AC- 15/04/2023

Item No: 6.18

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE VASHI

(EMPOWERED AUTONOMOUS)

Sector-15- A, Vashi, Navi Mumbai - 400 703

Program: M.Sc. Microbiology

Syllabus for M.Sc. I Microbiology

(NEP 2020)

with effect from the academic year 2023-2024

Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil College Vashi

(EMPOWERED AUTONOMOUS)

Syllabus

Sr. No.	Heading	Particulars
1	**Title of Program**	M.Sc. I Microbiology (NEP)
2	**Eligibility for Admission**	T.Y.B.Sc. (Microbiology), From a recognized university
3	**Passing Marks**	40%
4	**Ordinances/Regulations (if any)**	
5	**No. of Years/Semesters**	One year/Two semester
6	**Level**	P.G.
7	**Pattern**	Semester
8	**Status**	New
9	**To be implemented from Academic year**	2023-2024

Preamble of the Syllabus:

Master of Science (M.Sc.) in Microbiology is a postgraduate programme of Department of Microbiology, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai [Empowered Autonomous]. With the introduction of the NEP system, this syllabus in Microbiology has been revised for M.Sc. semester I and semester II. This syllabus is implemented with the effect from 2023-2024. The revised syllabus has been approved by the concerned authorities of the Empowered Autonomous College Committees formed by the college, BOS members and Head/ senior teachers from the Department of Microbiology. The syllabus has been designed such that the theory goes hand in hand with the practicums thus enabling students to develop the professional skills set of Microbiologist. The topics included will give hand on practising each paper has been designed emphasizing the need to develop research skills and critical thinking/ reasoning in students. This aids the students in their specific area of their interest/ specialization in particular. The syllabus covers various topics enlisted for employability and entrance exams that are CSIR-NET, SET, GATE, PET, research institutes etc.

This revised syllabus is aimed at equipping students with theoretical foundations and practical techniques required in R&D, Quality control, regulatory function in pharmaceutical, environmental sciences, pharmaceutical microbiology, advances in molecular biology, applied and medical microbiology. Applied and environmental monitoring and management. The areas covered in Semester I and II will boost employability of the students

As mentioned in the syllabus all the courses of theory and practical are compulsory to M.Sc. Microbiology.

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI, NAVI MUMBAI

(Autonomous)

Department of Microbiology

M. Sc. Microbiology

Program Outcomes (POs)

Learners are able to:

PO-1	**Disciplinary Knowledge and Skills**	Acquire the comprehensive and in-depth knowledge of various subjects in sciences such as Physics, Chemistry, Mathematics, Microbiology, Bio-analytical Science, Computer Science, Data Science, Information Technology and disciplinary skills and ability to apply these skills in the field of science, technology and its allied branches.
PO-2	**Communication and Presentation Skills**	Develop various communication skills including presentation to express ideas evidently to achieve common goals of the organization.
PO-3	**Creativity and Critical Judgement**	Facilitate solutions to current issues based on investigations, evaluation and justification using evidence-based approach.
PO-4	**Analytical Reasoning and Problem Solving**	Build critical and analytical attitude in handling the problems and situations.
PO-5	**Sense of Inquiry**	Curiously raise relevant questions based on highly developed ideas, scientific theories and its applications including research.
PO-6	**Use of Modern Tools**	Use various digital technologies to explore information/data for business, scientific research and related purposes.
PO-7	**Research Skills**	Construct, collect, investigates, evaluate and interpret information/data relevant to science and technology to adapt, evolve and shape the future.
PO-8	**Application of Knowledge**	Develop scientific outlook to create consciousness against the social myths and blind faith.
PO-9	**Moral and Ethical Reasoning**	Imbibe ethical, moral and social values to develop virtues such as justice, generosity and charity as beneficial to individuals and society at large.
PO-10	**Leadership and Teamwork**	Work cooperatively and lead proactively to achieve the goals of the organization by implementing the plans and projects in various field-based situations related to science, technology and society at large.

