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		
23_PSMB101	Molecular Genetics - I		4	23_PSMB201	Applied Biochemistry		4
23_PSMB102	Medical Microbiology and Microbial Pathogenesis		4	23_PSMB202	Applied Immunology		4
23_PSMB103	Practical I		4	23_PSMB203	Practical II		4
23_PSMB104	Environmental Microbiology and sustainability		2	23_PSMB204	Molecular Genetics - II		2
	Major Electives				Major Electives		
23_PSMB105	Biochemistry I	2	4	23_PSMB205	Biostatistics and Bioinformatics	2	4
23_PSMB106	Practical of Biochemistry I	2		23_PSMB206	Practical of Biostatistics and Bioinformatics	2	
	OR				**OR**		
23_PSMB107	Metabolism of extremophiles and anaerobes.	2		23_PSMB207	Biochemistry-II	2	
23_PSMB108	Practical of Metabolism of extremophiles and anaerobes	2		23_PSMB208	Practical of Biochemistry-II	2	
23_PSMB109	Research Methodology		4	23_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		
23_PSMB101	Molecular Genetics - I		4
23_PSMB102	Medical Microbiology and Microbial Pathogenesis		4
23_PSMB103	Practical I		4
23_PSMB104	Environmental Microbiology and sustainability		2
	Major : Elective (Any One from below)		
23_PSMB105	Biochemistry I	2	4
23_PSMB106	Practical's of Biochemistry I	2	
OR			
23_PSMB107	Metabolism of extremophiles and anaerobes.	2	
23_PSMB108	Practical of Metabolism of extremophiles and anaerobes	2	
23_PSMB109	Research Methodology		4
Total Credits			**22**

Name of the Course	Molecular Genetics-I
Course Code	23_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.

23_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:

23_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.	**15L (1 Credit)**

		1.3 Homologous recombination at molecular level 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,	**15L (1 Credit)**

		3.1.5Trp operon of *Bacillus subtilis*, 3.1.6 Riboswitch regulation	
IV	**Global regulation in Bacteria**	**4.1 Global regulation systems** 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*	**15L (1 Credit)**

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	23_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.

23_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:

23_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
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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	Practical I
Course Code	23_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.

23_PSMB103 – Practical I

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:

23_PSMB103 – Practical I		
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	23_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.

23_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:

23_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	**15 (1 Credit)**

		- Effects of solid waste pollution, - Key components of solid waste management. - 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	23_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.

23_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

23_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 Biochemistry I
Course Code	23_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.

23_PSMB106 – Practical of Biochemistry I

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

23_PSMB106 - Practical of Biochemistry I		
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	23_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.

23_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

23_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	Practical of Metabolism of Extremophiles and anaerobes
Course Code	23_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.

23_PSMB108 - Practical of Metabolism of Extremophiles and anaerobes

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

23_PSMB108 - Practical of Metabolism of Extremophiles and anaerobes		
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	23_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.

23_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:

23_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		
23_PSMB201	Applied Biochemistry		4
23_PSMB202	Applied Immunology		4
23_PSMB203	Practical II		4
23_PSMB204	Molecular Genetics - II		2
	Major : Elective (Any One from below)		
23_PSMB205	Biostatistics and Bioinformatics	2	4
23_PSMB206	Practical of Biostatistics and Bioinformatics	2	
OR			
23_PSMB207	Biochemistry-II	2	
23_PSMB208	Practical of Biochemistry-II	2	
23_PSMB209	On Job Training/ Field Project		4
Total Credits			22

Name of the Course	Applied Biochemistry
Course Code	23_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**.

23_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:

23_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	**15L** **(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	**15L** **(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	**15L** **(1 Credit)**

		4.1.6 DNA sequencing & analysis of DNA sequences 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	**15L** **(1 Credit)**

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	23_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.

23_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:

23_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 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		

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	Practical II
Course Code	23_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.

23_PSMB203 – Practical II

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:

23_PSMB203 – Practical II		
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	23_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.

23_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:

23_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.	**15L** **(1 Credit)**

II	**Genetic Regulation of The Development of Drosophila, Organelle DNA &Population Genetics**	**2.1 Drosophila developmentalStages** -Embryonic development, - Maternal effect genes, - 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	**15L** **(1 Credit)**

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, 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)
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	23_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.

