypersegmentation,hypo segmentation. **3.6** Haemostatisis& coagulation: vascular response, platelet plug formation, coagulation. **3.7** Automation in haematology: Introduction- the automated full blood count impedance cell counters, optical cell counters, automated blood cell morphology. **3.8** Blood bank: blood ABO (H), Rh, secretor and Lewis systems, lsoagglutinins& their titre, concept of universal donor & universal recipient blood transfusion: cross matching, transfusion reactions blood collection:screening of donor criteria for rejecting donor,registration of donor, blood collection procedure, transportation of blood, storage of blood. Preparation & use of blood components: whole blood, packed red cells, FFP, platelet concentrate.	
IV	**Clinical Biochemistry**	**4.1** Blood sugar level - Glucose tolerance curve and its interpretation. Evaluation methods of blood glucose – o toluidine, Glucose oxidase - peroxidase. Diabetes and its types. **4.2** Enzymes in diagnostics – determination of enzymes, AST, ALT, ALP, ACP, LDH, GGT, serum lipase. **4.3** Thyroid tests – Introduction – function of thyroid hormones, determination of T-3, T-4, TSH **4.4** Automation in clinical biochemistry - Introduction, classification of automated systems, steps of automation in biochemical analysis, computers in clinical lab with its drawbacks. Commonly used automated analyzers of biochemical laboratories – autoanalysers, clinicon, R X L system. **4.5** Cancer marker - Introduction, clinical application, enzymes as tumor markers ALP, CK, LDH, PAP, prostate specific antigens, hormones, oncofetalantigens, carbohydrates, bladder specific, breast tumor markers. **4.6** Pregnancy test – Role of hCG and testing.	**15L**

Learning Resources recommended:

1. Koneman'sColor Atlas and Textbook of Diagnostic Microbiology, 6th edition, Washington Winn, jr and others. Lippincott Williams & Wilkins.
2. Practical Medical Microbiology, Mackie and McCartney.
3. Medical Microbiology, B.S. Nagoba and Asha Pichare.
4. Essentials of Diagnostic Microbiology, 1998. Lisa Anne Shimeld, Anne T. Rodgers. Delmar Publishers.
5. Text book of medical laboratory technology, 2nd edition, Balani Publishing House. Authors: PrafulGodkar and DarshanGodkar.
6. Introduction to MLT 6th edF.J.Baker&R.E.SilvertonButterworths.
7. Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume I. Kanai Mukherjee. Tata McGraw Hill
8. Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume II. Kanai Mukherjee. Tata McGraw Hill
9. Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume III. Kanai Mukherjee. Tata McGraw Hill
10. Hand book of MLT -Vellore ed-Dr (Mrs) C. Bharucha, Wesley press, Mysore
11. A medical lab for developing countries- Maurice King-ELBS & Oxford uni press
12. Bailey & Scott's - Diagnostic microbiology, 11th ed., Betty Forbes, Daniel, Alice Weissfield. Mosby publisher
13. Atlas of Medical Helminthology and Protozoology, 4th ed. P. L. Chiodini, A. H. Moody, D. W. Manser. Churchill Livingstone
14. A hand book of medical laboratory technology, V. H. Talib 2nd ed.
15. Fundamentals of Biochemistry. New central book agency. Author: A. C. Deb

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Practicals of USACMT501
Course Code	USACMT5P1
Class	T.Y.B.Sc.
Semester	V
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	In the era of modern technology, health care delivery system involves so many different personnel and specialties that the caregiver must have an understanding and working knowledge of other professional endeavours, including the role of diagnostic evaluation. Basically, laboratory and diagnostic tests are tools by and of themselves, they are not therapeutic. In conjunction with a pertinent history and physical examination, these tests can confirm a diagnosis or provide valuable information about a patient status and response to therapy. In addition to these, laboratory findings are essential for epidemiological surveillance and research purposes. If the entire network of a laboratory service is to be effectively utilized and contribute to health care and disease prevention, every member of its work force need to: Follow professional ethics and code of conduct, Experience job satisfaction and have professional loyalty.

Nomenclature: Practicals of USACMT5P1

Course Outcomes:

1 – The learner will acquire the practical skills of laboratory based on antibiotic susceptibility test, blood grouping etc.
2 – The student will gain the knowledge in processing of blood samples with regard to check sugar levels.
3 – The learner shall understand the parts of instruments like hot air oven, microscope and incubator. Learner will also get trained to handle this instruments.

Curriculum:

USACMT5P1 - Practicals of USACMT501		
Title	**Learning Points**	**No of Lectures**
Techniques and Automation In MLT	1.Parts and functions of microscope 2. Study of hot air oven 3. Study of autoclave 4. Study of incubator 5. Widal test 6. VDRL test 7. ASO test 8. Disc diffusion method 9. Blood collection :capillary & venous 10. Hemoglobin estimation: acid hematin and drabkin'smethod 11. Total RBC &WBC count, Differential WBC count12. ESR 13. PCV 14. Red cell indices 15. Bleeding time & clotting time 16. Blood grouping ABO and Rh typing 17. Cross matching 18. Estimation of blood glucose	**60L (02)**

Learning Resources recommended:

1.Practical Medical Microbiology, Mackie and McCartney.

2.Text book of medical laboratory technology, 2nd edition, Balani Publishing House.

Authors: PrafulGodkar and DarshanGodkar.

3.Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume II and III Kanai Mukherjee. Tata McGraw Hill.

4. A hand book of medical laboratory technology, V. H. Talib 2nd ed.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Syllabus for T. Y. B. Sc. Microbiology Applied Component Semester VI

from the year 2023-24

Name of the Course	Microbiology, Clinical Pathology and Histopathology
Course Code	USACMT601
Class	T.Y.B.Sc.
Semester	VI
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Effective delivery of healthcare services depends largely on the nature of education, training and appropriate orientation towards community health of all categories of health personnel, and their Capacity to function as an integrated team. The course has been designed with a focus on performance-based outcomes pertaining to different levels. The learning goals and objectives of the undergraduate and graduate education program will be based on the performance expectations. Using the framework, students will learn to integrate their knowledge, skills and abilities in a hands-on manner in a professional healthcare setting. These learning goals are divided into different key areas, though the degree of required involvement may differ across various levels of qualification and professional cadres: Clinical care, Communication, Ethics and accountability at all levels (clinical, professional, personal and social), Scientific attitude and scholarship.

Nomenclature: Microbiology, Clinical Pathology and Histopathology

Course Outcomes:

1. The learner will understand the steps involved in specimen collection.
2. The students should be able to correlate virulence factors and other features of the pathogen.
3. The learner will get the knowledge of Parasitology, Mycology and Virology.
4. The student should be able to understand various organ function test.
5. The students shall understand the examination of biological specimens.

Curriculum:

USACMT601 - Microbiology, Clinical Pathology and Histopathology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Bacteriology**	Guidelines for collection, transport, processing, analysis and reporting of cultures from specific specimen sources for the following infections- **1.1** Infections of the respiratory tract. **1.2** Infections of the gastrointestinal tract. **1.3** Urinary tract infections. **1.4** Infections of the genital tract. **1.5** Infections of the bones and joints. **1.6** Infections of the CNS. **1.7** Wounds, abscesses and cellulites. **1.8** Eye infections. **1.9** Infections of the blood.	**15L**
II	**Mycology, Parasitology, and Virology**	**2.1** Mycology: a) Laboratory approach for diagnosis of fungal infections- Specimen collection and transport, processing, direct examination, preparation of mounts for study, selection and inoculation of culture media, incubation of fungal cultures. b) Identification of dermatophytes and Candida. **2.2** Parasitology: Collection, transport and processing of specimens a) Fecal specimens- Preservation of clinical specimens, visual examination, processing fresh stool specimens for ova and parasitic examination. b) Examination of intestinal specimens other than stool. c) Examination of extra intestinal specimens- sputum, blood d) Overview of life cycles of parasites of human importance. **2.3** Virology: a) Collection of specimens for diagnosis, b) Transportation and storage of specimens, c) Methods for diagnosis of viral infections (Tabulation),	**15L**

		d) Detection of HIV, Hepatitis B viral infections in clinical specimens.	
III	**Organ Function Tests**	**3.1** Cardiac Profile Test – Introduction, Functions of heart, Ischemic heart diseases and their manifestation; Groups in CPT, Lipid profile tests – total lipids, serum cholesterol, triglycerides, phospholipids, lipoproteins. **3.2** Gastric function Tests – Introduction, gastric analysis, tests involved and gastrointestinal hormones. **3.3** Liver function tests – Introduction to liver function, types of jaundice; abnormalities of bile pigment and bile acid, change in enzyme and plasma proteins and their determination **3.4** Kidney function test – Introduction- kidney function; groups in KFT; test to determine renal blood flow; creatinine clearance; urea clearance; diseases of kidney – acute and chronic glomerulonephritis; acute and chronic pyelonephritis, acute renal failure	**15L**
IV	**Clinical Pathology and Histopathology**	**4.1** Routine urine analysis – Physiology of urine formation, composition of normal urine, collection of urine specimens, routine examination of urine – physical, chemical & microscopic **4.2** Routine stool analysis – Importance of stool examination, collection of fecal specimen physical examination – color& consistency, odor, presence of blood mucus & pus. Study of some common ova found in stool – Hookworm, *Ascaris, Trichuris, Taenia, Schistosomamansoni, Enterobius, Strongyloides*. Study of some protozoa found in stool – *E. histolytica, E.coli,Giardialamblia,Trichromonashominis*. Other findings in stool microscopic examinations – fecal fat, blood cells, Crystals, occult blood test, measuring the pH & testing for Lactose **4.3** Examination of C.S.F. – Formation of C.S.F.,collection – lumbar puncture (in brief), C.S.F. analysis : color, cells, Pandy's test, stained films, C.S.F. proteins, C.S.F. sugar,	**15L**

		Trypanosomes., abnormalities of the C.S.F. suppurative, viral, Tuberculous meningitis. **4.4** Semen analysis, clinical significance, specimen collection, laboratory investigations: physical examination, microscopic examination, sperm morphology – normal & abnormal, chemical examination **4.5** Laboratory examination of miscellaneous body fluids – A brief account of the following body fluids w.r.t. clinical significance, specimen collection. Lab Investigations – Physical, chemical, microscopic examination, serous, synovial, ascitic fluids, & gastric juice **4.6** Lab examination of sputum – Collection, examination: quantity, consistency, Colour, odor, examination of stained/unstained sputum, chemical examination, parasites **4.7** Basic histopathology techniques – Basic steps for tissue processing: fixing, embedding, microtomy , staining, mounting (to be covered in brief), cytological techniques (brief idea)	

Learning Resources recommended:

1. Koneman'sColor Atlas and Textbook of Diagnostic Microbiology, 6th edition, Washington Winn, jr and others. Lippincott Williams & Wilkins.
2. Practical Medical Microbiology, Mackie and McCartney.
3. Medical Microbiology, B.S. Nagoba and Asha Pichare.
4. Essentials of Diagnostic Microbiology, 1998. Lisa Anne Shimeld, Anne T. Rodgers. Delmar Publishers.
5. Text book of medical laboratory technology, 2nd edition, Balani Publishing House. Authors: PrafulGodkar and DarshanGodkar.
6. Introduction to MLT 6th edF.J.Baker&R.E.SilvertonButterworths.
7. Medical laboratory technology, A procedure manual for routine diagnostic tests, VolumeI. Kanai Mukherjee. Tata McGraw Hill
8. Medical laboratory technology, A procedure manual for routine diagnostic tests, VolumeII. Kanai Mukherjee. Tata McGraw Hill
9. Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume III. Kanai Mukherjee. Tata McGraw Hill
10. Hand book of MLT -Vellore ed-Dr (Mrs) C. Bharucha, Wesley press, Mysore
11. A medical lab for developing countries- Maurice King-ELBS & Oxford uni press
12. Bailey & Scott's - Diagnostic microbiology, 11th ed., Betty Forbes, Daniel, Alice Weissfield. Mosby publisher

13. Atlas of Medical Helminthology and Protozoology, 4th ed. P. L. Chiodini, A. H. Moody, D.W. Manser. Churchill Livingstone
14. A hand book of medical laboratory technology, V. H. Talib 2nd ed.
15. Fundamentals of Biochemistry. New central book agency. Author: A. C. Deb

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Practicals of USACMT601
Course Code	USACMT6P1
Class	T.Y.B.Sc
Semester	V
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Using a practical-centered approach and best evidence, each student will organize and implement the prescribed preventive, investigative and management plans; and will offer appropriate follow-up services. Program objectives should enable the students to: Apply the principles of basic science and evidence-based practice, Use relevant investigations as needed, Identify the indications for basic procedures and perform them in an appropriate manner, etc. The student will also learn how to communicate with patients, care-givers, other health professionals and other members of the community effectively and appropriately. Communication is a fundamental requirement in the provision of health care services. Program objectives should enable the students to: Clearly discuss the diagnosis and options with the patient, and negotiate appropriate treatment plans in a sensitive manner that is in the patient‘s and society‘s best interests. Students will understand core concepts of clinical ethics and law so that they may apply these to their practice as healthcare service providers. This include the students to employ professional accountability for the initiation, maintenance and termination of patient-provider relationships

Nomenclature: Practicals of USACMT601

Course Outcomes:

1 - The learner will acquire the practical skills of laboratory based on identification of microorganisms.

2 - The learner shall understand the use of different media for isolation of bacteria.

3 - The student will learn the staining techniques to study bacteria.

Curriculum:

USACMT6P1- Practicals of USACMT601		
Title	**Learning Points**	**No of Lectures**
Microbiology, Clinical Pathology and Histopathology	1. Gram's staining. 2. Albert's staining. 3. Acid fast staining. 4. Identification of Dermatophytes (Demonstration of permanent slides). 5. Identification of *Candida albicans*. 6. Identification of Malarial parasitic forms in blood smears. 7. Study of Nutrient agar, SIBA, MacConkey's agar, XLD,CLED, Salt Mannitol, Tinsdale agar Cetrimide agar 8. Study of transport media. 9. Isolation and characterization pf bacterial pathogens- - *S. aureus* - *S. pyogenes* - *E.coli* - *K.pneumoniae* - *Salmonella spps* - *Proteus spps* - *Pseudomonas spp* 10. Physical, Chemical, Microscopic examination of a. Urine b.Sputum 11. Pap's staining for the demo of Barr bodies 12. Embedding of tissue in paraffin wax 13. Estimation of SGPT/ALT 14. Estimation of SGOT/AST 15. Estimation of Cholesterol- total, HDL, LDL 16. Estimation of total bilirubin 17. Estimation of creatinine in serum and urine 18. Estimation of blood urea 19.Report Writing: For various analyzed pathological samples(CBC, Complete Haemogram, Urine, Stool, C.S.F, Semen and Sputum)	**60L (02)**

Learning Resources recommended:

1.Practical Medical Microbiology, Mackie and McCartney.

2.Text book of medical laboratory technology, 2nd edition, Balani Publishing House.
Authors: PrafulGodkar and DarshanGodkar.

3.Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume II and III Kanai Mukherjee. Tata McGraw Hill.
4. A hand book of medical laboratory technology, V. H. Talib 2nd ed.

Evaluation Pattern

C. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

D. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Master of Science (M.Sc.) Microbiology

M.Sc. Part -1 [Sem I & II]

Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Name of Program	**Masters of Science**
Level	PG
No of Semesters	04
Year of Implementation	**2023-24**
Program Specific Outcomes (PSO)	At the end of the Program, Learner will be able to 1) Achieve the understanding of fundamental genetic processes for all organisms. 2) Understand microbial biodiversity in different habitats. 3) To understand waste management, biohazard and biosafety standards. 4) Strengthen the fundamental concepts of Biochemistry and understand the broad domains of biochemistry. 5) Reinforce the basic concepts in epidemiology and to elaborate on terms and methodologies in infectious diseases. 6) Emphasize on clinical laboratory practices followed in Bacteriology labs. 7) Conversant about Population genetics Hardy-Weinberg Lawanda related topics. 8) Have theoretical knowledge of important tools and techniques liker, DNaseFoot printing, DMS foot printing and other foot printing methods. 9) Gain information about Functional genomics-DNA Microarray technology, as well as Proteomics. 10) Open the domains of applied biochemistry. 11) Gain knowledge about advanced imaging techniques and emerging super-resolution methods, their principle, working and applications in biological fields with special emphasis to current imaging literature. 12) Providing in-depth knowledge wrt regulations and audit procedures carried out in an Industry. 13) Understand basic cellular structures 14) Learn basic skills in cell biology 15) To understand the significance of IPR and patents in Biotechnology 16) Study recent advances in food microbiology & industrial fermentation technology
Relevance of PSOs to the local, regional, national, and global developmental needs	Microorganism's role in nature is indispensable. They involved in biodegradation, Fermentation, Antibiotic production, etc. Likewise some are involved in disease generation too. Therefore the understanding of microorganisms becomes essential to propagate or to control its number. As microorganism is responsible for food spoilage, food borne diseases so the maintenance of quality standard high is important from local level to global level. With respect to this learner should know the branches of microbiology. As microorganisms are ubiquitous so learner should know the role of microorganism in day to day life. There are millions of

	different microbes present on earth so identification of those microbes is globally important. In addition to that such identification skills has great importance in an infectious diseases control. Industrial fermentation processes requires pure culture of microbes so the knowledge of isolation of pure culture and its propagation is essential. Contamination by unwanted microbes is a worldwide problem. Learners must know the methods of microbial growth control. The various decontamination methods is not only locally important but also it is globally essential. In a sterilized/controlled conditions only a good quality fermented food product can be prepared by specific microorganisms. Therefore learners should know skill and knowledge of such fermentation processes. Summarizing, postgraduates of M.Sc. Microbiology program will be informed citizens who can understand and apply basic microbiological technique at local to global level. It will be able to pursue wide range of careers including biological and life science research in higher educational institutions as well as careers in public health, clinical research, and food, pharmaceutical and biotechnological industries.

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part and by conducting the Semester End Examinations with 60% marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Descriptive Questions – 5 marks each X 3 Que. = 15 Marks		

B) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	III	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	IV	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II, III, IV	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment & Semester End Examination together.

Performance Grading:

LetterGradesandGradePoints

Semester GPA/ Program CGPA Semester/Program	%of Marks	Alpha-Sign/Letter GradeResult
9.00-10.00	90.0 -100	0(Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+(Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A(Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+(Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B(Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C(Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P(Pass)
Below4.00	Below40	F(Fail)
Ab (Absent)	-	Absent

Master of Science (M.Sc.) Program

Under Choice Based Credit System (CBCS)

Course Structure

M.Sc. I

(To be implemented from Academic Year 2023-24)

No. of Courses	Semester I		Credits	No. of Courses	Semester II		Credits
	Major Mandatory				Major Mandatory		
PSMB101	Molecular Genetics - I		4	PSMB201	Applied Biochemistry		4
PSMB102	Medical Microbiology and Microbial Pathogenesis		4	PSMB202	Applied Immunology		4
PSMB103	Practical's of PSMB101 and PSMB102		4	PSMB203	Practical's of PSMB201 and PSMB202		4
PSMB104	Environmental Microbiology and sustainability		2	PSMB204	Molecular Genetics - II		2
	Major Electives				Major Electives		
PSMB105	Biochemistry I	2	4	PSMB205	Biostatistics and Bioinformatics	2	4
PSMB106	Practical's of PSMB105	2		PSMB206	Practical's of PSMB205	2	
	OR				**OR**		
PSMB107	Metabolism of extremophiles and anaerobes.	2		PSMB207	Biochemistry-II	2	
PSMB108	Practical's of PSMB107	2		PSMB208	Practical's of PSMB207	2	
PSMB109	Research Methodology		4	PSMB209	On Job Training/ Field Project		4
Total Credits			22	Total Credits			22

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

Syllabus for M.Sc. I Microbiology Semester I

From the year 2023-24

No. of Courses	Semester I		Credits
	Major : Mandatory		
PSMB101	Molecular Genetics - I		4
PSMB102	Medical Microbiology and Microbial Pathogenesis		4
PSMB103	Practical's of PSMB101 and PSMB102		4
PSMB104	Environmental Microbiology and sustainability		2
	Major : Elective (Any One from below)		
PSMB105	Biochemistry I	2	4
PSMB106	Practical's of PSMB105	2	
	OR		
PSMB107	Metabolism of extremophiles and anaerobes.	2	
PSMB108	Practical's of PSMB107	2	
PSMB109	Research Methodology		4
Total Credits			22

Name of the Course	Molecular Genetics-I
Course Code	PSMB101
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Theory
Type	Major: Mandatory
Employability/ Entrepreneurship/ Skill Development	The benefits of learning Microbial Genetics, includes the understanding of microorganisms which involves the genetics and structure of microorganisms, including bacteria, viruses, and fungi, which can be applied to a variety of fields such as biotechnology, medicine, and agriculture. In addition to that career prospects available with the growing importance of biotechnology and microbiology in various fields, a degree in Microbial Genetics can open up many career opportunities. The course provides students with hands-on experience in laboratory techniques such as PCR, gene cloning, and genetic engineering of microorganisms, which can lead to research opportunities in genetics.