PO-11	**Environment and Sustainability**	Create social awareness about environment and develop sustainability for betterment of future.
PO-12	**Lifelong Learning**	Realize that pursuit of knowledge is a lifelong activity and in combination with determined efforts, positive attitude and other qualities to lead a successful life.

Program Specific Outcomes (PSO)	
PSO1	Explain different branches of Microbiology such as Bacteriology, Virology, Immunology, Medical.
PSO2	The student will be able to explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology and Quality assurance and Quality control, Biostatistics, Bioinformatics, Public health etc
PSO3	Students will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics.
PSO4	Students will be able to execute Research Project incorporating techniques of Basic and Advanced Microbiology under supervision and Hands on training (Internship)
PSO5	The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired

Rayat Shikshan Sanstha's

KARMAVEER BHAURAO PATIL COLLEGE, VASHI

[EMPOWERED AUTONOMOUS]

Department of Microbiology

M.Sc. Microbiology

NEP 2020

Program	SEM	CORE Course (4 credits per course)	DSEC (4 credits per course)	SEC (4 credits per course)
M.Sc.-I Microbiology	I	Cell Biology (4 Credit)* Molecular Genetics (4 Credit)* Fermentation Technology (6 Credit)*	Food Licensing and Certification **Or** Food & Dairy Microbiology	Research Methodology
	II	Molecular Genetics II (4 Credit)* Basic Biochemistry (4 Credit)* Pharmaceutical Microbiology (6 Credit)*	Advances in Biotechnology Or Quality Assurance and Quality Control in Pharmaceutical Industries	On the Job Training (OJT)
M.Sc.-II Microbiology	III	Virology (6 Credit)* Immunology & Immunodiagnostics (6 Credit)* Bio-Nanotechnology (2 Credit)*	Introduction to Omics and Analytical Techniques **Or** Soil and Agricultural Microbiology	Research Project (4 Credit)*
	IV	Medical & Clinical Microbiology (6 Credit)* Environmental Microbiology (6 Credit)*	Waste Management **Or** Bioinformatics	Research Project (6 Credit)*

CC: Core Course (these courses are compulsory to the students),
DSE: Discipline Specific Elective (Students can choose anyone)
SEC: Skill Enhanced Course (Compulsory Skill Based Course)
Compulsory: On the Job Training (OJT) for 4 credits (100 Marks) and Research Project for 4 credits
Credits: Part-I (22+22=44), Part-II (22+22=44), Total Credits: 88

Teaching - Evaluation Scheme

Semester-I

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	CIE	Sem End-Exam	Term	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
PGMB101.1 CC	Cell Biology	03	02	-	30	45	-	25	-	100	03	01	-	04
PGMB102.1 CC	Molecular Genetics I	03	02	-	30	45	-	25	-	100	03	01	-	04
PGMB103.1 CC	Fermentation Technology	04	04	-	40	60	-	50	-	150	04	02	-	06
PGMB104.1A (DSEC1) Or PGMB104.1B (DSEC2)	Food & Dairy Microbiology Or Food Licensing and Certification	03	02	-	30	45	-	25	-	100	03	01	-	04
PGMBSEC101.1	Research Methodology	04	-	-	40	60	-	-	-	100	04	-	-	04
Total		**17**	**10**	**-**	**170**	**255**	**-**	**125**	**-**	**550**	**17**	**05**	**-**	**22**
Total Credit												**-**	**-**	**22**