23_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:

23_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	**15L** **(1 Credit)**

		i. ANOVA- one-way classification, ii. two-way classification	
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	**15L** **(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 Biostatistics and Bioinformatics
Course Code	23_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

23_PSMB206 - Practical's of 23_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:

23_PSMB206 – Practical of Biostatistics and Bioinformatics		
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	23_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.

23_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:

23_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**	**15L** **(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	**15L** **(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 of Biochemistry – II
Course Code	23_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.

23_PSMB208 - Practical of Biochemistry – II

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:

23_PSMB208 - Practical of Biochemistry – II		
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
Course Code	23_PSMB209
Class	PG
Semester	II
No of Credits	4
Nature	Practical
Type	On Job Training
Relevance with Employability/ Entrepreneurship/ Skill development	On the job training provides learner with the opportunity to acquire hands on experience and practical skills required for specific job roles. It bridges the gap between theoretical knowledge and the practical requirements of the job. Learner can gain valuable insights into the industry practice, company culture, this experience makes them confident and competent candidate when applying for the position increasing the employability prospects. OJT is instrumental in skill development as it focuses on practical job specific competencies like technical skills, soft skills. Overall OJT enhances employability, foster entrepreneurship by providing valuable exposure in various field.

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

Introduction:

Inclusion of On Job Training in the course curriculum of the PG and UG programme is one of the ambitious aspects in the programme structure. The main objective of inclusion of On Job Training is to inculcate ability to interpret particular aspect of the study in his/ her own words.

Guidelines for On Job Training:

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 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 **120 hours** of On Job Training with an Organization/Industry/Government or Private Laboratory.

- The theme of the OJT should be based on any study area of the Major course.
- Project Report should be of minimum 30 pages.
- 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. 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.

b) **Certificate of Completion:**
A certificate issued by the organization or supervisor confirming the successful completion of the training.

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.

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 and overcoming of 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.

k) Appendix:

1.1 Appendix I: OJT Undertaking
1.2 Appendix II: Draft Resume Template
1.3 Appendix III: Organization Outreach Letter
1.4 Appendix IV(A/B): A) Relieving Letter of Student (for fulltime OJT) B)Relieving Letter of Student (for part time OJT)
1.5 Appendix V**:** Relieving Letter of Student from organization
1.6 Appendix VI: Student Diary (Log) Recording Format
1.7 Appendix VII: Attendance Sheet
1.8 Appendix VIII: Supervisor Evaluation of Intern
1.9 Appendix IX: Student Feedback of OJT
1.10 Appendix X: Performance for Evaluation of OJT by Institute

Broad guidelines for project report:

The project report based on On Job Training shall be prepared as per the broad guidelines given below**:**

- Font type: Times New Roman (Font size :16)
- 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.

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.

Rubric for Evaluation of 'On the Job Training' Project

Criteria	Marks	Description
Project Report (60 Marks)		
a) Title Page	02	Properly formatted with title, student name, program, institution, and training period.
b) Certificate of Completion	05	Inclusion of a valid certificate from the organization/supervisor.
c) Declaration	01	A clear statement of originality and acknowledgment of assistance.
d) Acknowledgments	02	Proper recognition of support and guidance received.
e) Table of Contents	05	Clear and accurate outline of the report's sections with page numbers.
f) Executive Summary	05	Concise overview of the entire presentation.
g) Introduction on the Company	05	Detailed representation of the company/organization including its scope, products, and services.
h) Role in the Organization	10	Comprehensive description of key aspects handled, department deployment, and summary report acknowledged by the reporting head.
i) Challenges and Overcoming Challenges	05	Insightful analysis of challenges faced and methods used to overcome them.
j) conclusion	05	Brief overview of the experience with suggestions to bridge the gap between theory and practice.
Appendix:		
Appendix I: OJT Undertaking	15	Mandatory inclusion
Appendix II: Draft Resume Template		Mandatory inclusion
Appendix III: Organization Outreach Letter		Mandatory inclusion
Appendix IV: Relieving Letter of Student		Mandatory inclusion
Appendix V: Student Diary (Log) Recording Format		Mandatory inclusion
Appendix VI: Attendance Sheet		Mandatory inclusion
Appendix VII: Supervisor Evaluation of Intern		Mandatory inclusion

