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.

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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

Chairperson,
(Dr. Nitin Potdar)
BoS, Microbiology