Semester-II														
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**			**Examination Scheme and Marks**						**Credit Scheme**			
		Lecture	**Practical**	**Tutorial**	**CIE**	**Sem End-Exam**	**Term**	**Practical**	**Oral**	**Total**	**Lecture**	**Practical**	**Tutorial**	**Total**
PGMB201.1 CC	Molecular Genetics II	03	02	-	30	45	-	25	-	100	03	01	-	04
PGMB202.1 CC	Basic Biochemistry	03	02	-	30	45	-	25	-	100	03	01	-	04
PGMB203.1 CC	Pharmaceutical Microbiology	06	04	-	40	60	-	50	-	150	04	02	-	06
PGMB204.1A (DSEC1) Or PGMB204.1B (DSEC2)	Quality Assurance and Quality Control in Pharmaceutical Industries Or Advances in Biotechnology	03	02	-	30	45	-	25	-	100	03	01	-	04
PGMBOJT201.1	On the Job Training (OJT)	-	2M*	-	-	-		100	-	100	-	04	-	04
Total		**15**	**10 + 2M***	**-**	**130**	**195**	**-**	**225**	**-**	**550**	**13**	**09**	**-**	**22**
Total Credit														**22**

2M* - Two Months of On-the-Job Training (Internship)

COURSE STUCTURE FOR M.Sc. I MICROBIOLOGY

SEMESTER I

	Course	Unit	Topic	Credit	L/W
CORE COURSE	**Cell Biology**				
	PGMB101.1	I	General Principle of Cellular Organization	4	3+2
		II	Cellular communication and cell division		
		III	Techniques in cell biology		
			Laboratory Sessions (Practicum)- 1 Credit		
CORE COURSE	**Molecular Genetics I**				
	PGMB102.1	I	Control of Gene Expression in Eukaryotes & Chromosomal rearrangement.	4	3+2
		II	Molecular Tools for Genetics		
		III	Cytoplasmic Inheritance & Population Genetics		
			Laboratory Sessions (Practicum)- 1 Credit		
CORE COURSE	**Fermentation Technology**				
	PGMB103.1	I	Scope of Industrial Microbiology and Biotechnology	6	4+4
		II	Biosynthesis of industrially important microbial products		
		III	Microbial Products		
		IV	Biosafety and Industrial Waste		
			Laboratory Sessions (Practicum) –2 Credits		
DISCIPLINE SPECIFIC ELECTIVE (DSE-A)	**Food & Dairy Microbiology**				
	PGMB104.1 A (DSEC1)	I	Microbes in Foods	4	3+2
		II	Microbial Detection and Food Safety		
		III	Dairy Microbiology		
			Laboratory Sessions (Practicum) –1 Credit		
DISCIPLINE SPECIFIC ELECTIVE (DSE-B)	**Food Licensing and Certification**				
	PGMB104.1 B (DSEC2)	I	Food Fundamentals and Chemistry	4	3+2
		II	Food Laws and Standards		
		III	Food Safety and Quality Management System		
			Laboratory Sessions (Practicum) –1 Credit		
SKILL ENHANCEMENT COURSE (SEC)	**Research Methodology**				
	PGMBSEC 101.1	I	Fundamentals of Research	4	4
		II	Data Collection		
		III	Data Analysis and Reporting		
		IV	Intellectual Property Rights		

SEMESTER II

	Course	Unit	Topic	Credit	L/W
CORE COURSE	**Molecular Genetics II**				
	PGMB201.1	I	Genetic Basis of Cancer	4	3+2
		II	Developmental Genetics		
		III	Epigenetics and CRISPR Cas9 Technology		
			Laboratory Sessions (Practicum)- 1 Credit		
CORE COURSE	**Basic Biochemistry**				
	PGMB202.1	I	Amino acids & Proteins	4	3+2
		II	Carbohydrates & Lipids		
		III	Enzymology		
			Laboratory Sessions (Practicum)- 1 Credit		
CORE COURSE	**Pharmaceutical Microbiology**				
	PGMB203.1	I	Quality Assurance and Quality Management concepts	6	4+4
		II	Quality Management and GMP In Pharmaceutical		
		III	Analytical Aspects of Pharmaceutical and Cosmetic Products		
		IV	Organization and personnel safety		
			Laboratory Sessions (Practicum)- 2 Credits		
DISCIPLINE SPECIFIC ELECTIVE (DSE-A)	**Quality Assurance and Quality Control in Pharmaceutical Industries**				
	PGMB204.1 A (DSEC1)	I	Quality Management systems	4	3+2
		II	Quality Control and Quality Assurance		
		III	Biological Standardization & Quality Control		
			Laboratory Sessions (Practicum)- 1 Credit		
DISCIPLINE SPECIFIC ELECTIVE (DSE-B)	**Advances in Biotechnology**				
	PGMT204.1 B (DSEC 2)	I	Marine Biotechnology	4	3+2
		II	Nano Biotechnology		
		III	Bioenergy and Bioplastics		
			Laboratory Sessions (Practicum)- 1 Credit		
SKILL ENHANCEMENT COURSE (SEC)	**On the Job Training**				
	PGMBOJT201.1		On the Job Training	4	2months