Appendix VIII: Student Feedback of OJT		Mandatory inclusion
Appendix IX: Performance for Evaluation of OJT by Institute		Mandatory inclusion
Documentation and Presentation (40 Marks)		
Quality and effectiveness of presentation	10	Assesses the clarity, engagement, and overall impact of the presentation in conveying the report objectives and outcomes.
Depth of knowledge and demonstrated skills	10	Evaluates the understanding and practical application of key concepts, techniques, and skills relevant to the report.
Relevance of learning experience	05	Measures how well the training experience aligns with the trainee's career goals and the industry's practical requirements.
Practical applications	10	Assesses the trainee's ability to effectively apply learned skills and knowledge to real tasks and challenges during the training project.
Understanding of Organizational Dynamics	05	Insight into organizational structure, culture, and dynamics.
Total Marks	**100**	

Appendices

Appendix I: OJT Undertaking

1. Student Name:	
2. Class	
3. Roll No	
4. UID	
5. ABC ID	
6. Current Address	
7. Residence Address	
8. Email id	
9. Mobile Nos.	
10. Aadhar Number	
11. Mode of OJT	Online /Offline
I confirm that I agree with the terms, conditions, and requirements of the OJT Policy Student Signature: Date:	
I confirm that the student has attended the OJT orientation and has met all paperwork and process requirements to participate in the OJT program, and has received approval from his/her mentor. Sign of Department Faculty Coordinator Date:	

Appendix II: Draft Resume Template

Name:
Contact Number and Email ID:
Education:

(HEI / COLLEGE) Name: Year:
Degree:
Specialization:
SGPA:(PG SEMESTER I)
College Name: <bachelor's degree> Year:
Degree:
Specialization:
CGPA:
OJT / Work Experience – Yes / No

If YES
Organization: Year:
Project:
Brief:
Academic Experience:

Other Achievements and Personal Interests

- List other achievements also in reverse chronological order
- Leadership positions held outside of your formal work environment
- Personal interests and accomplishments that will distinguish you from other applicants
- Volunteer service/Social Work

Appendix III: Organization Outreach Letter

< (HEI) /College Name Letter Head>

To,

The (Manager, HR) .....

.....

Subject: Request for 120 hours OJT of Students pursuing < >

Dear Sir,

The college (HEI) name established in <year>, < (HEI /college name) >, Maharashtra reflects the vision of leading industrialists and educationalists. Institute is accredited with '< >' grade by NAAC in [Month year]. The HEI /college name has been recognized about it's over all academic excellence and infrastructure.

In view of the above, I request your good self to allow our following (no. of students) students for practical raining in your esteemed organization. Kindly accord your permission and give at least one-week time for students to join training after confirmation.

Sr. No.	Name	Roll no.	Year	Department

The resumes of these students are attached with this letter. If vacancies exist, kindly do plan for Interviews for the students in above branches.

A line of confirmation will be highly appreciated.

Yours sincerely,

Nodal Officer/TPO

< HEI /college name and Date>

Appendix IV: A) Relieving Letter of Student (for fulltime OJT)

< HEI /college name Letter Head>

To,

The General Manager (HR) .....

.....

Subject: Relieving letter of student

Dear Sir,

Kindly refer your letter/e-mail dated ----------on the above cited subject. As permitted by your good self the following students will undergo Industrial OJT in your esteemed organization under your sole guidance and direction.

Sr. No.	Name	Roll no.	Year	Department

This training being an essential part of the curriculum, the following guidelines have been prescribed in the curriculum for the training. You are therefore, requested to please issue following guidelines to the concerned student mentor.

- OJT schedule may be prepared and a copy of the same may be sent to us.
- Each student is required to prepare OJT diary and report.
- Kindly check the OJT diary of the student daily.
- Issue instruction regarding working hours during training and maintenance of the attendance record

You are requested to evaluate the student's performance on the basis of grading i.e. Excellent, Very Good, Satisfactory and Non-Satisfactory on the below mentioned factors:

- Attendance and general behavior
- Relation with workers and supervisors
- Initiative and efforts in learning
- Knowledge and skills improvement
- Contribution to the organization

The performance report may please be forwarded to the undersigned on completion of training in sealed envelope.

Your efforts in this regard will positively enhance knowledge and practical skills of the students, your cooperation will be highly appreciated, and we shall feel obliged.

The students will abide by the rules and regulation of the organization and will maintain a proper discipline with keen interest during their OJT. The students will report to you on dated _____along with a copy of this letter.

Yours sincerely,

Nodal Officer/TPO

< HEI /college name and Date>

Appendix IV: B) Relieving Letter of Student (for parttime OJT)

< HEI /college name Letter Head>

To,

The General Manager (HR) .....

.....