PSMB101 – Molecular Genetics-I

Modules at glance

Unit No.	Modules	No. of Lectures
1	Genetic Exchange among Bacteria and Molecular basis of Homologous Recombination	15
2	Transposable elements, DNA repair and Genetics of Cancer	15
3	Regulation of gene expression in Prokaryotes	15
4	Global regulation in Bacteria	15
	Total	**60**

Course Outcomes:

At the end of the course students will be able to

1) Understand the molecular mechanism of DNA transfer, and Homologous recombination in *E.coli* and in eukaryotes that will enable the students to have a complete view of genetic transfer and exchange mechanisms.
2) Reason out the correlation between Oncogenes, Cellular Proto-Oncogenes, and Tumor Suppressor Genes and thus realizes their role in the development of Cancer.
3) Understand at molecular levels the different types of operons in *E.coli* as well as in Bacillus subtilis besides knowing about Riboswitch regulation.
4) Enhance their knowledge about Regulation of Nitrogen assimilation, Heat Shock response, Stress response and sulphur regulation and genetic analysis of sporulation.

Curriculum:

PSMB101 – Molecular Genetics-I			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Genetic Exchange among Bacteria and Molecular basis of Homologous Recombination**	**1.1Conjugation:** 1.1.1 Overview, Classification of self-transmissible plasmids 1.1.2 Mechanism of DNA transfer during Conjugation in Gram negative bacteria- 1.1.3 Chromosome transfer by plasmids- Formation of Hfr strains, transfer & mobilization of chromosomal DNA by integrated plasmids, prime factors 1.1.4 Transfer system of Gram-positive bacteria- Plasmid pheromones **1.2 Transformation** 1.2.1 Development of Competence in Gram positive bacteria and Gram- negative bacteria, competence based on type IV secretion systems. 1.2.2 Regulation of competence in *Bacillus subtilis*- Competence pheromones. 1.2.3 Role of natural transformation- Nutrition, repair, recombination, Importance of natural transformation for forward and reverse genetics. 1.2.4 Artificially induced competence- Calcium ion induction, transformation by plasmids, transfection by phage DNA, transformation of cells with chromosomal genes, Electroporation. **1.3 Homologous recombination at molecular level**	**15L (1 Credit)**

		1.3.1 Models for Homologues recombination 1.3.2 Homologues recombination protein machines 1.3.3 Homologous recombination in *E.coli* (Rec BCD pathway) 1 .3.4 Homologous recombination in eukaryotes- Mating type switching 1.3.5 Site Specific recombination	
II	**Transposable elements, DNA repair and Genetics of Cancer**	**2.1 Transposable genetic elements in eukaryotes:** 2.1.1Transposable Ac and Ds Elements in Maize, P Elements and Hybrid Dysgenesis in Drosophila. 2.1.2 Retrovirus and Retro transposons: Retrovirus, Retrovirus like elements, Retroposons 2.1.3 Transposable elements in Humans 2.1.4 The Genetic and Evolutionary Significance of Transposable Elements: Transposons as mutagens, Genetic transformation with transposons, Transposons and Genome organization, Evolutionary Issues Concerning Transposable Elements **2.2 DNA repair** 2.2.1 Eukaryotic Nucleotide Excision repair, 2.2.2 Mismatch repair mechanism in humans, 2.2.3Non-homologous end joining (NHEJ) pathway for repairing double stranded breaks **2.3 Genetic Basis of Cancer** 2.3.1Cancer: A Genetic Disease, Forms of Cancer, Cancer and the Cell Cycle 2.3.2 Oncogenes: Tumor-Inducing Retroviruses and Viral Oncogenes, Cellular Proto-Oncogenes, protein products of protooncogenes, Changing cellular proto-oncogenes into oncogenes, Chromosome Rearrangement and Cancer. 2.3.3 Tumor Suppressor Genes: The Retinoblastoma tumor suppressor gene- RB, P53, Breast cancer tumor suppressor genes, MicroRNAs genes, Mutator genes, Telomere shortening genes 2.3.4. The multistep nature of cancer	**15L (1 Credit)**
III	**Regulation of gene expression in Prokaryotes**	**3.1 Operon Systems (Detailed Molecular structure of repressor and operator sites**) 3.1.1 The *E. coli* Lac operon 3.1.2 The *E.coli* Gal operon, 3.1.3 The *E.coli*Ara operon, 3.1.4 The *E.coli* Maltose operon, 3.1.5Trp operon of *Bacillus subtilis*, 3.1.6 Riboswitch regulation	**15L (1 Credit)**
IV	**Global regulation**	**4.1 Global regulation systems**	**15L (1 Credit)**

	in Bacteria	4.1.1 Regulation of Nitrogen assimilation: 4.1.2 Pathways for nitrogen assimilation, regulation of nitrogen assimilation by the Ntr system. 4.1.3 Stress response In Bacteria: Heat shock regulation in *E. coli* 4.1.5 Iron regulation in *E. coli*. 4.1.6 Regulation of Sporulation in *Bacillus subtilis*	

Learning Resources recommended:

1. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition
2. Fundamental Bacterial Genetics, TrunTrempy, 1st edition, 2004, Blackwell Publishing
3. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education
4. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers
5. Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co
6. Principals of Genetics, Snustad& Simmons, 6th edition, 2012, John Wiley & Sons Inc
7. Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
8. Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM press)

Evaluation Pattern

A) **Internal Assessment: 40 % (40 Marks)**

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Discriptive Questions – 5 marks each X 3 Que. = 15 Marks		

B) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	III	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	IV	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II, III, IV	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Medical Microbiology and Microbial Pathogenesis
Course Code	PSMB102
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Theory
Type	Major: Mandatory
Relevance with Employability/ Entrepreneurship/ Skill development	Medical microbiologists often serve as consultants for physicians, providing identification of pathogens and suggesting treatment options. Using this information, a treatment can be devised. Other tasks may include the identification of potential health risks to the community or monitoring the evolution of potentially virulent or resistant strains of microbes, educating the community and assisting in the design of health practices. They may also assist in preventing or controlling epidemics and outbreaks of disease. Not all medical microbiologists study microbial pathology; some study common, non-pathogenic species to determine whether their properties can be used to develop antibiotics or other treatment methods.

PSMB102 – Medical Microbiology and Microbial Pathogenesis

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	Mechanisms of Pathogenesis- 1	15
2	Mechanisms of Pathogenesis- 2 and Human Microbiome	15
3	Emerging Infectious Diseases in India and Epidemiology	15
4	Clinical Bacteriology	15
	Total	**60**

Course Outcomes:

At the end of the course the Learner will be able to

1) Correlate molecular mechanisms of virulence expression, regulation and secretion to disease by different pathogens that cause chronic infections, toxin associated, & biofilm mediated infections
2) Correlate post interventional procedures to biofilm associated infections on implants and prosthetic devices.
3) Reason out
    i. the threat of antibiotic resistance and can create awareness
    ii. the importance of microbiome and can be equipped to research on it
4) Well informed about Emerging and re-emerging diseases in India

Curriculum:

PSMB102 – Medical Microbiology and Microbial Pathogenesis			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Mechanisms of Pathogenesis- 1**	1.1 Overview of bacterial mechanisms of i. evading/surviving host defense ii. Bacterial persistence within the host- a. Surviving phagocytosis e.g.: Legionella, Salmonella, and Mycobacterium b. Chronic infections e.g.: Brucellosis and typhoid fever 1.2Toxins and secretion systems i. Bacterial toxins and intoxications- e. g. Diphtheria and Botulism-its regulation, mode of action ii.Secretion Systems specific to GramNegative Bacteria and Gram-Positive Bacteria 1.3Mechanisms of Virulence Regulation: i.Types of Regulation ii. Bacterial communication and virulence: a.Quorum Sensing signaling molecules b.Mechanisms of quorum sensing in Gram Negativeand Gram-positive bacteria	**15(1 Credit)**
II	**Mechanisms of Pathogenesis- 2 and Human Microbiome**	**2.1Microbial biofilms** i. Structure, properties and formation ii. Biofilm-related Infections on Tissue Surfaces iii.Biofilms Associated with Medical Devices and Implants **2.2Antibiotic Resistance** i.Genetic Basis of antimicrobial resistance ii.Mechanistic basis of antimicrobial resistance-modification of antibiotic molecules, decreased penetration and efflux, changes in target sites, Resistance Due to Global Cell Adaptations. **2.3The Human Microbiome:** i. Introduction to the concept of Microbiome, The Human Microbiome Project ii. Gut microbiome- types of organisms, functions, role in health and disease	**15(1 Credit)**

III	**Emerging Infectious Diseases in India and Epidemiology**	**3.1Emerging infectious diseases in India**(with emphasis on etiology, virulence mechanism, diagnosis and prevention) i. Pandamic Influenza ii. Nipah Virus iii. Acinetobacter iv. Candida auris v. Hepatitis C vi. Rickettsial infections **3.2 Epidemiology** i.Methods and procedures for epidemiological study of infections. ii.Epidemiology of infectious diseases, case studies- food borne diseases, XDR-TB	**15(1 Credit)**
IV	**Clinical Bacteriology**	**4.1Laboratory Methods for Antimicrobial susceptibility testing** i. Conventional testing methods ii. Commercial Testing methods iii. Other methods- Time kill curves, Serum killing curves iv. Testing antibiotic combinations **4.2 Detection of specific types of Antibiotic Resistance** i.Methicillin (Oxacillin) resistant and decreased Vancomycin susceptibility in Staphylococci spps ii.Beta lactam resistance and Decreased susceptibility to Vancomycin in *Enterococci* **4.3 Quality Control in Medical Microbiology** i. Laboratory design and safe microbiological practice GLP in culture and media preparation ii. Sample management and Process control (an overview) iii. Quality control of culture media, reagents, equipments, process, personnel, report	**15(1 Credit)**

Learning Resources recommended:

1. Bacterial Pathogenesis- A Molecular Approach by Brenda Wilson, Abigail Saylers et al, Third ed, ASM Press, 2011
2. Virulence Mechanisms of Bacterial Pathogens, by Indira Kudva, Nancy Cornick et al, Fifth ed, ASM Press, 2016
3. Medical Biofilms-Detection Prevention and Control by Jana Jass, Susanne Surman et al, Wiley, 2003

4. The Human Microbiota and Microbiomeed by Julian Marchesi, Advances in Molecular and Cellular Microbiology 25, CAB International, 2014
5. A brief guide to emerging infectious diseases and zoonoses.WHO.
6. Understanding emerging and re-emerging infectious diseases by SuparnaDuggal and JyotiMantri Himalaya Publishing House
7. Friis, Robert H_Sellers, Thomas A, Epidemiology for Public Health Practice-Jones and Bartlett Learning (2014).pdf.
8. Principles of Epidemiology in Public Health Practice-Third Edition,An Introduction to Applied Epidemiology and Biostatistics –Centers for Disease Control and Prevention (CDC).
9. Introduction to Diagnostic Microbiology for the Laboratory Sciences, Maria DannessaDelost, 2015, Jones and Bartlett Learning
10. Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10thedUniversities Press; Tenth edition, 2017
11. Bailey and Scotts Diagnostic Microbiology Forbes, Sahem et al 12thed, Moshby

Evaluation Pattern

C) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Descriptive Questions – 5 marks each X 3 Que. = 15 Marks		

D) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	III	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	IV	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II, III, IV	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Practicals of PSMB101 & PSMB102
Course Code	PSMB103
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Practical
Type	Major: Mandatory
Relevance with Employability/ Entrepreneurship/ Skill development	Understanding of microorganisms: The course provides insights into the genetics and structure of microorganisms, including bacteria, viruses, and fungi, which can be applied to a variety of fields such as biotechnology, medicine, and agriculture. • Career prospects: With the growing importance of biotechnology and microbiology in various fields, a degree in Microbial Genetics can open up many career opportunities. • Research opportunities: The course provides students with hands-on experience in laboratory techniques such as PCR, gene cloning, and genetic engineering of microorganisms, which can lead to research opportunities in genetics. • Medical microbiologists often serve as consultants for physicians, providing identification of pathogens and suggesting treatment options. Using this information, a treatment can be devised. Other tasks may include the identification of potential health risks to the community or monitoring the evolution of potentially virulent or resistant strains of microbes, educating the community and assisting in the design of health practices. They may also assist in preventing or controlling epidemics and outbreaks of disease. Not all medical microbiologists study microbial pathology; some study common, non-pathogenic species to determine whether their properties can be used to develop antibiotics or other treatment methods.

PSMB103 – Practical's of PSMB101 & PSMB102

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	Molecular genetics- 1 Practical	60 Hours (2 Credit)
2	Medical Microbiology and Microbial Pathogenesis Practical	60 Hours (2 Credit)
	Total	120 Hours (4 Credits)

Course Outcomes:

At the end of the course

1) The learner will acquire the practical skills of preparing competent cells of *E.coli* and able to transform them by using plasmid DNA.
2) The learner will acquire the hands-on skill of identifying response of nutrient stress on growth and size of Pseudomonas spp.
3) The learner will be practically studying virulence mechanism in pathogens and will acquire the hands-on skill of detecting superbugs like MRSA, VRE.
4) The learner will acquire the hands-on skill of identification of isolates performing Quorum Sensing. For example- formation of Biofilm

Curriculum:

PSMB103 – Practical's of PSMB101 & PSMB102		
Title	**Learning Points**	**No of Lectures**
Molecular genetics- 1 Practical	1. Demonstration of Conjugation in *E. coli.* 2. Preparation of competent E. coli cells. 3. Isolation of plasmid DNA from mini cultures and maxi cultures. 4. Transformation of competent cells using plasmid DNA 5. Endospore formation in *Bacillus subtilis*: Requirements for germination and outgrowth of spores, correlation between sporulation and protease activity. 6. Response of nutrient stress on the growth and size of *Pseudomonas*spps 7. Problems on gene transfer mechanisms, and regulation. 8. Visit to industry and research institute	**60 Hours** **(2 Credit)**
Medical Microbiology and Microbial Pathogenesis Practical	1. Study of few virulence mechanisms in pathogens 2. Study of Quorum Sensing and Quorum sensing inhibitors in *C.violaecium* 3. Microbial Biofilm formation on various surfaces 4. Determination of Minimum Biofilm Inhibition Concentration of an antibiotic 5. Detection of specific types of Antibiotic Resistance. o MRSA o VRE 6. Antibiotic susceptibility testing- Conventional micro broth dilution method according to CLSI guideline. 7. Checker Board Assay for detecting synergistic activity of two antibiotics 8. Determination of Quality Assurance of laboratory media, reagents. 9. Problems on Epidemiology	**60 Hours** **(2 Credit)**

Learning Resources recommended:

1. Human Genetics and Genomics: A Practical Guide – B. Taneri, A. Asilmaz, T. Delikurt, P. Savas, S. Targen, and Y. Esemen – Wiley-VCH.
2. Practical Manual of Genetics & Plant Breeding – Bineeta Singh & G. M. Lal
3. Practical Handbook of Genetics by VikasPali - Kalyani Publishers

4. Practical Guide Book on Genetics, Plant Breeding & Seed Technology by AkshayTalukdar& Anil Kumar Chaudhary – MedTech Science Press
6. Principles of Gene Manipulation and Genomics by Primrose &Twyman – Seventh Edition – Wiley Blackwell
7. Protocols used in Molecular Biology by Sandeep Kumar Singh and Dhiraj Kumar – Bentham Books 2020.
8. An Introduction to Applied Epidemiology and Biostatistics –Centers for Disease Control and Prevention (CDC).
9. Handbook of Microbiological Quality Control, Pharmaceutical and Medical Devices- Rosamund M Baird. (CRC Press)
10. Manual of Antimicrobial Susceptibility Testing by Marie B. Coyle – American Society for Microbiology, 2005.
11. Practical Handbook of Microbiology – Emanuel Goldman, Lorrence H. Green; CRC Press 2015.
12. Medical Microbiology Practical Book by Dr. Mridushri – Bluerose publishers
13. Antibiotics in Laboratory Medicine, Chapter 9 (2005) Antimicrobial Combinations, pp. 365-441- Lorian 5th Ed. Lippincott Williams & Wilkins.

Evaluation Pattern

A. Internal Evaluation = 40 % = 40 Marks

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Environmental Microbiology and Sustainability
Course Code	PSMB104
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Theory
Type	Major: Mandatory
Relevance with Employability/ Entrepreneurship/ Skill development	Environmental microbiologists may involve in research on the use of microorganisms for bioremediation, which is the use of microorganisms to clean up pollution or other contaminants in the environment. This research can help to develop new technologies for cleaning up contaminated sites and protecting the environment from harmful substances. Overall, the study of environmental microbiology is important for understanding the role of microorganisms in the environment and for developing strategies to protect and preserve the health of ecosystems. Those with a career in Environmental Microbiology may work for companies in the pharmaceutical industry, agricultural, petroleum, environmental remediation, or waste management sectors, just to name a few. They may also work for the government at agencies like the Environmental Protection Agency.

PSMB104 – Environmental Microbiology & Sustainability

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	**Theories of evolution and astrobiology**	15
2	**Environment & Natural Resource Management & Safety Standards**	15
	Total	**30**

Course Outcomes:

At the end of the course students will be able to

1) Understand how life has evolved on earth and in space
2) Elaborate the characteristics of different groups of microorganisms found in different habitats
3) Discuss microorganisms in extreme environments and their adaptations
4) Reflect their role as global citizens, consumers and environment protectors.

Curriculum:

PSMB104 – Environmental Microbiology and Sustainability			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Theories of evolution and astrobiology**	**1.1 History of evolution** **1.2 Theories of organic evolution** -Lamarckism - Darwinism -Modern synthetic theory -Germplasm theory -Mutation theory **1.3Introduction to molecular evolution** **1.4 Neutral theory of evolution** - Polymorphism - Divergence - Near neutral theory of evolution **1.5 Mechanisms of Molecular Evolution and the Modern Molecular Clock** **1.6 Astrobiology** - Introduction - The space environment - Microbiological studies in the space environment - Microbial transfer through space	**15 (1 Credit)**
II	**Environment & Natural Resource Management & Safety Standards**	**2.1Natural resources**: -Renewable/non-renewable resources of Land, water, forest, minerals, energy, food. Associated problems and management practices. -Environmental Impact Assessment and Sustainable Development **2.2 Solid waste management**: - Classification of solid waste - Effects of solid waste pollution, - Key components of solid waste management.	**15 (1 Credit)**

		- On site disposal options -Offsite disposal options - Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or bio-methanation. -Non-biodegradable waste like plastics, glass, metal scrap, e-waste and building materials, and its recycling **2.3Hazardous waste management**: -Hazardous wastes: definition, levels of biohazards, Risk assessment and handling procedures. - Xenobiotic compounds and its biodegradation -Management of hazardous waste using biotechnological applications -Examples: cyanide detoxification, petrochemical industry effluents, phenols, Hazardous waste from paint, pesticides and chemical industries Probable means to reduce this waste through Common Effluent **2.4 Biosafety**: - Need for biosafety levels, - Biosafety guidelines for GMOs and LMOs. -Role of Institutional bio safety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. - Environmental release of GMOs. - Overview of national regulations and relevant international agreements. - Ecolabelling, ISO 14001, - Generally Recognized as Safe (GRAS)	

Learning Resources recommended:

Unit I

1) Cell biology, genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agarwal by S Chand publishers.
2) 2.Population Genetics by Matthew Hamilton, Wiley Blackwell, A John Wiley & Sons, Ltd., Publication.
3) Principles of population genetics by Daniel Hartl and Andrew Clark 3rd edition, Sinauer Associates, Inc. Publishers.
4) The causes of molecular evolution by John Gillespie, New York Oxford University Press 1991.