Teaching Pattern for Semester I and II:

1. Four lectures per week per course. Each lecture is of 60 minutes duration.
2. For SEC four lectures per week per course and practical sessions for 16Hrs. Each lecture is of 60 minutes duration.
3. In addition, there will be compulsory On the Job Training for all students. Students have to submit all documents related to the training and prepare a report on which they will be marked. The duration of On the Job Training will be minimum of 2 months (2M*).

Objective:

1. To introduce the application-based research in Microbiology
2. To inculcate sense of scientific responsibilities and social and environment awareness
3. To enrich students' knowledge and train them in the applied microbial sciences
4. To help student's build-up a progressive and successful career

SEMESTER I

Core Course
PGMB101-CC: CELL BIOLOGY

By the end of this course, the students will be able to

CO-1: Explain the structure & function of various eukaryotic cell organelles. [2*]
CO-2: Apply knowledge of cell biology to selected examples of changes in cell functions [3]
CO-3: Distinguish the types and mechanisms of Apoptosis. [3*]
CO-4: Understand the structure of the cytoskeleton & mechanisms of cellular mobility. [2] *
CO-5: Illustrate cellular communication with respect to Extracellular matrix and cell interaction [3*]
CO-6: Differentiate between various stages of mitosis [4*]
CO-7: Appraise different techniques used in cell biology [5] *
CO-8: Dissect causes and new strategies for combatting cancer. [4] *

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	-	-	-	-	-	-	-	-	-	1
CO2	1	3	-	-	-	-	2	-	-	-	-	1
CO3	1	-	-	-	-	-	2	-	-	-	-	1
CO4	1	-	-	-	-	-	-	-	-	-	-	1
CO5	1	-	-	-	-	-	-	-	-	-	-	1
CO6	1	-	-	-	-	-	-	-	-	-	-	1
CO7	1	-	2	-	-	3	2	3	-	-	-	1
CO8	1	-	-	-	-	-	-	2	3	-	-	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Core Course Code	Title	Credits (60 lectures)
PGMB 101.1	**CELL BIOLOGY**	4
Unit I	**General Principle of Cellular Organization**	**15 NH**
	1. Historical Prologue 2. Introduction to Cell: Basic Cellular Architecture of Eukaryotic Cell (Animal and Plant Cell) 3. Universal Principles of Living Cell 4. Overview of Eukaryotic Cellular Organization and Function of: a. Plasma Membrane b. Nucleus c. Ribosomes d. Endoplasmic Reticulum e. Golgi Apparatus f. Lysosomes g. Peroxisomes h. Mitochondria i. Cell Wall (Plant Cell) j. Chloroplast (Plant Cell) 5. Cytoskeleton and cellular mobility a. Actin and actin-binding proteins b. Microtubules and microtubule-associated proteins c. Intermediate filaments Cellular Mobility: Intracellular and cellular	**1 credit**
Unit II	**Cellular communication and cell division**	15NH
	2.1 Principle of cell signalling a. Extracellular matrix and cell interaction: • The extracellular space • Interaction of cells with extracellular materials • Interaction of cell with another cell Intracellular junctions 2.2 Cell signalling Pathways: a. Basic elements of cell signalling system survey of extracellular messenger & receptor b. G-protein coupled receptor & messenger Protein- tyrosine Phosphorylation as a mechanism for signal transduction c. Role of calcium as an intracellular messenger Cell Cycle: • Introduction to cell cycle and its control • The G1 phase & regulation of cell proliferation	1 Credit