Subject: Relieving letter of student

Dear Sir,

Kindly refer your letter/e-mail dated ----------on the above cited subject. As permitted by your good self the following students will undergo Industrial OJT in your esteemed organization under your sole guidance and direction. The students will attend their OJT after completing their daily college work as part of their academic curriculum.

Sr. No.	Name	Roll no.	Year	Department

This training being an essential part of the curriculum, the following guidelines have been prescribed in the curriculum for the training. You are therefore, requested to please issue following guidelines to the concerned student mentor.

- OJT schedule may be prepared and a copy of the same may be sent to us.
- Each student is required to prepare OJT diary and report.
- Kindly check the OJT diary of the student daily.
- Issue instruction regarding working hours during training and maintenance of the attendance record

You are requested to evaluate the student's performance on the basis of grading i.e. Excellent, Very Good, Satisfactory and Non-Satisfactory on the below mentioned factors:

- Attendance and general behavior
- Relation with workers and supervisors
- Initiative and efforts in learning
- Knowledge and skills improvement
- Contribution to the organization

The performance report may please be forwarded to the undersigned on completion of training in sealed envelope.

Your efforts in this regard will positively enhance knowledge and practical skills of the students, your cooperation will be highly appreciated, and we shall feel obliged.

The students will abide by the rules and regulation of the organization and will maintain a proper discipline with keen interest during their OJT. The students will report to you on dated _____along with a copy of this letter.

Yours sincerely,

Nodal Officer/TPO

< HEI /college name and Date>

Appendix V: Relieving Letter of Student from organization

<Organization Letter Head>

To,
The Principal
[College Name]
[College Address]

Subject: Relieving Letter for Student

Dear Sir,

This is to certify that the following students from your esteemed institution have successfully completed their Industrial OJT in our organization as per the guidelines provided:

Sr. No.	Name	Roll no.	Year	Department

The students were under the supervision and guidance of our mentors and were engaged in various projects/tasks as part of their training. They have followed the rules and regulations of our organization and maintained a proper discipline throughout the OJT period.

Performance Evaluation:
The performance of the students has been evaluated based on the following criteria:

- Attendance and General Behavior
- Relation with Workers and Supervisors
- Initiative and Efforts in Learning
- Knowledge and Skills Improvement
- Contribution to the Organization

We have provided each student with feedback on their performance, which we hope will assist in their continued academic and professional growth. The detailed performance reports are enclosed in sealed envelopes for your reference.
We appreciate the opportunity to collaborate with your institution in providing practical exposure to the students and look forward to future engagements.

Yours sincerely,
[Signature]
[Name]
General Manager (HR)
[Company Name]
[Date]

Appendix VI: Student Diary (Log) Recording Format

Week (Dates during the week)	Task Assigned	Activities Performed	Key Learnings	Additional Remarks

Signature of Industry Supervisor

Appendix VII: Attendance Sheet

<Organization Letter Head>

Name & Address of Organization

_____
_____
_____

Name of the Student	
Roll Number	
Name of Course	
Date of Commencement of Training	
Date of Completion of Training	

Month and Year:

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

- Attendance Sheet should remain affixed in Daily Training Diary. Do not remove or tear it off.
- Holidays should be marked in Red Ink in attendance column. Absent should be marked as ‘A’ in Red Ink.

Name and Signature with date of OJT Supervisor _____

Appendix VIII: Supervisor Evaluation of Intern

<Organization Letter Head>

Student Name: _____ Date: _____

Work Supervisor: _____ Title: _____

Organization: _____

OJT Address: _____ Dates

of OJT: From _____To _____

Please evaluate intern by indicating the frequency with which you observed the following behaviours:

Parameters	Needs Improvement	Satisfactory	Good	Excellent
1. Behaviours				
2. Performs in a dependable manner				
3. Cooperates with co-workers and supervisors				
4. Shows interest in work				
5. Learns quickly				
6. Shows initiative				
7. Produces high quality work				
8. Accepts responsibility				
9. Accepts criticism				
10. Demonstrates organizational skills				
11. Uses technical knowledge and expertise				
12. Shows good judgment				
13. Demonstrates creativity/originality				
14. Analyzes problems effectively				
15. Is self-reliant				
16. Communicates well				
17. Writes effectively				
18. Has a professional attitude				
19. Gives a professional appearance				
20. Is punctual				
21. Uses time effectively				

Overall performance of student intern (circle one):
(Needs improvement / Satisfactory / Good / Excellent)
Additional comments, if any: _____
Signature of Industry supervisor: _____
Manager: _____

Appendix IX: Student Feedback of OJT

(To be filled by Students after OJT completion)

Student Name: _____ Date: _____
Industrial Supervisor: _____Title: _____
Supervisor Email: _____OJT is: ____Paid ____Unpaid_____
Organization: _____
OJT Address:_____
Faculty Coordinator: _____Department: _____
Dates of OJT: From _____ To _____

Give a brief description of your OJT work (title and tasks for which you were responsible):
Was your OJT experience related to your major area of study?