5) Basic concepts of molecular evolution Anne- Mieke Van Damme (https://www.kuleuven.be/aidslab/phylogenybook/firstEdition/Chapter1.pdf).
6) Mechanisms of molecular evolution Tomoko Ohta National Institute of Genetics, Mishima, 411-8540,Japan (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1692885/pdf/11127908.pdf)
7) Molecular Evolution Lecture Notes Anders Gorm Pedersen (http://www.cbs.dtu.dk/dtucourse/cookbooks/gorm/27615/lecturenotebook.pdf)
8) Space Microbiology, GerdaHorneck, David M. Klaus, Rocco L. Mancinellihttps://mmbr.asm.org/content/74/1/121.
9) Venturing into new realms? Microorganisms in space, Christine Moissl-Eichinger Charles Cockell Petra Rettberg (https://academic.oup.com/femsre/article/40/5/722/2198066).
10) Minireview The theory and application of space microbiology: China's experiences in space experiments and beyond (https://onlinelibrary.wiley.com/doi/pdf/10.1111/1462-2920.13472)

Unit II

1) Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education by ErachBharucha for University Grants Commission.
2) Essential environmental studies, S.P.Mishra, S.N.Pandey,Ane books pvt ltd.
3) Environmental management, Jadhav H. V., 2002, VipulPrakashan.
4) Environmental Biotechnology (Industrial Pollution Management) by S N Jogdand, Himalaya publishing house
5) Environment and Ecology, S.P.Mishra, S.N.Pandey, Ane books pvt ltd.
6) Technical EIA guidance manual for Common Hazardous Waste Treatment, Storage and Disposal Facilities, Prepared by Ministry of environment and forests, Government of India, 2010: http://environmentclearance.nic.in/
7) Guidelines for environmentally sound management of e-waste, ministry of environment & forests central pollution control board, Delhi,2008: http://www.cpcb.nic.in/latest/e waste pdf
8) Evidence-Based Biosafety:Review of the Principles and Effectiveness of Microbiological Containment Measures, 2008: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2493080/

Evaluation Pattern

A) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05

Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Discriptive Questions – 5 marks each X 3 Que. = 15 Marks

B) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	III	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	IV	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II, III, IV	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Biochemistry – I
Course Code	PSMB105
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Theory
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	Biochemistry can lead to a broad range of related careers, so it's the perfect choice if you are unsure of what your future looks like at the moment. You could work in a research lab, product development, healthcare or forensics among many other fields. By choosing biochemistry, Students are able to studying the foundations of life so the options are endless.

PSMB105 – Biochemistry – I

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	Concepts in chemical reactivity and aqueous solution	**15 (1 Credit)**
2	Bioorganic molecules	**15 (1 Credit)**
	Total	**2 Credits**

Course Outcomes: For Theory

At the end of the course students will be able to

1)Think independently and work in the laboratory
2) Perform better in competitive exams
3) Gain employability in industry and take on research- oriented careers.

4) Improve their practical biochemistry knowledge especially while preparing media for their experiments, to calculate various parameters of acid -base chemistry and reason out chemical reactions observed during experiments

Curriculum: Theory

PSMB105 – Biochemistry – I			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Concepts in chemical reactivity and aqueous solution**	**1.1 Aqueous solutions**: concentrations based on weight, volume and degree of saturation. [Only problem solving] **1.2 Acids and bases Bronsted concept of conjugate acid-** conjugate base, pH, pOH, buffers, titration curves, Hendersen-Hasselbach equation, polyprotic acids, amphoteric salts[problem solving **1.3Chemical reactivity and forces between molecules**	**15 (1 Credit)**
II	**Bioorganic molecules**	**2.1Protein Chemistry**: peptides and the peptide bond,protein structures, protein types, factors determining structure, dynamics of globular proteins, Chaperonins, prion motifs and domains **2.2Carbohydrates**: Derivatives of monosaccharides, glycoconjugates, carbohydrates as informational molecules. **2.3Lipids**: Structural lipids, lipids as signal, cofactors and pigments	**15 (1 Credit)**

Learning Resources recommended:

Unit I:

1) Biochemical calculations, Segel I.R., John Wiley and Sons, 1995.
2) Schaum's solved problem series. 3000 solved problems in Chemistry. David E. Goldberg. McGraw Hill International Editions 1997.
3) Biochemistry: The chemical reactions of living cells (Vol 1) David E. Metzler Academic Press.

Unit II:

1) Biochemistry 3rd edition, Mathew, Van Holde and Ahern, Pearson Education.
2) Lehninger-Principles of Biochemistry, Michael M. Cox and David L. Nelson, 5th Edition. W.H. Freeman and Company, New York reprinted 2008.
3) Biochemistry, Voet D. and Voet J.G., 4th edition, 1995, John Willey and Sons Inc.

Evaluation Pattern

C) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Discriptive Questions – 5 marks each X 3 Que. = 15 Marks		

D) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Practicals of PSMB105
Course Code	PSMB106
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Practical
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	Biochemistry can lead to a broad range of related careers, so it's the perfect choice if you are unsure of what your future looks like at the moment. You could work in a research lab, product development, healthcare or forensics among many other fields. By choosing biochemistry, Students are able to studying the foundations of life so the options are endless.

PSMB106 - Practical's of PSMB105

Modules at a Glance

Unit	Modules	No. of Lectures
1&2	**Biochemistry I practical**	**60 Hours (2 Credit)**
	Total	**2 Credits**

Course Outcomes: Practical

1)The learner will acquire the hands-on skill of preparing solutions of difffrent concentrations.
2) The learner will able to extract isolate and purified different proteins and sugars from biological samples
3) The learner will able to determine their pK and pIvaluesof amino acids and able to interpret Ramachandran plot.

Curriculum: Practical

PSMB106 - Practical's of PSMB105		
Title	**Learning Points**	**No of Lectures**
Biochemistry I practical	1. Preparation of buffers. 2. Extraction, isolation, partial purification of lactose from cow milk, determination of percentage yield and performing a confirmatory test 3. Extraction, isolation, partial purification of, Albumins and globulins from egg white, determination of percentage yield and performing a confirmatory test 4. Determination of pk values of amino acids by titration curves a. Glycine b. Alanine c. Lysine/Glutamic Acid 5. Interpretation of Ramchandran plot.	**60 Hours** **(2 Credit)**

Learning Resources recommended:

1. Biochemical calculations, Segel I.R., John Wiley and Sons, 1995
2. Practical Biochemistry by GeethaDamodaran K – 2nd Ed. Jaypee Publication
3. Essentials of Practicals Biochemistry by P.P. Gupta & N. Gupta
4. Principles & Techniques of Biochemistry and Molecular Biology – Keith Wilson & John Walker – 7Th Ed.
5. Principle & Techniques of Practical Biochemistry by Wilson & Walker – 5th Ed.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Metabolism of Extremophiles and anaerobes.
Course Code	PSMB107
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Theory
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	These organisms have become more and more important to biotechnology as their genomes have been uncovered, revealing a plethora of genetic potential. Currently the main uses of extremophiles lies in processes such as PCR, biofuel generation and biomining, but there are many other smaller scale operations at play.

PSMB107 – Metabolism of Extremophiles and Anaerobes

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	Extremophiles	**15 (1 Credit)**
2	Physiology, types & cultivation of anaerobic bacteria	**15 (1 Credit)**
	Total	**2 Credits**

Course Outcomes: Theory

At the end of the course students will be able to

1) Be able to discuss microorganisms in extreme environments and their adaptations.
2) Be able to elaborate the characteristics of different extremophiles and anaerobes in different habitats
3) Be able to reflect their role as global citizens, consumers and environment protectors.

Curriculum: Theory

PSMB107 – Metabolism of Extremophiles and Anaerobes			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Extremophiles**	**1.1Physiology, Biochemistry and Applications of** - Thermophiles - Psychrophiles - Piezophiles - Radiation resistant organisms **1.2Physiology, Biochemistry and Applications of-** - Acidophiles - Alkaliphiles - Halophiles **1.3Geo-Microbiology**-Bio corrosion and Bioleaching	**15 (1 Credit)**
II	**Physiology, types & cultivation of anaerobic bacteria**	**2.1Anaerobic Bacteria** Anaerobes and oxygen, Physiology of anaerobes, Types of anaerobic and microaerophilic bacteria **2.2 Techniques in Anaerobic Microbiology** **2.3 Applications of anaerobes**	**15 (1 Credit)**

Learning Resources recommended:

Unit I

1) Gerday, C., Glansdorff, N., & American Society for Microbiology. (2007). Physiology and biochemistry of extremophiles. Washington, D.C: ASM Press.
2) Horikoshi, K., Antranikian, G., Bull, A.T., Robb, F.T., Stetter, K.O. (Eds.) (2011), Extremophiles Handbook. Springer
3) Fred A. Rainey and Aharon Oren (2006). Methods in Microbiology - Volume 35, Extremophiles, 1st edi., Academic Press.
4) S.K.Kawatra and K.A. Natarajan,"Mineral Biotechnology- Microbial Aspects of Mineral Beneficiation, Metal Extraction, and Environmental Control", published by SME, Littleton, CO (USA) 2001
5) S.W.Borenstein, Microbiologically influenced corrosion handbook, Woodhead pub. Ltd., Cambridge (1994)
6) MicroorganismsinBiofouling andBiocorrosion: https://nptel.ac.in/courses/113108055/module7/lecture34.pdf

Unit II

1. Anaerobic bacteria K.T.Holland, J.S. Knapp, J.S. Shoesmith. Chapman &Hall, New York. 1987.

2. Bacterial Metabolism, Gottschalk, G., 2nd edition, 1985, Springer-Verlag
3. Brock Biology of Microorganisms. Michael Madigan, John M. Martinko. Pearson International edition. 11th edition.

Evaluation Pattern

E) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Descriptive Questions – 5 marks each X 3 Que. = 15 Marks		

F) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Practicals of PSMB 107
Course Code	PSMB108
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Practical
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	Extremophiles and anaerobes like organisms have become more and more important to biotechnology as their genomes have been uncovered, revealing a plethora of genetic potential. Currently the main uses of extremophiles lies in processes such as PCR, biofuel generation and biomining, but there are many other smaller scale operations at play. Thus students are able to gain practical skills to isolate, purified characterize them accordingly.

PSMB108 - Practical's of PSMB 107

Modules at a Glance

Unit No.	Modules	No. of Lectures
I & II	Metabolism of Extremophiles & Anaerobes practical	**60 Hours (2 Credit)**
	Total	**2 Credits**

Course Outcomes: For Practical

1)The learner will acquire the hands-on skill of isolating membrane lipids and TLC.
2) The learner will able to extract isolate and characterize extremophiles.
3) The learner will able to cultivate anaerobic bacteria using different methods.

Curriculum: Practical

PSMB108 - Practical's of PSMB 107		
Title	**Learning Points**	**No of Lectures**
Metabolism of Extremophiles & Anaerobes practical	1. Isolation and Characterization of thermophiles and thermotolerant organisms from hot springs water samples 2. Screening of halophilic bacteria from salt pans and identification of isolates. 3. Extraction of membrane lipids of halophillic bacteria and its detection by TLC 4. Cultivation of anerobic bacteria using Gaspak method 5. Cultivation of *Clostridium* species 6. Stormy fermentation of milk	**60 Hours (2 Credit)**

Learning Resources recommended:

1. Practical Handbook of Microbiology – Emanuel Goldman, Lorrence H. Green; CRC Press 2015.
2. Laboratory methods in anaerobic bacteriology – CDC Laboratory Manual 1974.
3. Environmental Microbiology – A laboratory manual – I. L. Pepper, C. P. Gerba and J. W. Brendecke : Academic Press.
4. Practical Manual of Environmental Microbiology and Biotechnology by Dr. Ratna Trivedi

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Research Methodology
Course Code	PSMB109
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Theory
Type	Major: Mandatory
Relevance with Employability/ Entrepreneurship/ Skill development	This paper enhances critical thinking and problem solving skills crucial for employability. Develops a solid foundation for data analysis, a key skill in various professions. The syllabus also fosters a research oriented mindset valuable for entrepreneurial ventures. Apart from this it sharpens skills in designing effective research strategies, strengthen literature searching capabilities and instills a meticulous approach to measurement and data collection. In addition to this it cultivates a commitment to academic integrity and equips individuals with ability to convey complex ideas with effective communication skills.

PSMB109 - Research Methodology

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	Fundamentals of Research Methods	15
2	Research Design and Measurement Concepts and Literature Searching	15
3	Documentation, scientific writing and Academic Integrity	15
4	Hypothesis Testing and Communication Skills in Research	15
	Total	**60**

Course Outcomes:

Student will able to: -

1. Understand fundamentals of research methods
2. Learn design and measurement concepts of research
3. Know data collection and analysis tools
4. Test the hypothesis and communicate the research findings effectively
5. Write research report, research proposal, research paper etc. and get acquainted with ethical considerations in research.

Curriculum:

PSMB109 - Research Methodology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	Fundamentals of Research Methods	Definition of research, Role and objectives of research, importance of research, Applications and types of research, Creativity and innovation, Critical thinking, Research process and steps in it, Collecting and reviewing the literature, Conceptualization and Formulation of: research problem, identifying variables, constructing hypothesis and Synopsis. Interpretation of results and discussion.	**15 (1 Credit)**
II	Research Design and Measurement Concepts and Literature Searching	Selecting and defining a research problem, Need for research design, Features of a good research design, Different research designs, Scales of measurements, Nominal, Ordinal, Internal and ratio scales, Errors in measurements, Validity and Reliability in measurement, Scale Construction Techniques. Digital: Web sources, E-journals, Journal access, Citation Index, Impact factor, H-index, E-consortium, UGC info net, eBooks, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Google Scholar,, Scopus.	**15 (1 Credit)**
III	Documentation, scientific writing and Academic Integrity	Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a	**15 (1 Credit)**

		review of paper, Bibliography. for illustration, style, publications of scientific work, Research and Academic Integrity: Intellectual property rights (IPRs). Plagiarism, Copyright issues, Ethics in research, and case studies.	
IV	Hypothesis Testing and Communication Skills in Research	4.1. Hypotheses a. Meaning, Nature of hypothesis b. Functions of Hypothesis c. Importance of Hypothesis d. Kinds of Hypothesis e. Characteristics of good hypothesis 4.2. Hypothesis testing a. Null and alternate hypothesis b. Type I and Type II errors c. Level of significance d. Power of test e. p-value 4.3 Communication skills a. Importance communication through English b. The process of communication and factors that influence communication. Sender, receiver, channel, code, topic, message, context, feedback, noise, filters, and barriers. c. Verbal and Non verbal communication d. Comparison of general communication and business communication. 4.4. Presentation skills a. Structure of presentation b. Types of presentation, oral power point – Handling power point slides, organization, content, body language, gesture and voice modulation	**15 (1 Credit)**

Learning Resources recommended:

Main References:

1. Kothari C.R., “Research Methodology, Methods and Techniques” (Second revised edition, New Age International Publication, 2004).

2. Saravanavel P., “Research Methodology” (Kitab Mahal, Sixteenth edition, 2007).

3. Ranjit Kumar, “Research Methodology, a step-by-step guide for beginners” (Pearson education Australia, Second edition 2005).

4. Mark Saunders, Philip Lewis, Adrain Thornhiu, “Research Methods for Business Students”(Pearson Education ltd, Seventh edition, 2016)

5. Research Methodology and Scientific Writing by C. George Thomas 2nd Ed. Springer

Additional References:

1. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
2. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press,1976.
3. The Craft of Scientific Writing by Michael Alley, (Springer).
4. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005
5. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit, 2005, Pearson Education.
6. How to write and publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
7. S. Gupta, (2005). Research Methodology and Statistical techniques, Deep and Deep Publications (P) Ltd. New Delhi, India.
8. R. Kothari, (2008). Research Methodology, New Age International, New Delhi, India.
9. Standard /Reputed Journal authors’ instructions.
10. Web resources: www.sciencedirect.com for journal references,
11. www.aip.org and www.aps.org for reference styles.
12. Web resources: www.nature.com, www.sciencemag.org,
13. www.springer.com, www.pnas.org, www.tandf.co.uk,
14. www.opticsinfobase.org for research updates.

Evaluation Pattern

G) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Discriptive Questions – 5 marks each X 3 Que. = 15 Marks		

H) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	III	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	IV	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II, III, IV	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Syllabus for M.Sc. I Microbiology Semester II

From the year 2023-24

No. of Courses	Semester II		Credits
	Major : Mandatory		
PSMB201	Applied Biochemistry		4
PSMB202	Applied Immunology		4
PSMB203	Practical's of PSMB201 and PSMB202		4
PSMB204	Molecular Genetics - II		2
	Major : Elective (Any One from below)		
PSMB205	Biostatistics and Bioinformatics	2	4
PSMB206	Practical's of PSMB205	2	
OR			
PSMB207	Biochemistry-II	2	
PSMB208	Practical's of PSMB206	2	
PSMB209	On Job Training/ Field Project		4
Total Credits			22

Name of the Course	Applied Biochemistry
Course Code	PSMB201
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Theory
Type	Major: Mandatory
Employability/ Entrepreneurship/ Skill Development	In the present scenario study of Biochemistry is highly relevant, biochemistry students can aspire for bigger roles in industry as well as academia. • Thorough knowledge in biochemistry is essential in understanding different aspects of medical sciences like drug development, immunology, pathology, pharmacy, vaccine development, etc. After BSc. One can find jobs as **marketing executives** in different Pharmaceutical companies, as a **lab assistant** in different govt. and private organizations, **clinical co-ordinators** for big pathology chains and **medical transcriptionists** for different healthcare groups**.** • The most important use of medical biochemistry, however, is biochemical tests done in the clinical laboratory. In a diagnostic center, one can get jobs as **pathologists** related to diagnostics, monitoring, and screening of patients. • Genetic Engineering or Recombinant DNA Technology is another advanced part of biochemistry which has immense scope in **vaccine development**.

PSMB201 – Applied Biochemistry

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	Enzymes: the catalysts of Cells	15
2	Signalling and stress	15
3	Genomics, Metagenomics, Comparative & Functional Genomics	15
4	Proteomics	15
	Total	**60**

Course Outcomes:

At the end of the course students will

1) Understand and relate to metabolic and physiological complexities shown by living organisms.
2) Appreciate and understand the intricate manner of communications at the cellular and sub cellular level employing bio-molecules.
3) Obtain Knowledge of Proteomics which will give them a new perspective about diagnosis of diseases and make them competent to handle new challenges if they are employed in modern diagnostic laboratories.
4) Undertake advanced studies on enzyme kinetics will help them alter conditions favourably to increase industrial productions.

Curriculum:

PSMB201 – Applied Biochemistry			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Enzymes: the catalysts of Cells**	**1.1** Information from kinetics, specificity of enzymatic action, mechanisms of catalysis **1.2** Inhibition and activation of enzymes **1.3** Enzyme isolation and purification	**15 (1 Credit)**
II	**Signalling and stress**	**2.1** Introduction to two-component signalling systems **2.2** Synthesis of virulence factors in response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis, photoresponses, aerotaxis **2.3** Bacterial development and quorum sensing: Myxobacteria, Caulobacter, bioluminescence systems similar to LuxR/LuxI in nonluminescent bacteria	**15 (1 Credit)**
III	**Genomics, Metagenomics, Comparative & Functional Genomics**	**4.1 Genomics -** 4.1.1 Human Genome project 4.1.2 Converting genomes into clones & clones into genomes 4.1.3 DNA cloning 4.1.4 Genomic libraries 4.1.5 Chromosome libraries 4.1.6 DNA sequencing & analysis of DNA sequences	**15 (1 Credit)**

		4.1.7 Assembling & annotating genome sequences **4.2 Metagenomics** 4.2.1Comparative Genomics: finding Genes that make us human, recent changes in the human genome 4.2.2 Characterization of Gene amplification and deletions in Cancer using DNA microarrays (Representational Oligonucleotide Microarray Analysis (ROMA) 4.2.3 Functional genomics-DNA Microarray technology, Serial analysis of gene expression (SAGE)	
IV	**Proteomics**	**4.1** Proteomics and the proteome, branches **4.2** Overview of techniques and challenges **4.3** Applications : Disease diagnosis[cancer biology, autoimmune, allergic response], Glycomics, use of protein biomarkers	15 L

Learning Resources recommended:

Unit I

1. Biochemistry: The chemical reactions of living cells (Vol 1) David E. Metzler. Academic Press.
2. Fundamentals of enzymology. 2nd edition. Nicholas C. Price and Lewis Stevens. Oxford Science Publication. Reprint 1998.