	• S Phase & DNA replication • The G2 phase & control of entry into mitosis • Mitosis • Meiosis	
Unit III	**Techniques in cell biology**	**15 NH**
	1. Use of light microscope 2. Electron microscope 3. Study of living cells 4. Fixation and staining a. Freeze-drying and freeze-substitution b. Microtome and embedding c. Staining d. Metachromasia 5. Cytochemical methods a. Detection of aldehydes b. Detection of lipids c. Enzyme detection d. Cytophotometric methods e. Fluorescence microscopy 6. Immunocytochemistry a. IHC and IFA 7. Cell fractionation a. Gradient centrifugation b. Flow-sorting cytochemistry Radioautography	1 Credit

Laboratory Sessions (Practicum)- 1 Credit

1. Demonstration of the ultrastructure of plant and animal cell (Using SEM)
2. Separation and visualization of Mitochondria from plant cell
3. To study and demonstrate mitosis by preparing the mount of an onion root tip cell.
4. Visit a histopathological lab and report writing
5. H&E staining of histological samples of normal and cancerous specimens.

Reference Books:

1. Cooper GM. "The Cell": A Molecular Approach. 2nd edition. Sunderland (MA): Sinauer Associates; 2000.
2. Cell and Molecular Biology, by Eduardo D.P.DeRobertis and E.M.P.DeRobertis 8th Edition
3. Cell Biology by C.B. Powar Himalaya Publication House
4. Cell Biology by Thomas D. Pollard MD (Author), William C. Earnshaw PhD FRSE (Author)
5. Cell Biology by Gerald & Karp, international students Version (wily)
6. Lewin's "Cell" 2nd edition by George Plopper (Author), David Sharp (Author), Eric Sikorski

Core Course

PGMB102.1: Molecular Genetics I

By the end of this course, the student will be able to -

CO1: Distinguish between different molecular mechanisms of regulation on gene expression in eukaryotes [5] *
CO2: Assess the effect of chromosomal rearrangement in the functioning of cell [5] *
CO3: Categorize/ classify different molecular tools used in Genetics [4]*
CO4: Correlate inheritance of cellular organelles with that of nucleus. [3] *
CO5: Explain various factors leading to changes in the genetic structure of populations. [2] *
CO6: Evaluate genetic problems related to population genetics and restriction mapping [5] *
CO7: Design primers and carry out PCR [6]*