- Yes, to a large degree
- Yes, to a slight degree
- No, not related at all

Indicate the degree to which you agree or disagree with the following statements.

This experience has:	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
1. Given me the opportunity to explore a career field					
2. Allowed me to apply classroom theory to practice					
3. Helped me develop my decision-making and problem-solving skills					
4. Expanded my knowledge about the work world prior to permanent employment					
5. Helped me develop my written and oral communication skills					
6. Provided a chance to use leadership skills (influence others, develop ideas with others, stimulate decision-making and action)					
7. Expanded my sensitivity to the ethical implications of the work involved					
8. Made it possible for me to be more confident in new situations					
9. Given me a chance to improve my interpersonal skills					
10. Helped me learn to handle responsibility and use my time wisely					

11. Helped me discover new aspects of myself that I didn't know existed before					
12. Helped me develop new interests and abilities					
13. Helped me clarify my career goals					
14. Provided me with contacts which may lead to future employment					
15. Allowed me to acquire information and/ or use equipment not available at my Institute					

- In the Institute OJT program, faculty members are expected to be mentors for students. Do you feel that your faculty coordinator served such a function? Why or why not?

- How well were you able to accomplish the initial goals, tasks and new skills that were set down in your learning contract? In what ways were you able to take a new direction or expand beyond your contract? Why were some goals not accomplished adequately?
- In what areas did you most develop and improve?

- What has been the most significant accomplishment or satisfying moment of your OJT?

- What did you dislike about the OJT?

- Considering your overall experience, how would you rate this OJT? (Circle one).
- -Satisfactory/ Good/ Excellent

- Give suggestions as to how your OJT experience could have been improved. (Could you have handled added responsibility? Would you have liked more discussions with your professor concerning your OJT? Was closer supervision needed? Was more of an orientation required?)

<Signature of Student>
<Name, Roll number, Date>

Appendix X: Performa for Evaluation of OJT by Institute

< HEI /college name Letter Head>

1. Name of Student: _____
2. Mob. No.: _____
3. Roll No.: _____
4. Branch/Semester: _____
5. Period of Training: _____
6. Home Address with contact No. _____
7. Address of Training Site: _____
8. Address of Training Providing Agency: _____
9. Name/Designation of Training In- charge: _____
10. Type of Work: _____
11. Date of Evaluation: _____
12. Please rate the following: _____

Sr.no.	**Particular**	**Marks**
1	Project Report	60 Marks
2	Documentation and Presentation	40 Marks

Overall Marks: _____.

Additional Remarks:_____.

Signature of Faculty Mentor: _____.

Format

1 st page (Main Page)

Title of the Report

a Project Submitted

To

R. P. Gogate college of Arts & Science and

R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Under

University of Mumbai

For partial completion of the degree

of

Master of Science

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, Ratnagiri (Autonomous)

Near District Court

Month and Year

On separate page

Index

[Company/Institution Logo]

CERTIFICATE OF COMPLETION

This is to certify that [Student's Full Name] [Student's Roll Number], has successfully completed the Academic On-the-Job Training Programme at [Company/Institution Name]

This training covered a period of 120 hours, during which [he/she] actively participated and demonstrated excellent dedication and commitment to learning.

The following work was performed by [him/her]:
[Brief description of the work performed during the training period]

This training has provided [him/her] with valuable insights and practical experience in [relevant field/industry]. [He/She] has exhibited commendable skills, enthusiasm, and a keen interest in learning.

Certifying Authority:

_____

[Name and

Designation]

[Company/Institutio

n Name] [Contact

Information] [Date]

[Seal/Signature]

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 project work carried out under the guidance of [Name of the guiding teacher]

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

On separate page

Acknowledgment

(Model structure of the acknowledgement)

To list who all have helped me is difficult because they are so numerous and the depth is so enormous.

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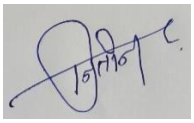

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