Unit II

1. The physiology and biochemistry of prokaryotes, White D., Drummond, T. J. and Fuqua C., 3rd edition, 2007, Oxford University Press

Unit III

1. Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co
2. Principals of Genetics, Snustad& Simmons, 6th edition, 2012, John Wiley & Sons Inc
3. Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
4. Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM press)
5. Molecular biology -Understanding the Genetic Revolution by David P. Clark(Elsevier Academic press)
6. Molecular Biotechnology Principles and applications of Recombinant DNA 4th edition Glick,Pastermak, Patten

Unit IV

1. Introduction to proteomics Tools for the new Biology. Daniel C. Liebler. Humana Press 2002
2. OMICS Applications in Biomedical, Agricultural and Environmental Sciences. Ed DebmalyaBarh, VasudeoZambare, Vasco Azevedo. CRC press. 2013.

Evaluation Pattern

I) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Discriptive Questions – 5 marks each X 3 Que. = 15 Marks		

J) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	III	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	IV	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II, III, IV	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Applied Immunology
Course Code	PSMB202
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Theory
Type	Major: Mandatory
Relevance with Employability/ Entrepreneurship/ Skill development	Immunology is widely used in numerous disciplines, including medicine, in the fields of organ transplantation, bacteriology, oncology, virology, parasitology, rheumatic diseases, psychiatric disorders, and dermatology. The Immunology of transplantation mainly deals with the process of transplantation from a donor to the recipient, so that the recipient's body does not reject the organ. The most important aspect of immunology is research because it is the biggest portion of their jobs. Immunologists work in various areas such as biomedical research, healthcare, agriculture and environmental monitoring. There is lots of scope for young aspirants in this field. Those students complete their master degree, they can work in the government & private hospitals. Many governments funded institutes, hospitals, laboratories and research agencies require such professionals. The demand of the Immunologists in market is more today as common antibiotics and other diseases have become resistant. So, the education in immunology assumes greater importance. This course opens up careers in molecular biology, diagnostics, biotechnology and regulation, and research into infectious agents associated with immune-based pathology. You can make your career as practitioners in this field and can earn good remuneration through watching patients. Interested students who wish to do further studies can go for research in immunology. Immunologists in the medical field are responsible for diagnosing and treating human patients with immunological disorders.

PSMB202 - Applied Immunology

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	**Adversarial strategies during infection**	15
2	**Immunodeficiency**	15
3	**Advances in Allergy and otherhypersensitivities**	15
4	**Immunological disorders**	15
	Total	**60**

Course Outcomes:

At the end of the course students will be able to

1) Give details of the adversarial strategies during various infections, recent advances in vaccines production and difficulties encountered in it.
2) Correlate the causes, principles involved, examples, control and treatment of immunodeficiency disorders, hypersensitivity reactions, autoimmune diseases and cancer.
3) Comment on the organs, tissue transplantation and blood transfusion-principle involved, types of transfusion reactions and their control, tests to be performed for safe transplantation.

\

Curriculum:

PSMB202 - Applied Immunology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Adversarial strategies during infection**	**1.1** 1.1.1 Bacterial survival strategies - Evading complement, - Evading killing by macrophages 1.1.2 The host counter attack against bacteria - Toxin neutralization - Opsonization of bacteria 1.1.3 The habitat of intracellular bacteria: Bacterial survival strategies - Defence against intracellular bacteria - Role of activated Macrophages 1.1.4 Viral survival strategies - antigenic variations - non functional T- cell epitopes - interference with antigen processing and/ or presentation - interference with immune effector Mechanism 1.1.5 Immunity to fungi **1.2 Vaccines** 1.2 .1. Subunit vaccines -purified components as bacterial vaccines - Viral subunit as vaccine - carbohydrate vaccine - DNA and RNA vaccines 1.2.2 Newer approaches to vaccine development 1.2.3 Current vaccines 1.2.4 Difficulties in the development of Parasitic vaccines : -Malaria 1.2.5 Vaccines for protection against bioterrorism 1.2.6 Immunization against cancer	**15** **(1 Credit)**

II	**Immunodeficiency**	**2.1** 2.1.1 Deficiencies of pattern recognition -Receptor signaling 2.1.2 Phagocytic cell defects 2.1.3 Complement system deficiencies 2.1.4 Cytokine and cytokine receptor deficiencies 2.1.5 Primary B-cell deficiency 2.1.6 Primary T- cell deficiency 2.1.7 Severe combined immunodeficiency 2.1.8 Diagnosis and treatment of primary Immunodeficiency **2.2Immune Tolerance** 2.2 .1 Major mechanisms for achieving tolerance 2.2.2 Central Tolerance 2.2.3 Peripheral Tolerance 2.2.4 Tolerance induction 2.2.5 Immunoprivileged sites-The brain, the Eyes	**15** **(1 Credit)**
III	**Advances in Allergy and other** **hypersensitivities**	**3.1** 3.1.1 Type –I hypersensitivity 3.1.2 Type –II hypersensitivity 3.1.3 Type –III hypersensitivity 3.1.4 Type –IV hypersensitivity 3.1.5Type -V hypersensitivity (Mechanism/principle, examples, diagnosis and treatment of these hypersensitive) **3.2 Transplantation and Transfusion Immunology** 3.2.1 Types of Graft 3.2.2 Types of graft rejection 3.2.3Mechanisms of graft rejection 3.2.4 Matching the donor and recipient 3.2.5 Immuno suppression 3.2.6The foetus as an allograft 3.2.7 Blood transfusion - Blood grouping and cross matching - Transfusion reactions - Criteria for selection and rejection of Blood Donor	**15** **(1 Credit)**

IV	**Immunological disorders**	**4.1 Tumor Immunology** 4.1.1Cell- intrinsic and extrinsic mechanisms of tumor suppression 4.1.2 Role of inflammation in the enhancement of tumor initiation, promotion and progression 4.1.3 Tumor antigens and their classes 4.1.4 Approaches to cancer immunotherapy - Passive immunotherapy with monoclonal antibodies - Unmasking of the latent T- cell responses - Antigen independent cytokine therapy **4.2Autoimmune diseases** 4.2.1 Causes 4.2.2 Mechanisms 4.2.3 Pathogenic effects of autoantibody 4.2.4 Pathogenic effects of complexes with auto antigens 4.2.5 T cell mediated hypersensitivity as a Pathogenic factor in autoimmune disease	**15** **(1 Credit)**

Learning Resources recommended:

Text books:

1. Roitt's Essential Immunology 13th Ed. –Wiley Blackwell
2. Kuby Immunology 6th Ed – W. H. Freeman and Company, New York

Reference Books:

1.Immunology –Essential and Fundamental – Sulbha Pathak, UrmiPalan, 3rd Ed. Capital Publishing Company (New Delhi-Kolkata)
2. Kuby Immunology 7th Ed – W. H. Freeman and Company, New York
3. Kuby Immunology 8th Ed – Macmillan education
4. Immunology – An Introduction 4th Ed – Tizard
5. Elements of Immunology- Fahim Halim Khan –Pearson Education
6. Medical Laboratory Technology - Kanai Mukherjee vol. 1

Evaluation Pattern

K) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and	05

	articulation and exhibit of leadership qualities in organizing related academic activities	

Question Paper Pattern for Periodical Class Test
Maximum Marks: 20
Duration: 40 Minutes
Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks
Discriptive Questions – 5 marks each X 3 Que. = 15 Marks

L) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	III	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	IV	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II, III, IV	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Practicals of PSMB201 & PSMB202
Course Code	PSMB203
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Practical
Type	Major: Mandatory
Relevance with Employability/ Entrepreneurship/ Skill development	Thorough knowledge in biochemistry is essential in understanding different aspects of medical sciences like drug development, immunology, pathology, pharmacy, vaccine development, etc. After BSc. One can find jobs as **marketing executives** in different Pharmaceutical companies, as a **lab assistant** in different govt. and private organizations, **clinical co-ordinators** for big pathology chains and **medical transcriptionists** for different healthcare groups**.** The most important use of medical biochemistry, however, is biochemical tests done in the clinical laboratory. In a diagnostic center, one can get jobs as **pathologists** related to diagnostics, monitoring, and screening of patients. Genetic Engineering or Recombinant DNA Technology is another advanced part of biochemistry which has immense scope in **vaccine development**. Immunology is widely used in numerous disciplines, including medicine, in the fields of organ transplantation, bacteriology, oncology, virology, parasitology, rheumatic diseases, psychiatric disorders, and dermatology. The Immunology of transplantation mainly deals with the process of transplantation from a donor to the recipient, so that the recipient's body does not reject the organ. The most important aspect of immunology is research because it is the biggest portion of their jobs. Immunologists work in various areas such as biomedical research, healthcare, agriculture and environmental monitoring. There is lots of scope for young aspirants in this field. Those students complete their master degree, they can work in the government & private hospitals. Many governments funded institutes, hospitals, laboratories and research agencies require such professionals. The demand of the Immunologists in market is more today as common antibiotics and other diseases have become resistant. So, the education in

	immunology assumes greater importance. This course opens up careers in molecular biology, diagnostics, biotechnology and regulation, and research into infectious agents associated with immune-based pathology. You can make your career as practitioners in this field and can earn good remuneration through watching patients. Interested students who wish to do further studies can go for research in immunology. Immunologists in the medical field are responsible for diagnosing and treating human patients with immunological disorders.

PSMB203 - Practical's of PSMB201 & PSMB202

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	**Applied Biochemistry Practical**	60 Hours (2 Credit)
2	**Applied ImmunologyPractical**	60 Hours (2 Credit)
	Total	120 Hours (4 Credits)

Course Outcomes:

At the end of the course students will be able to

1) Understand the challenges and problems encountered while dealing with bio-molecules like proteins and train students practically.
2) Know and elaborate the effect of different physiological conditions on the growth of microorganisms.
3) Explain the enzyme kinetics
4) Understand the human blood group system.
5) Apply advance techniques in diagnosis of a disease.

Curriculum:

PSMB203 - Practical's of PSMB201 & PSMB202		
Title	**Learning Points**	**No of Lectures**
Applied Biochemistry Practical	1. Isolation, partial purification and study of enzyme kinetics of amylase. 2. Adaptation of *E. coli* to anaerobiosis *3.* Effect of temperature and water activity on swarming of *Proteus spps* 4. Isolation of amylopectin and amylose from potato starch. 5. Isolation of Lycopene from tomatoes 6. Preparation of lectin from plant source and its application	**60 Hours** **(2 Credit)**
Applied Immunology Practical	1.Hemoglobin estimation by Cyanmethaemoglobin method using Drabkins Fluid as one of the criteria used for selection of blood donor during collection of blood for safe transfusion. 2.Blood grouping and Compatibility testing /cross matching of blood for safe blood transfusion. 3.Determination Of Enzymes Of Oxidative Stress (SOD And Catalase) 4.NBT Analysis Of Blood Sample 5. Serum Lysozyme Activity 6. Serum Myeloperoxidase Activity (MPO) 7. Rheumatoid factor test for laboratory diagnosis of Rheumatoid arthritis. 8. Lupus erythematosus (LE) cell preparation-Principle, Procedure and Significance to be explained during the practicals using permanent slides/ color atlas of diagnostic immunology/Microbiology 9. RIST and RAST- Principle, Procedure and Significance to be explained during the practicals using power point presentation/ youtube.	**60 Hours** **(2 Credit)**

Learning Resources recommended:

1. Laboratory manual in biochemistry by Jayaraman J. , New Age InternationalPublishers.
2. An introduction to practical biochemistry 3rd. edition, David T Plummer, Tata McGraw Hill edition 1998.
3. Experimental biochemistry –A student companion, Rao Beedu, S. Deshpande, IK InternationalPvt. Ltd.
4. Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A. Tata McGraw Hill edition.

5. Source of Experiments for teaching Microbiology, Primrose and Wardlaw.
6. Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach , David White.
7. Medical Laboratory Technology - Kanai Mukherjee vol. 1
8. Practical Handbook of Microbiology – Emanuel Goldman, Lorrence H. Green; CRC Press 2015.
9. Medical Microbiology Practical Book by Dr. Mridushri – Bluerose publishers
10. Practical Immunology A Laboratory Manual – 1st Ed. Lambert.

Evaluation Pattern

C. Internal Evaluation = 40 % = 40 Marks

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

D. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Molecular Genetics II
Course Code	PSMB204
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Theory
Type	Major: Mandatory
Relevance with Employability/ Entrepreneurship/ Skill development	There are various benefits of learning microbial genetics which enhances variety of skills among students as well as contribute to the society: • Problem-solving skills: The course develops students' problem-solving skills by teaching them to analyze genetic data, identify patterns, and apply their knowledge to real-world problems. • Contribution to society: Microbial Genetics has the potential to contribute to society by providing solutions to global issues such as food security, environmental degradation, and disease prevention. Overall, learning Microbial Genetics can be a rewarding experience for those interested in genetics, biotechnology, microbiology, and genetic engineering, as it provides a comprehensive understanding of microorganisms and their genetic makeup.

PSMB204 - Molecular Genetics II

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	**Regulation of gene expression in eukaryotes.**	15
2	**Genetic Regulation of The Development of Drosophila, Organelle DNA & Population Genetics**	15
	Total	**30**

Course Outcomes:

At the end of the course students will be able

1) To elaborate on regulation of gene expression in eukaryotes.
2) To reflect on their knowledge about development of Drosophila
3) To understand and apply principles of population genetics

Curriculum:

PSMB204 - Molecular Genetics II			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Regulation of gene expression in eukaryotes.**	1.1 Control of Gene Expression in Eukaryotes: 1.1.1 role of regulatory proteins, activators and repressors molecules 1.1.2 The Role of Chromatin in Regulating Gene transcription: 1.1.3 Silencing and Genomic Imprinting 1.1.4 RNA Processing Control 1.1.5 RNA Interference 1.1.6 Post transcriptional regulation of gene expression.	**15 (1 Credit)**
II	**Genetic Regulation of The Development of**	**2.1 Drosophila developmentalStages** -Embryonic development, - Maternal effect genes,	**15 (1 Credit)**

	Drosophila, Organelle DNA &Population Genetics	- segmentation genes, - Homeotic genes **2.2.1Organelle DNA**: - The genetics of organelle encoded traits, - The endosymbiotic theory, **2.2.2 Mitochondrial DNA** - The gene structure and organization of mitochondrial DNA, - Non universal codons in Mitochondrial DNA, replication, transcription and translation of Mitochondrial DNA, - Evolution of Mitochondrial DNA, **2.2.3 Chloroplast DNA**– - Properties similar to Eubacterial DNA - Gene structure and organization of chloroplast DNA, - Replication, transcription and translation of chloroplast DNA **2.3 Population genetics** - Genetic structure of population - Hardy-Weinberg Law - Genetic variation in space and time - Genetic variation in Natural population - Forces that change gene frequencies in populations: i. Mutation, ii. Random genetic drift iii. Migration iv. Natural selection v. Balance between mutation and selection vi. Assertive mating vii. Inbreeding - Summary of the effects of evolutionary forces on the genetic structure of population - The role of genetics in conservation Biology	

Learning Resources recommended:

1) iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition
2) Fundamental Bacterial Genetics, Trun, Trempy, 1st edition, 2004, Blackwell Publishing.
3) Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7thedition, 2007, Pearson Education.
4) Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers.
5) Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman & Co
6) Principals of Genetics, Snustad& Simmons, 6th edition, 2012, John Wiley & Sons Inc

7) Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
8) Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM press)
9) Molecular biology -Understanding the Genetic Revolution by David P. Clark(Elsevier Academic press)
10) Molecular Biotechnology Principles and applications of Recombinant DNA 4th edition Glick,Pastermak, Patten
11) Recombinant DNA J.D. Watson 2nd edition

Evaluation Pattern

M) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Descriptive Questions – 5 marks each X 3 Que. = 15 Marks		

N) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Biostatistics and Bioinformatics
Course Code	PSMB205
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Theory
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	These include (a) advanced methods in computational biology, (b) the chemical principles that underlie biochemistry, molecular biology and genomics, (c) the design and implementation of relational databases, (d) fundamental methods in probability and statistics, and (e) the construction of predictive mathematical models of biological systems. Students are capable of using critical thinking and research methods in Bioinformatics to understand computational and experimental data. In addition to formal course work, this ability will be learned and demonstrated in (a) dissertation research, (b) preparation for and presentations at scientific meetings, and (c) graduate seminars, student seminars, and qualifying examinations.

PSMB205 - Biostatistics and Bioinformatics

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	**Biostatistics**	**15 (1 Credit)**
2	**Bioinformatics**	**15 (1 Credit)**
	Total	**2 Credits**

Course Outcomes:

At the end of the course students will be able to

1) Understand fundamentals of biostatistics and its applications.
2) Understand the concepts of hypothesis testing and parametric tests.
3) Apply concepts of statistics in research.
4) Well versed with different tools and softwares of bioinformatics.
5) Use of bioinformatics tools in various aspects of research.

Curriculum:

PSMB205 - Biostatistics and Bioinformatics			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Biostatistics**	3.1.1Measures of central tendency -mean, median, mode, geometric mean 3.1.2Measures of dispersion- Range, Q.D., M.D., variance, standard deviation 3.1.3Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations & their equations, interpretation of regression coefficients, principles of least squares, Two regression lines, curve fitting Karl Pearson's coefficient of correlation, Spearman's coefficient of correlation **3.2 Parametric tests** 3.2.1 Large sample Tests i. Testing significance of single population mean ii. Testing significance of two population mean 3.2.2 Small sample Tests i. Testing significance of single population mean ii. Testing difference between two independent normal population mean iii. Testing difference between two correlated normal population mean iv. Testing significance of correlation coefficient 3.2.3 -2 test i. Testing single population variance ii. Testing Goodness of fit iii. Testing association between two attributes 3.2.4 F-test- Testing equality of variance i. ANOVA- one-way classification, ii. two-way classification	**15 (1 Credit)**

II	**Bio informatics**	**4.1 Introduction and overview of bioinformatics** 4.1.1 Biological databases-nucleic acid sequence databases-gene bank/ EMBL/ DDBJ 4.1.2 Protein sequence data bases- (UniProtKB), Derived databases(Prosite, BLOCKS, Pfam/Prodom) **4.2Structural databases (PDB, NDB) and Enzyme databases** 4.2.1 Concept in sequence analysis- Needleman &Wunsch, Smith & Waterman alignment algorithms 4.2.2.Scoring Matrix for nucleic acids and protein- MDM.BLOSUM.CSW 4.2.3Alignment: Pair wise BLAST, FASTA 4.2.4 Multiple sequence alignment, PRAS, CLUSTAL W 4.3Phylogenetic analysis and Tree construction Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction 4.4 Structure predictions for proteins- Basic approaches for protein structure predictions, comparative modelling, fold recognition 4.5Chemo-informatics- Introduction, applications in pharmaceutical industries 4.6 Immuno-informatics- Overview, Reverse vaccinology, Rational Vaccine design	**15 (1 Credit)**

Learning Resources recommended:

1) Fundamentals of Research methodology and statistics- Yogesh Kumar Singh, New Age International Publishers
2) Biostatistics: A foundation for analysis in health sciences. Daniel WW, Cross CL. 10thEdn, Wiley.2013
3) Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
4) Introduction to Bioinformatics T.K. Attwood and D.J Perry-Smith
5) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005
6) Biostatistical Analysis. Zar JH. 5th Edition Pearson Education.2010.
7) Principles of Biostatistics. Pagano M., Gauvreau K., 2ndEdn. Cargege Learning, 2010
8) Fundamentals of Biostatistics. Rosner B. 7thEdn. Duxbury Thomson 2011
9) Introductory Applied Biostatistics D'Agostino RB., Sullivan LM., Beiser AS., Thomson Brooks/Cole 2006
10) Statistical Analysis in Microbiology: Statnotes, By Richard A. Armstrong And Anthony C. Hilton, A John Wiley & Sons, Inc. Publication, ISBN: 978-0-470-55930-7 December 2010 Wiley-Blackwell 192 Pages

Evaluation Pattern

O) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Descriptive Questions – 5 marks each X 3 Que. = 15 Marks		

P) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Practicals of PSMB205
Course Code	PSMB206
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Practical
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	These include (a) advanced methods in computational biology, (b) the chemical principles that underlie biochemistry, molecular biology and genomics, (c) the design and implementation of relational databases, (d) fundamental methods in probability and statistics, and (e) the construction of predictive mathematical models of biological systems. Students are capable of **using critical thinking and research methods in Bioinformatics** to understand computational and experimental data. In addition to formal course work, this ability will be learned and demonstrated in (a) dissertation research, (b) preparation for and presentations at scientific meetings, and (c) graduate seminars, student seminars, and qualifying examinations

PSMB206 - Practical's of PSMB205

Modules at a Glance

Unit No.	Modules	No. of Lectures
I & II	Biostatistics and Bioinformatics practicals	**60 Hours (2 Credit)**
	Total	**2 Credits**

Course Outcomes:

1) The students will understand computational biology and insilico analytical techniques using bioinformatics.
2) Students will be able to apply concepts of statistics in research
3) Students will be well versed with different tools and software of bioinformatics.