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Mapping Matrix												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	-	2	1	2	-	-	1	-	-	-	-
CO2	3	-	2	1	2	-	-	1	-	-	-	-
CO3	3	-	3	1	1	2	2	1	-	-	-	-
CO4	2	-	3	2	2	2	2	1	-	-	-	-
CO5	3	-	3	2	2	1	2	1	-	-	-	-
CO6	3	-	3	3	2	3	2	2	-	-	1	-
CO7	3	-	2	2	2	3	2	2	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Core Course Code	Title	Credits (60 lectures)
PGMB102	**Molecular Genetics I**	4
Unit I	**Control of Gene Expression in Eukaryotes & Chromosomal rearrangement.**	
	1. Control of Gene Expression in Eukaryotes- . Regulation through Modification of Gene Structure- DNase I Hypersensitivity, Histone Modifications, Chromatin Remodeling, DNA Methylation. a. Regulation through Transcriptional Activators, Co-activators & Repressors, Enhancers and Insulators b. Regulation through RNA Processing & Degradation c. Regulation through RNA Interference d. Regulation of Translation and Modification of Proteins. 2. Chromosomal Rearrangements and effects on gene expression a. Amplification and Deletion of Genes b. Inversions that Alter Gene Expression c. Transpositions that Alter Gene d. Expression Antigenic Variation in Trypanosomes e. Mating Type Switching in Yeast	1 credit
Unit II	**Molecular Tools for Genetics**	**15NH**
	Molecular Tools for Genetics a. Molecular Tools for Studying Genes and Gene Activity b. Use of Recombinant DNA technology to Identify Human Genes (Huntington's diseases, Cystic Fibrosis), Molecular Diagnosis of Human Diseases, Human Gene Therapy) c. Labelled Tracers (Autoradiography, Phosphor- Imaging, Liquid Scintillation Counting, Non- Radioactive Tracers) d. DNA Fingerprinting with their Forensic Applications, In situ hybridization), DNA Sequencing (Sanger's Chain Termination Method, Maxam Gilbert's Sequencing Method), Restriction Mapping, Site-Directed Mutagenesis e. Mapping and Quantifying Transcripts (S1 Mapping, Primer Extension, Run-off Transcription. f. Measuring Transcription Rates *in vivo* (Nuclear Run-on transcription, Reporter Gene Transcription), Assaying DNA – Protein Interactions (Filter Binding, Gel Mobility Shift, DNase, and DMS Foot-printing, Knockin, Knockouts and Transgene g. Positional Cloning	1 Credit
Unit III	**Cytoplasmic Inheritance & Population Genetics**	**15NH**
	1. Cytoplasmic Inheritance (Organellar Genetics) a) Mitochondrial-DNA b) Mitochondrial Genome Structure	

	c) Ancestral and Derived Mitochondrial Genome d) Mitochondrial DNA of Human, Yeast and Flowering Plants e) Endosymbiotic Theory f) Mitochondrial DNA Replication, Transcription & Translation g) Codon Usage in Mitochondria h) Damage to Mitochondrial DNA and Ageing. i) Evolution of Mitochondrial DNA j) mtDNA Analysis for Study of Evolutionary Relationships 2. Cytoplasmic DNA a) Gene Structure and Organization b) General Features of Replication, Transcription and Translation of cpDNA c) Comparison of Nuclear, Eukaryotic, Eubacterial Mitochondrial and Chloroplast DNA d) Examples of ExtraNuclear Inheritance e) Leaf Variegation f) Poky Mutant of Neurospora g) Yeast Petite Mutant h) Human Genetic Diseases i) Maps of mtDNA and cp DNA 3. Population Genetics a) Population and Gene Pool b) Genotypic and Allelic Frequencies c) Calculation of Genotypic frequencies and Allelic Frequencies for autosomal and X linked loci d) Hardy-Weinberg Law, Genotypic Frequencies at HWE e) Changes in the Genetic Structure of Populations: Overview • Mutation • Migration and Gene Flow • Genetic Drift • Natural Selection	1 credit

Practicum:

1. Problems on Population Genetics.
2. Restriction digestion.
3. Protein characterization by Electrophoresis (SDS PAGE).
4. Problems on Restriction Mapping.
5. Curing of Plasmid.
6. Design of primer & PCR
7. RFLP
8. PCR

Reference Books:

1. Russell, P.J., “iGenetics- A Molecular Approach”, Third Edition, Pearson International Edition
2. Trun & Trempy, “Fundamental Bacterial Genetics”, Blackwell Publishing
3. Snustad & Simmons, “Principles of Genetics”, Third Edition, John Wiley & Sons Inc.
4. Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce
5. Gene IX, X and XII- Lewin
6. Genetics: A Conceptual Approach, 3rd Edition by Benjamin Pierce [pg.579, 584-588, 593- 595] (Unit II)
7. Klug & Cummings, “Concepts of Genetics”, Seventh Edition, Pearson Education (LPE)

Core Course

PGMB103.1: Fermentation Technology

By the end of this course, the student will be able to -

CO1: Understand organizational set up in Fermentation Industry [2]*
CO2: Distinguish between methods of Bioseparation [2]*
CO3: Explain carbon pathways for the formation of industrially important Secondary Metabolites [4]*
CO4: Schematically explain production of different fermentation products [4]*
CO5: Evaluate different types of Risk management, Containment levels [5]*
CO6: Diagrammatically explain treatment of different industrial waste [4]*
CO7: Produce & analyse different fermentation product at laboratory scale [6]*