Curriculum:

PSMB206 - Practical's of PSMB205		
Title	**Learning Points**	**No of Lectures**
Biostatistics and Bioinformatics Practical	1. Problem solving in biostatistics 2. Practicals Based on Bioinformatics- • Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained • Visiting & exploring various databases mentioned in syllabus • Using BLAST and FASTA for sequence analysis • Fish out homologs for given specific sequences (by teacher) • Decide sequence of some relevance to their syllabus and related to some biological problem e.g. evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology) • Six frame translation of given nucleotide sequence • Restriction analysis of given nucleotide sequence • Pair-wise alignment and multiple alignment of a given protein sequences • Formation of phylogenetic tree	**60 Hours** **(2 Credit)**

Learning Resources recommended:

1) Fundamentals of Research methodology and statistics- Yogesh Kumar Singh, New Age International Publishers
2) Biostatistics: A foundation for analysis in health sciences. Daniel WW, Cross CL. 10thEdn, Wiley.2013
3) Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
4) Introduction to Bioinformatics T.K. Attwood and D.J Perry-Smith
5) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005
6) Biostatistical Analysis. Zar JH. 5th Edition Pearson Education.2010.
7) Principles of Biostatistics. Pagano M., Gauvreau K., 2ndEdn. Cargege Learning, 2010
8) Fundamentals of Biostatistics. Rosner B. 7thEdn. Duxbury Thomson 2011
9) Introductory Applied Biostatistics D'Agostino RB., Sullivan LM., Beiser AS., Thomson Brooks/Cole 2006

Evaluation Pattern

C. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

D. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Biochemistry - II
Course Code	PSMB207
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Theory
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	Biochemistry can lead to a broad range of related careers, so it's the perfect choice if you are unsure of what your future looks like at the moment. You could work in a research lab, product development, healthcare or forensics among many other fields. By choosing biochemistry, Students are able to studying the foundations of life so the options are endless.

PSMB207 - Biochemistry - II

Modules at a Glance

Unit No.	Modules	No. of Lectures
1	**Degradation and transformation of organic molecules**	**15 (1 Credit)**
2	**Natural and Unusual bio-molecules andbioactive compounds**	**15 (1 Credit)**
	Total	**2 Credits**

Course Outcomes:

At the end of the course students will be able to

1) Understand mechanistic aspects of biodegradation.
2) Apply the knowledge of biodegradation and biotransformation to design a flow sheet to degrade and transform aromatic compounds.
3) Apply biological processes at molecular level for production and synthesis of bioactive molecules of commercial significance.
4) Learn the unusual bio-molecules and bioactive compounds.

Curriculum:

PSMB207 - Biochemistry - II			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Degradation and transformation of organic molecules**	**3.1Biotic reactions-** Mechanistic aspects Environmental factors affecting biodegradation 3.**2Degradation and transformation of aromatic compounds**: Monocyclic, polycyclic, carboxylates and related compounds, halogenated hydrocarbons. **3.3Persistence and biomagnification of xenobiotics**	**15 (1 Credit)**
II	**Natural and Unusual bio-molecules and bioactive compounds**	**3.1 Bioactive proteins & peptides**: peptides as bioactive agents, peptides with anti-oxidative activity, antimicrobial peptides, enzyme based antimicrobial proteins, non-enzyme based antimicrobial proteins, commercialization of antimicrobial proteins and peptides. Lectins, surfactants, albumin, cryoprotectants, lyoprotectants **3.2 Classes of Natural Products**: polyketides, Terpenes& steroids, alkaloids, phenylpropanoids, Flavonoids. Non coding RNAs **3.3 Functional carbohydrates and hydrocolloids** Cereal βGlucans, modified starch, microbial Polysaccharides, Chitosan	**15 (1 Credit)**

Learning Resources recommended:

Unit I:

1. Environmental degradation and transformation of organic chemicals- Alasdair H. Neilson andAnn-Safie Allard. CRC press, 2008
2. Biotransformations: Microbial degradation of health-risk compounds edited by Ved Pal Singh. Elsiever 1995.
3. Microbial Ecology: Fundamentals and applications 4th ed. Ronald H. Atlas and Richard Bartha.Reprint 2005. Pearson Education.
4. Environmental Microbiology. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Academic Press (Elsevier) 2000

Unit II

1. Bioactive food proteins & peptides Applications in human health, edNavam S.Hettiarachchy, CRC press, 2012
2. Natural products: the secondary metabolites. James R. Hansen. Royal Society of Chem.
3. Development & manufacture of Protein Pharmaceuticals. Ed Steven L. Nail and Michael J. Akers. Springer Science 2002 [ISBN 978-1-4615-0549-5]
4. Functional food carbohydrates. Costas G. Biliaderis and Marta S. Izydorczyk. CRCpress 2007.
5. Chemistry of Natural products by SV Bhat, BA Nagasampagi& M Sivakumar, Berlin Springer (2005) (ISBN 3-540-40669-7).
6. Handbook of hydrocolloids. 2nd edition. Ed G.O. Phillips and P.A. Williams. CRC Press. Woodhead Publishing Limited [ISBN-978-1-84569-587-3]

Evaluation Pattern

Q) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test to be conducted in the given semester	20
02	Assignments	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05
Question Paper Pattern for Periodical Class Test Maximum Marks: 20 Duration: 40 Minutes Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 5 Que. = 05 Marks Descriptive Questions – 5 marks each X 3 Que. = 15 Marks		

R) Semester End Examination: 60% (60 Marks)

Question No	Unit	Marks	Distribution
Q1	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q2	I	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q3	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q4	II	Short Note (12)	6 marks each X 2 Que. [out of 4] = 12 Marks
Q5	I, II	Objective (12)	Match the Column / Fill in the Blanks / Multiple Choice Questions/ True or False / Answer in One or Two Lines (Concept based Questions) (1 Marks each X 12 Que. = 12 Marks

Name of the Course	Practical's of PSMB 207
Course Code	PSMB208
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Practical
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	A biochemist studies the chemistry of living processes, such as cell development, breathing and digestion, and living energy changes, such as growth, ageing, and death. Researches methods of transferring characteristics, such as resistance to disease, from one organism to other. Examine chemical aspects of the formation of antibodies, and researches chemistry of cells and blood corpuscles. A biochemist develops and executes tests to detect disease, genetic disorders, or other abnormalities. Develops and tests new drugs and medications used for commercial distribution thus, they have large job opportunities in the field of pharmaceuticals where they can Cleans purifies, refines, and otherwise prepares pharmaceutical compounds for commercial distribution. As they can analyzes foods to determine nutritional value and effects of cooking, canning, and processing on this value, they can serve as nutritionist. A biochemist also prepares reports and recommendations based upon research outcomes.

PSMB208 - Practical's of PSMB 207

Modules at a Glance

Unit No.	Modules	No. of Lectures
	Practical	
I & II	Biochemistry – II practical	**60 Hours (2 Credit)**
	Total	**2 Credits**

Course Outcomes:

At the end of the course students will be able to

1) Understand degradation pathways of different compounds practically
2) Learn & apply mechanistic aspects of biodegradation of xenobiotic compounds
3) Extract & characterize hydrocolloids and other compounds from natural sources
4) Determine the degradation or biotransformation pathways of different xenobiotic compounds

Curriculum:

PSMB208 - Practical's of PSMB 207		
Title	**Learning Points**	**No of Lectures**
Biochemistry II practical	1. Degradation of aromatic compounds 2. Study of factors affecting environmental degradation of organic compounds 3. Isolation of pesticide degrading organisms & degradation studies. 4. Extraction & characterization of hydrocolloids from plants & algae 5. Study of antimicrobial proteins & peptides 6. Extraction of lectins from plants 7. Extraction & characterization of Terpenes, polyketides, alkaloids	**60 Hours** **(2 Credit)**

Learning Resources recommended:

1. Laboratory manual in biochemistry by Jayaraman J. , New Age InternationalPublishers.
2. An introduction to practical biochemistry 3rd. edition, David T Plummer, Tata McGraw Hill edition 1998.
3. Experimental biochemistry –A student companion, Rao Beedu, S. Deshpande, IK internationalPvt. Ltd.
4. Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A. Tata McGraw Hill edition.
5. Source of Experiments for teaching Microbiology, Primrose and Wardlaw.
6. Chemistry of Natural products by SV Bhat, BA Nagasampagi& M Sivakumar, Berlin Springer (2005) (ISBN 3-540-40669-7).
7. Handbook of hydrocolloids. 2nd edition. Ed G.O. Phillips and P.A. Williams. CRC Press.
   Woodhead Publishing Limited [ISBN-978-1-84569-587-3]
8. Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach , David White.

Evaluation Pattern

C. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

D. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	On Job Training/ Field Project
Course Code	PSMB209
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Practical
Type	On Job Training/ Field Project
Relevance with Employability/ Entrepreneurship/ Skill development	The courses' primary goal is to provide students with the experimental knowledge and skills necessary to carried out research projects.The on job training to students will inculcate the work culture and discipline of industry in the students.

Guidelines and Evaluation pattern for On Job Training/ Field Project (100 Marks)

Introduction:

Inclusion of On Job Training/ Field Project in the course curriculum of the M.Sc. Program is one of the ambitious aspect in the Program structure. The main objective of inclusion of On Job Training/ Field Project is to inculcate ability to interpret particular aspect of the study in his/ her own words.

Guidelines for On Job Training

On-the-Job Training/Field Project: Students will be required to undertake a designated project or tasks in an organization or industry relevant to their field of study. The course aims to provide students with practical exposure and hands-on experience in a professional work environment related to their field of study.

Course Objectives:

By the end of the course, students should be able to:

1. Gain exposure to real-world insights and apply theoretical knowledge to practical situations
2. Enhance his skills regarding problem-solving, decision-making, and communication skills.
3. Understand organizational dynamics and work culture.
4. Build industry connections and networking opportunities

Course Duration:

Minimum 15 days / 75 hours of On Job Training with avarious pharmaceutical industry/ food industry/ diagnostic laboratories etc.

- The theme of the internship should be based on any study area of the Major course
- Project Report should be submitted.
- Experience Certificate is Mandatory

Report Structure:

The students will be required to submit a comprehensive report at the end of the On-the-Job Training/Field Project. A project report has to be brief in content and must include the following aspects:

a) **Title Page:**

Mentioning the title of the report, name of the student, program, institution, and the period of training/project.

b) **Certificate of Completion:**

A certificate issued by the organization or supervisor confirming the successful completion of the training/project.

c) **Declaration:**

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) Acknowledgments:

Recognizing individuals or organizations that provided support, guidance, or resources during the training/project.

e) Table of Contents:

Providing a clear outline of the report's sections and page numbers.

f) **Executive Summary:**

A bird's eye view of your entire presentation has to be precisely offered under this Category.

g) **Introduction on the Company:**

A Concise representation of company/ organization defining its scope, products/ services and its SWOT analysis.

h) **Your Role in the Organization during the on Job Training:**

The key aspects handled, the department under which you were deployed and brief Summary report duly acknowledged by the reporting head.

i) **Challenges**:

The challenges confronted while churning out theoretical knowledge into practical world.

j) **Conclusion:**

A brief overview of your experience and suggestions to bridge the gap between theory and practice.

Course Outcomes:

1. Apply theoretical knowledge and concepts acquired during the academic program to real-world work scenarios.
2. Develop practical skills and competencies necessary for successful professional engagement.
3. Demonstrate effective problem-solving, decision-making, and critical thinking abilities in a work environment.
4. Adapt to and navigate organizational dynamics and work culture in the chosen industry.
5. Prepare a comprehensive report documenting the training/project experience, findings, and recommendations.

Guidelines for Field Project

The Field Project for Master of Science is designed to provide students with hands-on learning experiences in understanding different microbial contexts. The project aims to expose students to research methodology.

Course Objectives:

By the end of the course, students should be able to:

1. Gain exposure to research activities.
2. Understand the theoretical concepts through practical knowledge.

Course Duration: One Semester.

Course Outline:

1. **Introduction to Field Project**
2. **Field Visits and Observations**
3. **Research and Data Collection**

Report writing should be as per following flow.

a) **Title Page:**

Mentioning the title of the report, name of the student, program, institution, and the period of training/project.

b) **Certificate of Completion:**

A certificate issued by the organization or supervisor confirming the successful completion of the training/project.

c) **Declaration:**

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) **Acknowledgments:**

Recognizing individuals or organizations that provided support, guidance, or resources during the training/project.

e) **Table of Contents:**

Providing a clear outline of the report's sections and page numbers.

f) **Executive Summary:**

A bird’s eye view of your entire presentation has to be precisely offered under this Category. A brief overview of the project, its objectives, and key findings should be mentioned

g) Introduction:

Background information about the field project and its significance. Objectives and scope of the project.

h) Literature Review:

Overview of relevant literature and studies related to the chosen field and development issues.

i) Methodology:

Description of the research methods used for data collection.

j) Field Visits and Observations:

Detailed accounts of the field visits, including locations, dates, and observations made during the visits. Photographs or visual aids to support the observations.

k) Data Analysis:

Presentation and interpretation of the data collected during the field visits. Charts, graphs, or tables to illustrate the findings.

l) Conclusion:

Summary of the key findings and outcomes of the field project.

m) References&Appendices:

List of all sources cited in the project report.

The project report based on 'On Job Training/ Field Project' shall be prepared as per the broad guidelines given below:

- Font type: Times New Roman
- Font size: 12-For content, 14-for Title
- Line Space: 1.5-for content and 1-for in table work
- Paper Size: A4
- Margin: in Left-1.5, Up-Down-Right-1
- The Project Report shall be bounded.

Format

1 st page (Main Page)

Title of the problem of the Project

A Project Submitted

to

R. P. Gogate college of Arts & Science and

R.V. Jogalekar College of Commerce Autonomous College

under

University of Mumbai

for partial completion of the degree

of

Master in Science

In a subject of Microbiology.

Under the Faculty of Science

By

Name of Student

Under the Guidance of

Name of the Guiding Teacher

R. P. Gogate college of Arts & Science and

R.V. Jogalekar College of Commerce Autonomous College,

Near District Court

Month and Year

On separate page

Index

On separate page

Declaration by learner

I the undersigned Miss/Mr. _____
[Name of the learner] here by, declare that work embodied in this project work titled _____ forms my own contribution to the research work carried out under the guidance of [Name of the guiding teacher] _____ is a result of my own research work and has not been previously submitted to any other University for any other Degree/ Diploma to this or any other University.

Wherever reference has been made to previous works of others, it has been clearly indicated as such and included in the bibliography.

I, here by further declare that all information of this document has been obtained and presented in accordance with academic rules and ethical conduct.

Name and Signature of the learner

Certified by
Name and signature of the Guiding Teacher

R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Master of Science (M.Sc.) Microbiology

M.Sc. Part -2 [Sem III& IV]

Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Name of Program	**M.Sc.**
Level	PG
No of Semesters	04
Year of Implementation	**2023-24**
Program Specific Outcomes (PSO)	1] Learner shall know the advanced technique in Microbiology. 2] Learner shall able to carry out simple research projects. 3] Learner shall gain the knowledge of industrial and food microbiology techniques. 4] Learner shall know the advancement in the field of biotechnology and virology. 5] Learner shall able to run industry based assays. 6] Learner shall apply knowledge of bioinformatics and biostatistics for research purpose.
Relevance of PSOs to the local, regional, national, and global developmental needs	Microbiology is the study of microorganisms. At the postgraduate level this discipline needs a more advanced and updated knowledge of microbiology. Therefore the said curriculum is designed in such a way that learner should get the knowledge of advanced technique in microbiology. At local to global level research and innovation is the key to success. This research abilities will be inculcated by simple research projects. Globally the demand of skilled microbiologist is increasing so the keen knowledge of industrial and food microbiology techniques is essential. The Covid 19 pandemic have established the global threat of communicable diseases. In such situation control strategy should not limit at local level. The vaccines produced by animal cell culture technique has remarkable role in fight against such global problem. The current curriculum provide the knowledge of such animal cell culture technique. The pharmaceutical industries needs a skilled microbiologist accompanied with the knowledge of industrial product assays. The said curriculum provides knowledge about such assay methods. Summarizing, Post graduates of MSc. Microbiology program will be informed citizens who can understand and evaluate impact of new research and innovation in Life sciences and will be able to pursue wide range of careers including biological and life science research in higher educational institutions as well as careers in public health, clinical research, food, pharmaceutical and biotechnological industries.

M.Sc. II Microbiology Syllabus (General Outline)

Semester 3

THEORY

Course Code	Unit	Topic Headings	Credits	Lec/topic
PSMB301 Tools and Techniques in Microbiology	I	Biological sample preparation and Modified analytical techniques	04	15
	II	Advanced Electron Microscopy		15
	III	Spectroscopic and Chromatography Techniques: Principle, working and applications		15
	IV	Identification methods in microbiology		15
PSMB 302 Pharmaceutical & Cosmetic Microbiology	I	Introduction to Pharmaceutical Microbiology	04	15
	II	Pharmaceutical Analysis & Regulation		15
	III	Cosmetic Microbiology		15
	IV	Audit, Validation & documentation		15
PSMB 303 Cell Biology	I	Introduction To Cell Biology And Cell Membrane	04	15
	II	Organisation And Function Of Mitochondria, Chloroplast, Peroxisomes And Cytoskeleton		15
	III	Cell Division,Cell Cycle And Cell Junctions		15
	IV	Cell Communication And Multi cellular Cell Development		15
PSMB 304 Advances in Biotechnology	I	IPR and Biodiversity Law	04	15
	II	Bioethics		15
	III	Nano Biotechnology		15
	IV	Algal Biotechnology		15

PRACTICALS

PSMBP-301	**Tools and Techniques in Microbiology**	2	04
PSMBP-302	**Pharmaceutical & Cosmetic Microbiology**	2	04
PSMBP- 303	**Cell Biology**	2	04
PSMBP-304	**Advances in Biotechnology**	2	04

Semester 4

THEORY

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
Paper PSMB401- Industrial & Food Microbiology	**I**	Applications of Microbial technology in food processing	**4**	**01**
	II	Food Preservation & Food safety		**01**
	III	Strain improvement: Modern methods		**01**
	IV	Fermentations of Microbial products for commercial use		**01**
PSMB402 Applied Microbiology	I	Applications of Microbiology in bioremediation & pollution control	**4**	01
	II	Applications of Enzymes		01
	III	Microbial bio-molecules in diagnostics and therapeutics		01
	IV	Novel uses of microorganisms and microbial products		01
PSMB403 Plant, Agriculture and Animal Biotechnology	I	Plant Biotechnology	**4**	**01**
	II	Animal Biotechnology		**01**
	III	Bio-augmentation and Bio-stimulation in Agriculture		**01**
	IV	Bio-control in Agriculture		**01**
PSMB404 Mycology, Virology & Protozoology	I	Fungal technology	**4**	**01**
	II	Animal and Plant Virology		**01**
	III	Study of Bacteriophages and Algal Phages		**01**
	IV	Protozoology		**01**

PRACTICALS

PSMBP-401	Industrial & Food Microbiology	2	04
PSMBP-402	Applied Microbiology	2	04
PSMBP- 403	Plant, Agriculture and Animal Biotechnology	2	04
PSMBP-404	Mycology, Virology & Protozoology	2	04

Syllabus for M.Sc. II Microbiology Semester III

From the year 2023-24

Name of the Course	Tools and Techniques in Microbiology
Course Code	PSMB301
Class	M.Sc. II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Developing expertise in sample preparation techniques for phytopharmaceutical analysis, microscopy, chromatography and spectroscopy enhances your employability in various industries such as pharmaceuticals, research, and quality control. Proficiency in fluorescence microscopy is beneficial for careers in cell biology, neuroscience, and diagnostics. Expertise in advanced analytical techniques like Mass Spectrometry, NMR Spectroscopy is sought after in pharmaceuticals, biotechnology, and environmental monitoring. Understanding microbial analysis and genomics is valuable in fields like microbiology, biotechnology, and medical research. Skill development includes precision, attention to detail, and adherence to safety protocols during lab & research work. Entrepreneurs can offer microbial identification services or develop novel DNA extraction kits. They also can establish microscopy training workshops or consulting services for image analysis.

Nomenclature: Tools and Techniques in Microbiology

Course Outcomes:

At the end of the course students will

1) Be able to understand mechanism of imaging by advance microscopy enabling them to have a complete view of mechanism and application of advance microscopy

2) Be able to learn instrumentation which will help them in their professional career.

3) Be able to gain analytical and interpretative skills which is critical for working in the laboratory

4) Be able to understand concept of genome sequencing, analysis and its applications

Curriculum:

PSMB301 - Tools and Techniques in Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	Biological sample preparation and Modified analytical techniques	1.1 Sample preparation: An analytical perspective 1.2 General sample preparation for analysis of Phyto pharmaceuticals 1.3 Preparation of sample and staining for SEM, TEM, Atomic force Microscopy, Confocal Microscopy. 1.4 Preparation of sample and general principle of chromatography and spectroscopic techniques 1.5 Combination procedures for analysis with relevant examples/case studies : a) TLC and HPLC b) HPTLC and MS c) TLC and FTIR d) TLC and Raman spectroscopy	15 (1)
II	Advanced Microscopy Techniques	2.1 Principle and working of a. TEM & SEM b. Confocal Microscopy c. AFM 2.2 Principle & Working of a. Fluorescence Microscopy, b. High Resolution Fluorescent Microscope, Concept Understanding of Fluorescence recovery after photobleaching (FRPA), and Forster Resonance Energy Transfer (FRET)	15 (1)
III	Spectroscopic and Chromatography Techniques: Principle, working and applications	3.1 Mass Spectroscopy : ESI-MS and MALDIMS 3.2 NMR spectroscopy. 3.3 FTIR 3.4Ion exchange chromatography 3.5Gel filtration chromatography	15 (1)

IV	Identification methods in microbiology	4.1 Introduction of microbial systematic Phylogeny: Overview of phylogeny and Phylogenetic trees 4.2 i) Culture dependent analysis of microbial communities: Laser Tweezer Flow cytometry ii) For classification &identification through Phenotypic analysis using VITEK , API 20, FAME. 4.3 Culture independent methods i) Methods for DNA / RNA extraction ii) Gene sequence analysis 1. Amplification of 16S rRNA gene for prokaryotes and SSU, LSU, ITS. 2. Multi-locus sequence typing 3. Genome fingerprinting (Multi gene and whole genome)– Ribotyping iv) Sequencing genomes • First generation - Sanger sequencing and sequence analysis using different tools (Chromas – Pro, SeqMan) • Shotgun – genomic library • Second generation – Amplicon sequencing Illumina • Third and fourth generation Heliscope and Ion torrent Oxford nanopore v) Environmental genomics An introduction to meta-genomics, meta trancriptomes and Meta-proteomics	15 (1)

Learning Resources recommended:

1) Sample Preparation Techniques in Analytical Chemistry by S. Mitra (01-06)
2) Herbal Drug Technology by S S Agarwal and MParidhavi
3) Scanning Electron Microscopy by V Kazmiruk
4) Handbook of TEM by Ayache J., Beaunier L., Boomendil J., Ehret G.
5) Atomic force Microscopy by NunuC.Santos.
6) Methods in molecular biology- Confocal Microscopy by Paddock
7) Advanced Techniues in Biological electron microscopy, James K Koehler
8) Handbook from Anchrome laboratory
9) Thin layer chromatography- a modern practical approach by Peter E. Wall
10) Biotechniques by N. Arumugan, V kumaresan
11) A Textbook of Biophysics by R N Roy

12) Study of Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) by Hongbao Ma , Kuan-Jiunn Shieh , Tracy X. Qiao
13) A beginner's Guide to SEM by AnwerUl Hamid
14) Modern BiophysicalChemistry, Detection and Analysis of Biomolecules by Peter Jomo Walla , Second, Updated and Expanded Edition (2014)
15) Applied NMR Spectroscopy for Chemists and Life Scientists by Oliver Zerbe and Simon Jurt, (2014)
16)Techniques and Instrumentation in Analytical Chemistry Volume 18, 1997
17) High-Performance Thin-Layer Chromatography(HPTLC) by ManMohanSrivastava. 2011Springer-Verlag Berlin Heidelberg
18) Protein Purification: Principles, High Resolution Methods, and Applications by JanChristerJanson. 2011. Third Edition John Wiley & Sons, Inc., Hoboken, New Jersey
19) Brock Biology of microorganisms 14th ed.
20) Molecular cloning : a lab manual, Green and Sambrook vol. 1 4th edn
21) https://www.olympus-lifescience.com/en/microscoperesource/primer/techniques/confocal/confocalintro/
22) http://www.ammrf.org.au/myscope/pdfs/tem.pdf
23) https://www.olympus lifescience.com/en/microscoperesource/primer/techniques/confocal/applications/fretintro/

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class test	20
Assignment	15
Class performance	05
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q1	I	Short Note (12)
Q2	II	Short Note (12)
Q3	III	Short Note (12)
Q4	IV	Short Note (12)
Q5	I, II, III, IV	Objective (12)
Total		**60**

Name of the Course	Pharmaceutical And Cosmetic Microbiology
Course Code	PSMB302
Class	M.Sc. II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Strong understanding of microbiology in pharmaceuticals enhances employability in quality control, research, and regulatory roles. Proficiency in Good Manufacturing Practices (GMP) is vital for roles involving compliance and quality assurance. Expertise in assessing water systems and endotoxin/pyrogen testing is crucial for product safety. Knowledge of cleaning, disinfection, and clean room practices is valuable for maintaining aseptic environments. Skill development includes risk assessment, audit procedures, and knowledge of relevant ISO standards. It also involves knowledge of cosmetic formulation, preservation techniques, and microbial testing protocols along with in-depth understanding of GMP principles, audit procedures, and quality management systems. Entrepreneurs can offer consulting services for water, pharmaceutical & cosmetic product analysis.

Nomenclature: Pharmaceutical And Cosmetic Microbiology

Course Outcomes:

At the end of the course learners will be

1. Be able to understand the different process and work culture in the Pharmaceutical & Cosmetic Industry
2. Equipped with in-depth knowledge w. r. t. regulations and audit procedures carried out in an industry
3. Equipped with risk assessment tools and process understanding to make them skilled and competent as per job requirement.

Curriculum:

PSMB302 - Pharmaceutical And Cosmetic Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	Introduction to Pharmaceutical Microbiology	1.1 Role of Microbiology for pharmaceuticals industries 1.2 GMP and Regulations 1.3 Laboratory management and design 1.4 Microbiological culture media & Microbiology laboratory techniques 1.5 Bio burden determination 1.6 Specified and objectionable microorganisms 1.7 Guidelines for preparing a laboratory information file	15 (1)
II	Pharmaceutical Analysis & Regulation	2.1 Assessment of pharmaceutical water systems and Endotoxin and pyrogen testing 2.2 Sterilization and sterility assurance. Use of Biological indicators for measuring sterilization 2.3 Cleaning and disinfection Use of Antibiotics and preservatives ,Clean rooms and environmental monitoring 2.4 Rapid microbiological methods 2.5 Risk assessment and microbiology 2.6 Good practices for pharmaceutical quality control laboratories 2.7 Good manufacturing practices for pharmaceutical Products.	15 (1)
III	Cosmetic Microbiology	3.1 History of cosmetic Microbiology ,Preservation of cosmetics 3.2 Antimicrobial preservative efficacy & microbial content testing 3.3 Microbiology Laboratory methods in support of sterility Assurance System 3.4 Bio burden testing & Environmental monitoring 3.5 Sampling: Principles and Practice	15 (1)

IV	Audit, Validation & documentation	4.1 Microbiological hazard analysis & audit Validation 4.2 IS and ISO standards: 9001/14001. 4.3 Introduction to Validation and documentation 4.4 Auditing sterilization processes and facilities	15 (1)

Learning Resources recommended:

1. Pharmaceutical Microbiology by Tim Sandle
2. WHO Guidelines for preparing a laboratory information file
3. WHO Good practices for pharmaceutical microbiology laboratories
4. WHO-GMP for pharmaceutical products
5. Cosmetic Microbiology: A practical Approach, 2nd edition. Philip A Geiss.Taylor & Francis group
6. Handbook of Microbiological Quality Control for Pharmaceuticals and MedicalDevices, Rosamund M.Baird, Stephen P.Denyer, Norman Hodges

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class test	20
Assignment	15
Class performance	05
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q1	I	Short Note (12)
Q2	II	Short Note (12)
Q3	III	Short Note (12)
Q4	IV	Short Note (12)
Q5	I, II, III, IV	Objective (12)
Total		**60**

Name of the Course	Cell Biology
Course Code	PSMB303
Class	M.Sc. II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	A strong foundation in cell biology is essential for roles in research, biotechnology, and medical fields. Proficiency in understanding membrane structure is valuable in drug delivery, biophysics, and bioengineering. Understanding cell division mechanisms is crucial in cancer research, drug development, and regenerative medicine. Mastery of developmental biology concepts is essential in regenerative medicine, genetics, and biotechnology. Skill development includes understanding model organism development, genetic regulation, and morphogenesis as well as encompasses knowledge of lipid bilayers, membrane proteins, and their interactions. Entrepreneurs can develop tools for developmental biology research or offer services for model organism analysis.

Nomenclature: Cell Biology

Course Outcomes:

At the end of the course learners will be able to

1. Understand the structure and compartmentalization of organelles, protein export, protein sorting
2. Understand the events of cell cycle and its regulation
3. Explain the communications of cells with other cells and to the environment
4. Explain the process of development in general

Curriculum:

PSMB303 - Cell Biology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	Introduction To Cell Biology And Cell Membrane	1.1Introduction to cell biology- Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast 1.2Membrane structure : Cell membrane structure: Lipid bilayer, membrane proteins, Spectrins, Glycophorin, Multipass membrane proteins Bacteriorhodopsin 1.3Membrane Transport: Principles of membrane transport, ion channels and electrical properties of membranes. protein transport, post translation transport and co translation transport. 1.4Intracellular Compartments and protein sorting: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum, transport of proteins into mitochondria and chloroplasts 1.5Cell wall and extracellular matrix- matrix proteins, matrix polysaccharides.	15 (1)
II	Organisation And Function Of Mitochondria, Chloroplast, Peroxisomes And Cytoskeleton	2.1 Mitochondria: Structure, electron-transport chains and proton pump, Chloroplasts: Structure, energy capture from sunlight, genetic system of Mitochondrion and chloroplast 2.2 Intracellular vesicular traffic :The molecular mechanism of membrane transport and the maintenance of compartmental diversity, transport from the ER through the Golgi apparatus, transport from trans Golgi network to lysosomes 2.3 Cytoskeleton: The self-assembly and dynamic structure of cytoskeletal filaments, How cells regulate their cytoskeletal filament, (Cytoskeletal filaments, Microtubules, Actin and intermediate filaments).	15 (1)

III	Cell Division, Cell Cycle And Cell Junctions	3.1Mechanism of cell division: M-phase, Mitosis, Cytokinesis, Germ cells and fertilization, 3.2Cell cycle and Programmed cell death: Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis. 3.3Cell Junctions and cell-cell adhesion: Anchoring, adherence junctions, Desmosomes, Gap junctions, cell-cell adhesion, Cadherins, Selectins, N-CAM, The extracellular matrix of animals., Integrins,	15 (1)
IV	Cell Communication And Multi cellular Cell Development	4.1Cell communication: General principles of cell communication (Nitric oxide gas signal and nuclear receptors, Three classes surface receptors), Signaling through G-protein linked cell surface receptors 4.2Signalling through enzyme linked cell surface receptors: Tyrosine kinase, Docking sites, Ras, MAP kinase, Pl3 kinase, TGF- β, Signaling pathways by regulated proteolysis. Signalling in plants: Serine / Threonine kinases, role of ethylene, Phytochromes 4.3Development of multicellular organisms: Caenorhabditiselegans, Drosophila melanogaster.	15 (1)

Learning Resources recommended:

1. Molecular Biology of the Cell – Alberts, Johnson, Lewis, Raff, Roberts &Walter, 6th edition.
2. Cooper, G.M., Hausman R.E. (2009) The Cell: A Molecular Approach- 6th edition.
3. Molecular Cell Biology. Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; HiddePloegh; Angelika Amon; Kelsey C. Martin , 8th edition
4. Karp G. (2008). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
5. Gilbert , Barresi (2016) Developmental Biology : 11th Edition

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class test	20
Assignment	15
Class performance	05
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q1	I	Short Note (12)
Q2	II	Short Note (12)
Q3	III	Short Note (12)
Q4	IV	Short Note (12)
Q5	I, II, III, IV	Objective (12)
Total		**60**

Name of the Course	Advances in Biotechnology
Course Code	PSMB304
Class	M.Sc. II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding intellectual property rights (IPR) is crucial for career opportunities in biotechnology companies and research institutions. Proficiency in biotech patents is essential for research protection and technology transfer roles. Proficiency in ethical guidelines is vital for careers involving human subject's research and clinical trials. Proficiency in nanotechnology applications in biotech fields enhances employability in materials science, medicine, and agriculture. Entrepreneurs can develop algal-based products for sustainable food, energy, and cosmetics markets. They can also establish IPR consulting services to help biotech startups protect their innovations. Skill development includes knowledge of patent laws, patent filing procedures, and patent infringement issues. Other skills such as understanding nanomaterial properties, biosynthesis, and applications in various sectors are also imparted.

Nomenclature: Advances in Biotechnology

Course Outcomes:

At the end of the course students will:

1. Reflect on the need and implications of patents in Biotechnology
2. Understand the biodiversity law
3. Learn the bioethical guidelines in Biotechnology and Microbiology
4. Relate to various applications of nano technology
5. Learn the culturing and application of algal technology

Curriculum:

PSMB304 - Advances in Biotechnology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	IPR and Biodiversity Law	1.1Need for IPR in Biotechnology 1.2 Patents for Biotechnology 1.3Case Studies- Basmati Rice Issue- Turmeric Patent- Agriculture Neem Patent- Chakraborty case- Corn genetically engineered withan insecticide 1.4Biodiversity law: introduction, Development, International and National Biodiversity laws	15 (1)
II	Bioethics	2.1 The goals of biotechnology, Challenging characteristics of biotechnology 2.2 Bioethics and microbiology Ethical issues and Perspectives in the Discipline of Microbiology Ethics Perspectives from India Bioethics, bioweapons and the microbiologist 2.3 Ethical guidelines for Biomedical research on Human subjects 2.4 Case study –Infectious disease -Effects ,Causes and Prevention of infectious diseases through vaccination -Benefits and risks of vaccination -Alternative approaches to vaccination: voluntary, quasi-mandatory and incentivized Schemes, Comparing and assessing vaccination strategies, Children as special cases, Surveillance - HIV and AIDS as notifiable diseases, - Control of infectious diseases, - Issues raised by quarantine and isolation, -Use of vaccines in control of infectious diseases 2.5 Public perception of biotechnology: Genetic engineering –safety, social, moral and ethical consideration	15 (1)

III	Nano Biotechnology	3.1 Basics of Nanotechnology - Types of nano materials -Properties of nano materials 3.2 Fundamentals of Bio-nanotechnology - nanomotors of biological systems - ATPsynthase: a nanoturbine - Flagellar motors in bacteria - Linear molecular motors 3.3 Biosynthesis of nanomaterialsbiosystems as nano factories - Bacteria as machinery for synthesis of nano metals- gold, silver, Zinc, cadmium, platinum - Fungi and Actinomycetes as fabricators of nano metals, Algae as nanotechnologists 3.4 DNA and proteins as templates for molecular Nanotechnology and nano electronics 3.5 Applications of nanotechnology – Nanomedicine, nano bio-devices, nano implants, applications in agriculture, food and cosmetics	15 (1)
IV	Algal Biotechnology	4.1 Culture techniques and media for growth of fresh water algae: - Measurement of algal growth in culture - lag phase, log phase, stationary phase and death phase using biomass, chlorophyll content, Measurement of algal pigemnts. 4.2 Culturing microalgae in Photo bioreactors, Fermentor and Outdoor ponds: Variation in design, culture conditions, scale up, advantages and disadvantages 4.3 Applications of Algal Biotechnology: Food Supplements and fertilizers, Bioactive compounds and cosmetics, Biofuel,Bioplastics.	15 (1)

Learning Resources recommended:

Unit 1

1. Molecular Biology by M D Morris
2. Microbial Biotechnology – principles and applications by Lee Yuan Kun
3. IPR- Unleading the knowledge economy by PrabuddhaGanguli
4. Issues and Dilemmas of Biotechnology by Bernice Schacter
5. Biotechnology and IPR – Legal and Social Implications by Kshitij Kumar Singh
6. Law and National Biodiversity Strategies and Action Plans by the Law Division for the United Nations Environment Program

Unit 2

1.https://www.researchgate.net/publication/23467644 Bioethics and biotechnology Article in Cytotechnology · May 2007
2.Ethical issues in microbiology, *P Desikan, A Chakrabarti, V Muthuswamy. Indian Journal of Medical Microbiology, (2011) 29(4): 327-301
3. Ethical Perspectives in the Discipline of Microbiology: Article · December 2015 DOI: 10.18099/ijetv.v1i2.6817Article · December 2015DOI 10.18099/ijetv.v1i2.6817
4. Health Ethics in South-East Asia. Health ethics in six sear countries. Volume 1 Edited by NilamKasturiaratchi, Redar Lie, Jens Seeberg.
5.Bioethics, bioweapons and the microbiologist: Fernando AnayaVelázquez*RevLatinoamMicrobiol2002;44 (1)
6. Ethical guidelines For Biomedical research on Human subjects .National Institute of Tuberculosi and Respiratory Diseases. Based on ICMR, CDSCO, GCP& International Ethical Guidelines.
7. Ethics in medical research: General principles with special reference to psychiatry research. AjitAvasthi, Abhishek Ghosh, Sidharth Sarkar, Sandeep Grover. Indian Journal of Psychiatry 55(1), Jan-Mar 2013
8. Case study: Public health - ethical issues, Nuffield Council on Bioethics, Chapter 4 page no.51- 77.
9. Biotechnology- John E. Smith Fifth edition, Chapter 15, 232-242.

Unit 3

1. Bionanotechnology –concepts and applications. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey,GoldieOza
2.Nanotechnology- Principles and Practices 2 nd edition Sulabha K. Kulkarni Capital Publishing Company
3. Nanotechnology- Nanomaterials and NanodevicesG.Mohan Kumar .Narosa Publications

Unit 4

1. Bellinger, E. G. and Sigee, D. C. (2010). Freshwater algae: Identification and use as a bioindicators.Wiley-Blackwell (Pre-read Book)
2. Lee, R. E. (2008). Phycology. 4ed. Cambridge University Press (Pre-read Book)
3. Andersen, R. A. (2005). Algal culturing techniques. Elsevier Academic Press
4. Sahoo, D. and Seckbach, J. (2015). The Algae World. Springer
5. Prescott, G. W. (1954). How to Know Fresh-Water Algae. WM C. Brown Company (For practicals only)
6. Vuuren, S. J. (2006). Easy identification of the most common freshwater algae. A guide for the identification of microscopic algae in South African freshwaters. DWAF and NWU (For practicals only)
7. Sharma, P., Sharma, N. (2017) Industrial and Biotechnological Applications of Algae: A Review. Journal of Advances in Plant Biology - 1(1):01-25. (Review Paper)
8.Barkia, I., Saari, N., Manning, S. R. (2019). Microalgae for High-Value Products Towards Human Health and Nutrition. Mar. Drugs 2019, 17, 304; doi:10.3390/md17050304 (Review Paper)
9. Rasul, I. et. al. (2017) Algae Biotechnology: A green light for engineered algae. From Algae Based Polymers, Blends and Composites. Elsevier (Book Chapter)

10.Barsanti, L. and Gualtieri P. (2014). Algae: Anatomy, Biochemistry, and Biotechnology, 2ed. CRC Press.
11. Richmond, A. and Hu, Q. (2013). Handbook of Microalgal Culture: Applied Phycology and Biotechnology, 2ed. John Wiley & Sons,

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class test	20
Assignment	15
Class performance	05
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q1	I	Short Note (12)
Q2	II	Short Note (12)
Q3	III	Short Note (12)
Q4	IV	Short Note (12)
Q5	I, II, III, IV	Objective (12)
Total		**60**

Name of the Course	Tools and Techniques in Microbiology Practical
Course Code	PSMBP301
Class	M.Sc. II
Semester	III
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Developing expertise in sample preparation techniques for phytopharmaceutical analysis, microscopy, chromatography and spectroscopy enhances your employability in various industries such as pharmaceuticals, research, and quality control. Proficiency in fluorescence microscopy is beneficial for careers in cell biology, neuroscience, and diagnostics. Expertise in advanced analytical techniques like Mass Spectrometry, NMR Spectroscopy is sought after in pharmaceuticals, biotechnology, and environmental monitoring. Understanding microbial analysis and genomics is valuable in fields like microbiology, biotechnology, and medical research. Skill development includes precision, attention to detail, and adherence to safety protocols during lab & research work. Entrepreneurs can offer microbial identification services or develop novel DNA extraction kits. They also can establish microscopy training workshops or consulting services for image analysis.

Nomenclature: Tools and Techniques in Microbiology Practical

Course Outcomes:

At the end of the course learners will be able to

1. Generate a phylogenetic tree
2. Perform extraction and separation of pigments and phyto-chemicals
3. Perform DNA extraction and agarose electrophoresis

Curriculum:

PSMBP301 - Tools and Techniques in Microbiology Practical		
Title	**Learning Points**	**No of Lectures**
Tools and Techniques in Microbiology Practical	**PRACTICALS** 1. Extraction and Qualitative detection of different phyto-chemicals using chemical methods. 2. Extraction and separation of different pigments using TLC 3. Spectrum analysis of pigments using UV spectrophotometer. 4. Generation of phylogenetic tree. 5. Extraction of DNA from soil and checking its purity using agarose electrophoresis and UV260/280 ratio **SELF STUDY** 1. Determination of purity of extracted DNA using Qubit 2. Study the working of TEM, SEM, Fluorescence and Confocal microscopy /Nuclear magnetic resonance spectrocopy and evaulation of simple 1H NMR spectra of select organic compounds / Determination of Molar Mass of Simple Compounds Using Mass Spectroscopy using virtual lab 3. Assignment on "Application of advanced electron microscopy"./ protocol for culture submission to NCBI database 4. Use of VITEK (Demonstration)	60 (2)

Learning Resources recommended:

1. Handbook from Anchrome laboratory
2. Molecular cloning : a lab manual, Green and Sambrook vol. 1 4th edn
3. Techniques and Instrumentation in Analytical Chemistry Volume 18, 1997
4. Handbook of TEM by Ayache J., Beaunier L., Boomendil J., Ehret G.
5. https://www.olympus-ifescience.com/en/microscoperesource/primer/techniques/confocal/confocalintro/
6. http://www.ammrf.org.au/myscope/pdfs/tem.pdf
7. https://www.olympus-ifescience.com/en/microscoperesource/primer/techniques/confocal/applications/fretintro/
8. https://www.microscopyu.com/techniques/fluorescence/introduction-to-fluorescencemicroscopy

Evaluation Pattern –

Practical Course	Major technique	Minor Technique	Journal	Viva	Spots / Quiz/ Lab	Total
PSMBP301	20 Marks	10 Marks	05 Marks	05 Marks	10 Marks	50 Marks

Name of the Course	Pharmaceutical And Cosmetic Microbiology Practical
Course Code	PSMBP302
Class	M.Sc. II
Semester	III
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Strong understanding of microbiology in pharmaceuticals enhances employability in quality control, research, and regulatory roles. Proficiency in Good Manufacturing Practices (GMP) is vital for roles involving compliance and quality assurance. Expertise in assessing water systems and endotoxin/pyrogen testing is crucial for product safety. Knowledge of cleaning, disinfection, and clean room practices is valuable for maintaining aseptic environments. Skill development includes risk assessment, audit procedures, and knowledge of relevant ISO standards. It also involves knowledge of cosmetic formulation, preservation techniques, and microbial testing protocols along with in-depth understanding of GMP principles, audit procedures, and quality management systems. Entrepreneurs can offer consulting services for water, pharmaceutical & cosmetic product analysis.

Nomenclature: Pharmaceutical and Cosmetic Microbiology Practical

Course Outcomes:

At the end of the course learners will be able to

1. Know the different process and work culture in the Pharmaceutical & Cosmetic Industry.

2. Perform variety of tests carried out in pharmaceutical and cosmetic industry

3. Understand in-depth knowledge wrt regulations and audit procedures carried out in an industry

Curriculum:

PSMBP302 - Pharmaceutical And Cosmetic Microbiology Practical		
Title	**Learning Points**	**No of Lectures**
Pharmaceutical And Cosmetic Microbiology Practical	**PRACTICAL** 1) Perform an audit of any test. 2) Preservative efficacy test as per ISO 11930 3) Bio burden test 4) Quality control of microbial content of cosmetics 5) MIC of an antibiotic by tube method using Indian pharmacopeia protocol **SELF-STUDY :** 1. Market survey of 5 cosmetic products and the Common cosmetic preservatives used 2. HACCP of College canteen or home kitchen wrt a food preparation.	60 (2)

Learning Resources recommended:

1. WHO Guidelines for preparing a laboratory information file
2. WHO Good practices for pharmaceutical microbiology laboratories
3. WHO-GMP for pharmaceutical products
4. Cosmetic Microbiology: A practical Approach, 2nd edition. Philip A Geiss.Taylor & Francis group

Evaluation Pattern –

Practical Course	Major technique	Minor Technique	Journal	Viva	Spots / Quiz/ Lab	Total
PSMBP302	20 Marks	10 Marks	05 Marks	05 Marks	10 Marks	50 Marks

Name of the Course	Cell Biology Practical
Course Code	PSMBP303
Class	M.Sc. II
Semester	III
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	A strong foundation in cell biology is essential for roles in research, biotechnology, and medical fields. Proficiency in understanding membrane structure is valuable in drug delivery, biophysics, and bioengineering. Understanding cell division mechanisms is crucial in cancer research, drug development, and regenerative medicine. Mastery of developmental biology concepts is essential in regenerative medicine, genetics, and biotechnology. Skill development includes understanding model organism development, genetic regulation, and morphogenesis as well as encompasses knowledge of lipid bilayers, membrane proteins, and their interactions. Impart skills such as SDS PAGE & cell viability analysis. Entrepreneurs can develop tools for developmental biology research or offer services for model organism analysis.

Nomenclature: Cell Biology Practical

Course Outcomes:

At the end of the course learners will be able to

1. Perform SDS PAGE using protein separation
2. Perform cell viability assays using different techniques
3. Perform isolation of cell organelles

Curriculum:

PSMBP303 - Cell Biology Practical		
Title	**Learning Points**	**No of Lectures**
Cell Biology Practical	**PRACTICALS** 1. Disruption of bacterial cells followed by characterization of cellular proteins by SDSPAGE 2. Isolation of lymphocytes and its Viability staining using trypan blue 3. Determination of cell viability of lymphocytes by MTT Assay& neutral red uptake assay 4. Comparison of various cell viability techniques 5. Isolation of mitochondria 6. Isolation of chloroplast and checking photophosphorylation	60 (2)

Learning Resources recommended:

1. Molecular cloning : a lab manual, Green and Sambrook vol. 1 4th ed.
2. Cell Viability Assays; Terry L Riss, PhD, Richard A Moravec, BS, Andrew L Niles, MS, Sarah Duellman, PhD, Hélène A Benink, PhD, Tracy J Worzella, MS, and Lisa Minor. (https://www.ncbi.nlm.nih.gov/books/NBK144065/)

Evaluation Pattern –

Practical Course	Major technique	Minor Technique	Journal	Viva	Spots / Quiz/ Lab	Total
PSMBP303	20 Marks	10 Marks	05 Marks	05 Marks	10 Marks	50 Marks

Name of the Course	Advances in Biotechnology Practical
Course Code	PSMBP304
Class	M.Sc. II
Semester	III
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding intellectual property rights (IPR) is crucial for career opportunities in biotechnology companies and research institutions. Proficiency in biotech patents is essential for research protection and technology transfer roles. Proficiency in ethical guidelines is vital for careers involving human subjects' research and clinical trials. Proficiency in nanotechnology applications in biotech fields enhances employability in materials science, medicine, and agriculture. Entrepreneurs can develop algal-based products for sustainable food, energy, and cosmetics markets. They can also establish IPR consulting services to help biotech startups protect their innovations. Skill development includes knowledge of patent laws, patent filing procedures, and patent infringement issues. Other skills such as understanding nanomaterial properties, biosynthesis, and applications in various sectors are also imparted.

Nomenclature: Advances in Biotechnology Practical

Course Outcomes:

At the end of the course learners will be able to

1. Synthesize silver nanoparticles and determine its antibacterial activity
2. Prepare growth culture medium for algae
3. Cultivate microalgae form freshwater environments

Curriculum:

PSMBP304 - Advances in Biotechnology Practical		
Title	**Learning Points**	**No of Lectures**
Advances in Biotechnology Practical	PRACTICALS 1. Preparation and characterization of Silver Nanoparticles 2. Survival Curve and antibacterial activity of nano silver particles 3. Study of nano silver coated gauze / textiles for antimicrobial effect on different bacteria. 4. Preparation of growth culture medium for fresh water algae and study its diversity with respect to its type count and morphology . 5. Counting algal Cells in Cultures with the Light Microscope. SELF STUDY 1. Assignment on Measurement of Chlorophyll a and Carotenoids Concentration in Cyanobacteria 2. Study various types of microalgae and its role in climate change	60 (2)

Learning Resources recommended:

1. Andersen, R. A. (2005). Algal culturing techniques. Elsevier Academic Press
2. Vuuren, S. J. (2006). Easy identification of the most common freshwater algae. A guide for the identification of microscopic algae in South African freshwaters. DWAF and NWU
3. Richmond, A. and Hu, Q. (2013). Handbook of Microalgal Culture: Applied Phycology and Biotechnology, 2ed. John Wiley & Sons, Ltd.

Evaluation Pattern –

Practical Course	Major technique	Minor Technique	Journal	Viva	Spots / Quiz/ Lab	Total
PSMBP304	20 Marks	10 Marks	05 Marks	05 Marks	10 Marks	50 Marks

Syllabus for M.Sc. II Microbiology Semester IV

From the year 2023-24

Name of the Course	Industrial and Food Microbiology
Course Code	PSMB401
Class	M.Sc. II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding starter cultures enhances employability in food industry roles, such as food technologist or quality control specialist. Proficiency in fermented food production is valuable in food technology and culinary industries. Proficiency in advanced detection methods enhances employability in food safety and quality assurance. Expertise in microbial metabolite production is valuable in biotechnology and pharmaceutical industries. Skill development involves implementing quality control measures, adhering to standards, and risk assessment. Apart from this mastering sampling technique, understanding detection principles, and data interpretation is also covered. Course also encompasses knowledge of fermentation techniques, controlling microbial growth, and optimizing flavor profiles. Entrepreneurs can establish testing labs specializing in rapid and sensitive microorganism detection & can offer quality assurance consulting services to food companies.

Nomenclature: Industrial and Food Microbiology

Course Outcomes:

At the end of the course the learner will be able

1. To develop employable skills concurrently with an understanding of various fermentation processes.
2. Understand the basic knowledge of food fermentation, along with advanced methods of food preservation, food analysis and food safety.
3. To develop the skill for production & assessment of probiotic microbes
4. To acquire knowledge about probiotics and prebiotics and their applications
5. To understand the high throughput screening techniques used for fermentation.

Curriculum:

PSMB401 - Industrial and Food Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	Applications of Microbial technology in food processing	1.1Starter culture of bacteria , yeast & mold used in food fermentation 1.2Fermented Foods :- 1.2.1 General methods of fermented food production 1.2.2 Fermented cereals :- Bread production 1.2.3 Fermented vegetables: - Sauerkraut production. 1.2.4 Production of microbial flavoring compounds :- Vanilla flavor 1.3Prebiotic & Probiotic 1.3.1 Probiotics 1.3.2 Screening of Potential Probiotics 1.3.3 Industrial Aspects of Probiotic Production 1.3.4 Prebiotics	15 (1)
II	Food Preservation & Food safety	2.1 Advanced methods of food preservation Microwave Processing, Ohmic Heating, High-Pressure Processing, Pulsed Electric Fields, Pulsed Light Technology Magnetic Fields, Ultrasound, Pulsed X-Rays, Ozone, Antimicrobial Edible Films 2.2 Advanced methods of detection of microorganisms in food Sampling plans and sample preparation, physical methods, chemical methods. 2.3 Controlling quality of food Control at Source, Codes of Good Manufacturing Practice ,The Hazard Analysis and Critical Control Point (HACCP) Concept Quality Systems: BS 5750 and ISO 9000 Series Risk Analysis	15 (1)

III	Strain improvement: Modern methods	3.1 Screening methods and high throughput screening 3.2 Return of natural products 3.3 Broadening the base of the discovery process and increasing the gene expression 3.4 Post genomics era- the influence of genomics, transcriptomics and fluxomics on the improvement of primary metabolite producers 3.5 Use of recombination systems for the improvement of secondary metabolite production. A) The application ofparasexualcycle B) Protoplast fusion C) Recombinant technology.	15 (1)
IV	Fermentations of Microbial products for commercial use	4.1 Microbial production of Rosmeric acid &Caffeic acid 4.2 Production of bacterial polysaccharide & Commercially produced Polysaccharides 4.3 Microbial Production of Riboflavin 4.4 Microbial Production of Antibiotic :- Cephalosporin , Tetracycline	15 (1)

Learning Resources recommended:

1. Bibek Ray and Arun Bhunia (2008) Fundamental Food Microbiology. 4th Ed. CRC Press.
2. Petra Foerst, Chalat Santivarangkna 2016 Advances in Probiotic Technology ,CRC Press A Science Publishers Book
3. Prescott and Dunn's ‘’Industrial Microbiology’’.1982 4th Edition, McMillanPublishers
4. OkaforNkuda 2007 ‘’Modern Industrial Microbiology and Biotechnology’’, SciencePublications Enfield, NH, USA.
5. Wilfried Schwab, Bernd Markus Lange, Bernd Markus Lange “Biotechnology of natural products” Springer International Publishing,
6. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology’’. Vol 1 &2 ,Academic Press
7. Stanbury P. F., Whitaker A. & HaII--S. J., 1997, "Principles of FermentationTechnology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
8. Osman Erkmen, T. FarukBozoglu, Food Microbiology - Principles into Practice Volume I and II, John Wiley (2016)
9. Adams and Moss , Food Microbiology, 3rd edition, RSC Publishing (2008)
10. Robert E.C. , Wildman 2nd Ed. “ Handbook of Neutraceuticals& Functional Foods “CRC Press A SCIENCE PUBLISHERS BOOK
11. Ronald Ross Watson, Victor R. Preedy 1st Edition 2010 “Bioactive Foods in Promoting Health: Probiotics and Prebiotics” Academic Press is an imprint of Elsevier

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class test	20
Assignment	15
Class performance	05
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q1	I	Short Note (12)
Q2	II	Short Note (12)
Q3	III	Short Note (12)
Q4	IV	Short Note (12)
Q5	I, II, III, IV	Objective (12)
Total		**60**

Name of the Course	Applied Microbiology
Course Code	PSMB402
Class	M.Sc. II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding bioremediation strategies enhances employability in environmental science, waste management, and consulting roles.Proficiency in ecosystem-specific bioremediation techniques is valuable in addressing pollution across diverse environments.Understanding enzyme applications enhances employability in food technology, pharmaceuticals, and industrial sectors.Expertise in biotech applications in medicine is sought after in pharmaceutical research and healthcare.Skill development involves designing in situ bioremediation strategies, monitoring microbial activity, and assessing ecological impact. Besides this it includes optimizing biosensor technologies, understanding microbial contributions to climate change, and developing sustainable bioproducts.Entrepreneurs can offer services in molecular diagnostics, vaccine development, or biopharmaceutical production. They can develop enzyme-based products for food processing, cosmetics, and industrial processes.

Nomenclature: Applied Microbiology

Course Outcomes:

At the end of the course the learner will be able

1. To understand and explain different applications of Microbiology
2. To explain the role of microbial biomolecules in diagnostic and therapeutic industry
3. To understand the role of microbiology in pollution control and remediation
4. To assess and apply the novel uses of microorganisms and microbial products.

Curriculum:

PSMB402 - Applied Microbiology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	Applications of Microbiology in bioremediation & pollution control	1.1 Introduction to Bioremediation strategies for synthetic compounds, petrochemicals, inorganic waste. 1.2 Bioremediation strategies and techniques in situ and testing its efficacy and side effects 1.3 Bioremediation of metals & gaseous ex situ. Environment modification for bioremediation 1.4 Approaches to bioremediation : Microbial seeding & bioengineering using rDNA technology 1.5 Bioremediation of various ecosystems-Soil, marine, air	15 (1)
II	Applications of Enzymes	2.1 Enzymes as analytical tool for the assessment of food quality, safety, and monitoring food processing 2.2 Applications of enzymes in food : Baking, fruit juice production, processing, brewing, and dairy. Applications of nonfood enzymes in detergents, Textiles, medical. 2.3 New industrial enzyme applications: Cosmetics, enzymes for preservation. Hard surface cleaning, oil field application, waste water treatment.	15 (1)
III	Microbial bio-molecules in diagnostics and therapeutics	3.1 Protein therapeutics: Pharmaceuticals, monoclonal antibodies. Enzymes (Dnase I, Alginate lyase, Glycosidasese) 3.2 Nucleic acid as a therapeutic agent – antisense RNA, ribozymes and Nucleic acid delivery. 3.3 Vaccines – Subunit and Peptide vaccines. 3.4 Molecular diagnosis of genetic diseases.	15 (1)

IV	Novel uses of microorganisms and microbial products	4.1 Biosensors, microbial concrete, Bioleaching, Enhanced oil recovery, Biofuels 4.2 Biotech of the marine environment, microbial contribution of climate change 4.3 Biopolymers, Bio surfactants	15 (1)

Learning Resources recommended:

1. Environmental Biotechnology by Alan Scragg2nd edition
2. WolfangAehle ,Enzyme in industry
3. Muthuswamy --Enzymes in Food and Beverage Processing Edited by MuthusamyChandrasekaran,CRC Press-
4. Medical Biotechnology –PratibhaNallari –
5. Comprehensive Biotechnology-Ramawat 4th Edition.
6. Glick: Molecular Biotechnology - Principles and Applications of Recombinant DNA (3rd, Third Edition) By Bernard R. Glick Nallari
7. Alan Scragg , Environmental Biotechnology by Alan Scragg B. D. Singh Kalyani Publishers, 2010 - Biotechnology -

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class test	20
Assignment	15
Class performance	05
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q1	I	Short Note (12)
Q2	II	Short Note (12)
Q3	III	Short Note (12)
Q4	IV	Short Note (12)
Q5	I, II, III, IV	Objective (12)
Total		**60**

Name of the Course	Plant Agriculture and Animal Biotechnology
Course Code	PSMB403
Class	M.Sc. II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding genetic engineering of plants enhances employability in biotechnology, agriculture, and horticulture sectors.Proficiency in transgenic plant traits and applications is valuable in agricultural innovation and biotech research.Expertise in sustainable agriculture practices enhances employability in farming, agribusiness, and environmental roles.Proficiency in biological pest control methods is crucial in integrated pest management and agricultural sustainability.Skill development includes knowledge of plant transformation methods, gene delivery techniques, and manipulation of plant genomes. It also includes understanding nutrient management, biofertilizers, organic farming principles, and vermicomposting.Entrepreneurs can establish organic farming ventures or offer consulting on sustainable practices. Apart from this they can develop plants as bioreactors for pharmaceutical production or nutrient enhancement. They can also develop biopesticides or offer pest management consulting to farmers.

Nomenclature: Plant Agriculture and Animal Biotechnology

Course Outcomes:

By the end of the course, the learner will have sufficient scientific understanding & will be able to: -

1. Demonstrate different methods to get transgenic crops and their applications in getting resistant varieties.
2. Comprehend the different methods of obtaining Transgenic animals and their applications.
3. .Assess the importance of Vermicomposting and Biofertilizers in agriculture.
4. Understand the role of microbiologist in Organic farming and its scope.
5. Critically evaluate the need for the use of Biocontrol agents in the field of a agriculture.

Curriculum:

PSMB403 - Plant Agriculture and Animal Biotechnology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	Plant Biotechnology	1.1 Genetic engineering of Plants Plant transformation with Ti plasmids of Agrobacterium tumefaciens,Ti plasmid derived vector systems, physical methods of transferring genes to plants:, Use of guns and electric shock to transfer DNA into plant cells, Microprojectile bombardment, Chloroplast engineering 1.2 Bombardment with DNA coated beads can produce transgenic organelles, Plant genes can be cloned by using transposable elements, T-DNA is used as an insertion mutagen. Use of reporter genes in transformed plant cells, viruses can be used as vectors for whole plants, Manipulation of gene expression in plants: Gene targeting, Facilitating protein purification: Oleosins, Rhizosecretion, Glysosylation 1.3 Uses genetically engineered plants: To overcome Biotic and abiotic stress: Insect resistance: Increasing expression of the B. thuringiensisprotoxin, other strategies for protecting plants against insects, Virus resistance, Herbicide resistance, fungus and bacterium resistance, Oxidative stress, Salt and drought stress, Fruit ripening and Flower wilting. To improve plant quality and proteins. 1.4 Modification of plant nutritional content, Modification of plant taste and appearance, Plants as bioreactors, edible vaccines	15 (1)

II	Animal Biotechnology	2.1 Transgenic animals: Transgenic Mice: methodology: The retroviral Vector method, The DNA microinjection method, The engineering embryonic stem cell method, Genetic modification with the Cre-loxP recombination system, RNA interference, Transgenesis with high capacity vectors. 2.2 Uses of transgenic animals: Transgenic disease model, transgenic mice as test system, Conditional regulation of transgene expression, , Cloning live stock by Nuclear transfer, Transgenic livestock: production of pharmaceuticals, Production of Donor organs, Disease resistant livestock, Improving milk quality, Improving animal production traits, Transgenic poultry and transgenic fish	15 (1)
III	Bio-augmentation and Biostimulation in Agriculture	3.1 Introduction 3.2 Vermicomposting 3.3 Bio-intensive Nutrient Management, Use of Biofertilizers: Rhizobium, blue green algae, phosphate solubilizers, Mycorrhiza 3.4 Organic Farming and scope of organic farming in India	15 (1)
IV	Bio-control in Agriculture	4.1 Biological control of Pests: Biological Control agent, mechanism of biocontrol, biopesticide, bioinsecticide, bioherbicide 4.2 Induced systemic resistance in Biocontrol of Plant diseases: a) Induction of systemic resistance by Pseudomonas, Bacillus, Tricoderma, Fungi and others. b) Mechanism of Induced systemic resistance 4.3 Microbial control strategies: Postharvest diseases of Fruits, Vegetables, Roots and Tubers a) Mode of action of biocontrol agents b) Extensive of use of biocontrol agents c) Enhancing biocontrol efficacy of Microbial Antagonist d) Biotechnological Approach	15 (1)

Learning Resources recommended:

1. B.R. Glick, J.J. Pasternak and C.L. Patten. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edition. ASM Press, Washington D.C.
2. J.D. Watson, M. Gilman, J. Witkowski and M. Zoller. Recombinant DNA. 2nd Edition. Scientific American Books.
3. A.K. Sharma. A handbook of Organic Farming. 2004. Agrobios India.
4. A. Singh, A. Parmar and R.C.Kuhad. Bioaugmentation, Biostimulation and Biocontrol. Soil Biology Volume 28. Springer.
5. H. M. Gupta. Organic Farming and Sustainable Agriculture. 2005. ABD Publishers, Jaipur, India.

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class test	20
Assignment	15
Class performance	05
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q1	I	Short Note (12)
Q2	II	Short Note (12)
Q3	III	Short Note (12)
Q4	IV	Short Note (12)
Q5	I, II, III, IV	Objective (12)
Total		**60**

Name of the Course	Mycology Virology and Protozoology
Course Code	PSMB404
Class	M.Sc. II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding mycology enhances employability in biotechnology, pharmaceuticals, and ecology roles. Proficiency in fungal pigments, mycotoxins, and lipid production is valuable in food, cosmetics, and bioproduction industries.Understanding virology and viral detection enhances employability in healthcare, research, and diagnostics roles. Expertise in bacteriophages and phage therapy enhances employability in microbiology and medical research. Skill development includes understanding disease symptoms, virus detection techniques, and economic losses due to viral infections, microscopy, serological methods, nucleic acid detection, and virus neutralization. Other skills such as protozoan classification, culturing techniques, and understanding their ecological significance are also being imparted. Entrepreneurs can establish viral diagnostic labs; wastewater treatment consulting and can also offer plant virus detection services to farmers or develop disease-resistant crops.

Nomenclature: Mycology Virology and Protozoology

Course Outcomes:

At the end of this course the learner will

1. Be familiar to contributions that show new applications, developments of well established technology, novel research into new technology with reference to these three categories of microorganisms.
2. Have solid understanding of basic concepts in these fields and the knowledge gained will enable students to apply these concepts to problems in the different fields of Mycology, Virology and Protozoa.
3. Be able to predict the outcome of intervention measures both on the cellular as well as the population level.

Curriculum:

PSMB404 - Mycology Virology and Protozoology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	Fungal technology	1.1 Mycology a) A neglected Mega Science b) The diversity of fungi and fungus like organisms c) Fungal molecular taxonomy: An overview 1.2 Fungal Pigments and Mycotoxins a) Genetic basis of pigment production b) Factors affecting pigment production c) Fermentation for pigment synthesis d) Mycotoxins and their replacement e) Relevance of pigments in various fields 1.3 Fungal siderophores – structure, function and applications 1.4 Fungal Lipid production a) Oleaginous fungi b) Lipid production from lignocelluloses and crude glycerol 1.4Fungal Metabolites a) Enzymes - Xylanase, Laccase, Galactosidase, Inulinase, Catalase and b). Flavors and Aroma c) Engineering of fungal biomolecules	15 (1)
II	Animal and Plant Virology	2.1 (Study of virus with respect to Clinical Features and Epidemiology Pathogenesis, Diagnosis, Prevention, and Control) Veterinary and Zoonotic viruses a) Study of members of the genus Capripoxvirus –(Sheep pox Virus, Goat pox Virus, and Lumpy Skin disease virus)	

		b) Study of Members of the Genus AsfarviridaeAfrican swine fever virus c) Marburg and Ebola disease viruses d) Members of the genus Influenza Virus A – Swine Influenza viruses and Avian influenza viruses e) Detection of viruses - Measurement of virus particles – Electron microscopy, f) Measurement of viral enzyme activity serological method, virus neutralization, Hemagglutination,, Protein detection, Immuno precipitation and Immunoblotting, ELISA, Nucleic acid detection, DNA microarray. 2.2 Plant virology a) Origin and Evolution of plant virus – history and descriptors used in virus taxonomy b) Disease symptoms and Economic losses Economic losses due to plant virus, Macroscopic symptoms- Local and systemic c) Detection of plant viruses: d) Use of plant viruses in industry.	15 (1)
III	Study of Bacteriophages and Algal Phages	3.1 Intemperate and Temperate Bacteriophage a) Intemperate Bacteriophage –T2, T6, T1, T5, T3 and T7 Bacteriophages belonging to the Ff Group. Bacteriophages Infecting **Bacillus subtilis**- Bacteriophage SP01, Bacteriophage φ29 b) Temperate Bacteriophage – Other Lambdoid Phages- Bacteriophage P22, Bacteriophage P2and P4, Bacteriophage P1, Bacteriophage Mu,SSV1 and SSV2.c) Study of bacteriophages by one step growthcurve 3.2 Study of Mycobacteriophage -Phage therapy - therapeutic approach to Mycobacterial infections 3.3Cultivation of viruses from Environment	15 (1)

IV	Protozoology	4.1Introduction to Protozoa a) Classification of Protozoa b) Processes in Protozoa: Motility, Nutrition, Reproduction c) Cultivation of Protozoa 4.2Protozoa used in Wastewater Microbiology a) Sarcodina b) Flagellates c) Ciliates d) Sporozoa e) Rhizopoda 4.3Importance of Protozoans in water and wastewater treatment a) Protozoa as indicators of wastewatertreatment efficiency b) Activated sludge ecosystems c) Microfaunas as indicators 4.4Importance of Protozoans in Soil bioremediation 4.5Protozoan Parasites a) Giardia spps b) Microsporidia c) Toxoplasma	15 (1)

Learning Resources recommended:

Unit 1 – Applications of fungal technology

1. Applied Mycology by MahendraRai, Paul Dennis Bridge, 2009, CAB International.
2. Fungal Biology 4thed. By J. W. Deacon ,2006, Blackwell Publishing.
3. Fungal Biomolecules – sources, Applications and Recent developments by Vijay kumar Gupta, Robert L. Mach, S. Sreenivasaprasad2015, Published by John Wiley & Sons .ltd.
4. Developments in Fungal Biology and Applied Mycology by TulsiSatyanarayana, Sunil K. Deshmukh, B. N. Johri2017, Springer.
5. Gunther Winkelmann (2007) "Ecology of siderophores with special reference to the fungi" *Biometals*, 20:379–392.
6. E. Ahmed* and S. J. M. Holmström (2014); "Siderophores in environmental research: roles and applications" *Microbial Biotechnology*, 7, 196–208. Published by John Wiley & Sons Ltd and Society for Applied Microbiology.
7. Biotechnology of Yeasts and Filamentous Fungi by Andriy A. Sibirny 2017, Springer International Publishing AG .

Unit 2 – Animal and Plant Virology

1. Fenners Veterinary Biology - 4th edition, 2011, N.JamesMaclachlan& Edward J. Dubovi
2. Principles of Molecular virology- Allan J. Cahn. 6th edition, 2016.
3. Plant Virology ,Roger Hull

Unit 3 - Study of Bacteriophages and Algal Phages

1. Bacterial and Bacteriophage genetics - 5th edition, 2006, Edward A. Birge.
2. Advances in viral research. – Past, present and future. Said A. Ghabrial
3. Corina P. D. Brussaard and JoaquínMartínezMartínez, Algal bloom viruses Plant Viruses 2 (1), 1-13 ©2008 Global Science Books
4. Protozoal Viruses, Louis S.Diamond and Carl F.T.Mattern
5. Principles of Virology – Flint 2nd edition
6. Understanding Viruses – Teri Shors. Jones and Bartlett pub
7. https://doi.org/10.2147/IDR.S218638
8. https://doi.org/10.1086/343812
9. https://www.researchgate.net/publication/23642149
10. doi:10.1128/AEM.07175-11

Unit 4 – Protozoology

1. The handbook of water and waste water Microbiology by Duncan Mara and Nigel Horan,2003
2. Wastewater Microbiology, 2nd edition by Bergey, D.H
3. Wastewater Microbiology, 4th edition by Gabriel Bitton,2011
4. Pauli W, Berger S, Protozoa in wastewater treatment: Function and Importance. Biodegradation and Persistence,2001,Pg 203-252.doi:10,1007/10508767_3
5. Atlas of Medical Helminthology and Protozoology, 2001 Peter L. Chiodini, A.H.Moody, D.W.Manser
6. Textbook of Medical Parasitology: Protozoology and Helminthology, 4 thedition by S. C. Parija
7. https://www.sciencedirect.com/science/article/abs/pii/S1872203207600687
8. https://www.nature.com/articles/ismej201320

Evaluation Pattern

A. Internal Evaluation

Method	Marks
Class test	20
Assignment	15
Class performance	05
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
Q1	I	Short Note (12)
Q2	II	Short Note (12)
Q3	III	Short Note (12)
Q4	IV	Short Note (12)
Q5	I, II, III, IV	Objective (12)
Total		**60**

Name of the Course	Industrial and Food Microbiology Practical
Course Code	PSMBP401
Class	M.Sc. II
Semester	IV
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding starter cultures enhances employability in food industry roles, such as food technologist or quality control specialist. Proficiency in fermented food production is valuable in food technology and culinary industries. Proficiency in advanced detection methods enhances employability in food safety and quality assurance.Expertise in microbial metabolite production is valuable in biotechnology and pharmaceutical industries.Skill development involves implementing quality control measures, adhering to standards, and risk assessment. Apart from this mastering sampling technique, understanding detection principles, and data interpretation is also covered. Course also encompasses knowledge of fermentation techniques, controlling microbial growth, and optimizing flavor profiles. Entrepreneurs can establish testing labs specializing in rapid and sensitive microorganism detection & can offer quality assurance consulting services to food companies.

Nomenclature: Industrial and Food Microbiology Practical

Course Outcomes:

At the end of the course the learner will be able to

1. Perform bioassay of antibiotics
2. Preparation and analysis of sauerkraut
3. Isolate and characterize the probiotic producing microorganisms

Curriculum:

PSMBP401 - Industrial and Food Microbiology Practical		
Title	**Learning Points**	**No of Lectures**
Industrial and Food Microbiology Practical	**Practical** 1. Isolation & Characterization of organisms with probiotic potential from food samples 2. Effect of prebiotic on probiotic culture 3. Sauerkraut preparation and Microbiological analysis 4. Production of antibiotic and assay **Assignment** 1. Detection of microorganism in food by any one Novel method. 2. BIS methods to study different adulterants in foods	60 (2)

Learning Resources recommended:

1. Petra Foerst, ChalatSantivarangkna 2016 Advances in Probiotic Technology ,CRC Press A Science Publishers Book
2. Robert E.C. , Wildman 2nd Ed. " Handbook of Neutraceuticals& Functional Foods " CRC Press A SCIENCE PUBLISHERS BOOK
3. https://www.researchgate.net/publication/351692943_Isolation_and_Characterization_of_Probiotics_from_Different_Curd_Samples
4. https://www.academia.edu/7844126/Isolation_and_characterization_of_probiotic_lactic_Acid_bacteria_from_milk_and_curd_samples
5. Bibek Ray and ArunBhunia (2008) Fundamental Food Microbiology. 4th Ed. CRC Press.

Evaluation Pattern –

Practical Course	Major technique	Minor Technique	Journal	Viva	Spots / Quiz/ Lab	Total
PSMBP401	20 Marks	10 Marks	05 Marks	05 Marks	10 Marks	50 Marks

Name of the Course	Applied Microbiology Practical
Course Code	PSMBP402
Class	M.Sc. II
Semester	IV
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding bioremediation strategies enhances employability in environmental science, waste management, and consulting roles.Proficiency in ecosystem-specific bioremediation techniques is valuable in addressing pollution across diverse environments. Understanding enzyme applications enhances employability in food technology, pharmaceuticals, and industrial sectors. Expertise in biotech applications in medicine is sought after in pharmaceutical research and healthcare. Skill development involves designing in situ bioremediation strategies, monitoring microbial activity, and assessing ecological impact. Besides this it includes optimizing biosensor technologies, understanding microbial contributions to climate change, and developing sustainable bioproducts.Entrepreneurs can offer services in molecular diagnostics, vaccine development, or biopharmaceutical production. They can develop enzyme-based products for food processing, cosmetics, and industrial processes.

Nomenclature: Applied Microbiology Practical

Course Outcomes:

At the end of the course the learner will be able to

1. Isolate pigments and biopolymer producing bacteria from environmental samples
2. Isolate & characterize agarase producing bacteria
3. Perform residual starch degradation

Curriculum:

PSMBP402 - Applied Microbiology Practical		
Title	**Learning Points**	**No of Lectures**
Applied Microbiology Practical	PRACTICALS 1) Enrichment and isolation of Agarase producing bacteria 2) Isolation of pigment producing bacteria from marine environment and extraction of pigments through solvent extraction procedures 3) Removal of blood stains by using proteases/detergents. 4) Residual starch degradation by amylase SELF STUDY 1. Report on an visit to an relevant industry/institute	60 (2)

Learning Resources recommended:

1. Comprehensive Biotechnology-Ramawat 4th Edition.
2. https://link.springer.com/chapter/10.1007/978-3-642-24520-6_2
3. WolfangAehle ,Enzyme in industry
4. https://www.sciencedirect.com/science/article/abs/pii/S2352554121002096

Evaluation Pattern –

Practical Course	Major technique	Minor Technique	Journal	Viva	Spots / Quiz/ Lab	Total
PSMBP402	20 Marks	10 Marks	05 Marks	05 Marks	10 Marks	50 Marks

Name of the Course	Plant Agriculture and Animal Biotechnology Practical
Course Code	PSMBP403
Class	M.Sc. II
Semester	IV
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding genetic engineering of plants enhances employability in biotechnology, agriculture, and horticulture sectors. Proficiency in transgenic plant traits and applications is valuable in agricultural innovation and biotech research. Expertise in sustainable agriculture practices enhances employability in farming, agribusiness, and environmental roles. Proficiency in biological pest control methods is crucial in integrated pest management and agricultural sustainability. Skill development includes knowledge of plant transformation methods, gene delivery techniques, and manipulation of plant genomes. It also includes understanding nutrient management, biofertilizers, organic farming principles, and vermicomposting. Entrepreneurs can establish organic farming ventures or offer consulting on sustainable practices. Apart from this they can develop plants as bioreactors for pharmaceutical production or nutrient enhancement. They can also develop biopesticides or offer pest management consulting to farmers.

Nomenclature: Plant Agriculture and Animal Biotechnology Practical

Course Outcomes:

At the end of the course the learner will be able to

1. Prepare and analyze vermicompost
2. Isolate plant growth promoting bacteria & estimate PGP substances
3. Perform qualitative and quantitative analysis of phosphate solubilizers

Curriculum:

PSMBP403 - Plant Agriculture and Animal Biotechnology Practical		
Title	**Learning Points**	**No of Lectures**
Plant Agriculture and Animal Biotechnology Practical	**PRACTICALS** 1. Preparation of Vermicompost and microbiological analysis of vermicompost 2. Isolation of organisms producing plant growth promoting substances 3. Production and estimation of plant growth promoting substances (any one) 4. Qualitative and quantitative study of Phosphate solubilizers **SELF STUDY** 1. Report on a visit to Biofertilizer and biopesticide production plants 2. Assignment on Transgenic organelles in plants/ Uses of transgenic lifestock	60 (2)

Learning Resources recommended:

1. H. M. Gupta. Organic Farming and Sustainable Agriculture. 2005. ABD Publishers, Jaipur, India.
2. A.K. Sharma. A handbook of Organic Farming. 2004. Agrobios India.
3. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-95162013000300011

Evaluation Pattern –

Practical Course	Major technique	Minor Technique	Journal	Viva	Spots / Quiz/ Lab	Total
PSMBP403	20 Marks	10 Marks	05 Marks	05 Marks	10 Marks	50 Marks

Name of the Course	Mycology Virology and Protozoology Practical
Course Code	PSMBP404
Class	M.Sc. II
Semester	IV
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Understanding mycology enhances employability in biotechnology, pharmaceuticals, and ecology roles. Proficiency in fungal pigments, mycotoxins, and lipid production is valuable in food, cosmetics, and bioproduction industries. Understanding virology and viral detection enhances employability in healthcare, research, and diagnostics roles. Expertise in bacteriophages and phage therapy enhances employability in microbiology and medical research. Skill development includes understanding disease symptoms, virus detection techniques, and economic losses due to viral infections, microscopy, serological methods, nucleic acid detection, and virus neutralization. Other skills such as protozoan classification, culturing techniques, and understanding their ecological significance are also being imparted. Entrepreneurs can establish viral diagnostic labs; wastewater treatment consulting and can also offer plant virus detection services to farmers or develop disease-resistant crops.

Nomenclature: Mycology Virology and Protozoology Practical

Course Outcomes:

At the end of the course the learner will be able to

1. Isolate bacteriophages from environmental samples
2. Perform HA and HAI tests for virus titre determination
3. Estimate fungal enzymes using chemical assay

Curriculum:

PSMBP404 - Mycology Virology and Protozoology Practical		
Title	**Learning Points**	**No of Lectures**
Mycology Virology and Protozoology Practical	**PRACTICALS** 1. Qualitative and quantitative estimation of fungal Laccase enzyme 2. Enrichment and Enumeration of bacteriophage. 3. Haemagglutination/ Haemagglutination Inhibition test for determination of titre of viruses 4. Demonstration of virus cultivation within chick embryo 5. Detection of viral enzyme activity /viruses by ELISA test 6. Isolation and characterization of fungal pigments. **SELF STUDY** 1. Report on Visit to virology institutes like NIV Pune, Veterinary college or any other relevant institute 2. Assignment on Emerging protozoa/fungal/viral diseases .	60 (2)

Learning Resources recommended:

1. Bacterial and Bacteriophage genetics - 5th edition, 2006, Edward A. Birge.
2. Advances in viral research. – Past, present and future. Said A. Ghabrial
3. Principles of Virology – Flint 2nd edition
4. The handbook of water and waste water Microbiology by Duncan Mara and Nigel Horan,2003
5. Textbook of Medical Parasitology: Protozoology and Helminthology, 4 thedition by S. C. Parija

Evaluation Pattern –

Practical Course	Major technique	Minor Technique	Journal	Viva	Spots / Quiz/ Lab	Total
PSMBP403	20 Marks	10 Marks	05 Marks	05 Marks	10 Marks	50 Marks