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Mapping Matrix												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	-	-	1	-	-	-	-	2	-	-	-	3
CO2	1	1	3	2	1	3	3	2	-	2	-	1
CO3	1	-	-	1	-	-	-	2	-	-	-	2
CO4	2	1	2	2	1	-	3	2	1	-	1	2
CO5	1	-	1	2	-	1	2	3	-	-	-	1
CO6	1	-	-	-	-	-	-	1	-	-	2	3
CO7	1	-	-	2	-	3	-	-	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Core Course Code	Title	Credits (60 lectures)
PGMB103.1 CC	**Fermentation Technology**	6
Unit-I	**Scope of Industrial Microbiology and Biotechnology** 1.1 Introduction: - Nature of Industrial Microbiology and Biotechnology 1.2 Characteristic of Industrial Microbiology 1.3 Organizational set up in Industrial Microbiology 1.4 Process Design Criteria for • Low Value High Volume • High Value Low Volume 1.5 Physio-chemical Basis of Bioseparation- electrostatic charges, biological activity, polarity, size or mass 1.6 The preservation of Gene pool in Industrial Microorganisms: • Place of culture collections • Type of culture collections • Handling culture collections • Appropriate method of preservation. 1.7 Fermentation Economics 1.8. Computers in fermentation, modelling, software sensors, control and supervision of fermentation processes.	15 L
Unit-II	**Biosynthesis of industrially important Microbial products**	**15NH**
	The nature of Metabolic Pathways Industrial Microbiological Products as Primary and Secondary Metabolites Trophophase- idiophase relationships in the production of secondary metabolites Role of Secondary Metabolites in the Physiology of organisms producing them Pathways for the synthesis of Primary and Secondary Metabolites of Industrial Importance- a. Catabolism of Carbohydrates b. Catabolism of Hydrocarbons	

	Carbon Pathways for the formation of some Industrial Products Derived from Primary Metabolism a. Catabolic Products b. Anabolic Products 1. Carbon Pathways for the Formation of Some Products of Microbial Secondary Metabolism of Industrial Importance	
Unit-III	**Microbial Products (15L)** 3.1 Single Cell Protein Production 3.2 Vaccine Production 3.3 Biofertilizer Production 3.4 Microbial Ergot alkaloids production 3.5 Production of antibiotic- Cephalosporin and research for new antibiotic 3.6 Production of Microbial anti-tumour agent	15 L
Unit-IV	**Biosafety and Industrial Waste** 4.1 Biosafety • Risk assessment- recombinant microorganisms and animal cell • Containment levels • Risk management- spill management, building and facilities • Process equipment-fermentation plant, downstream processing Other systems- personal protective equipment, personal training, medical surveillance, bio waste 4.2 Merits and Demerits of Industrial waste and treatment: • Paper and Pulp Industry • Tanning Industry • Dye Industry • Petroleum Industry • Antibiotic Industry	15 L

Practicum: (2 Credits)

1. Production of Antibiotic
2. Production of SCP
3. Produce and formulate Biofertilizer
4. Detection of microbial anti-tumor agents
5. Preparation TAB Vaccine
6. Physico-chemical, Microbiological analysis of dairy waste
7. Effect of medium Formulation on Biomass amount.

References:

1. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
2. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol. 1 & 2, Academic Press
3. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India.
4. Okafor Nduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
5. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology", 2nd edition, Panima Publishing Corporation, New Delhi.
6. Prescott and Dunn's ''Industrial Microbiology" (1982) 4th edition, MacMillan Publisher
7. INDUSTRIAL WASTE WATER TREATMENT by A.D. Patwardhan.

DISCIPLINE SPECIFIC ELECTIVE (DSE-A)

PGMB104.1A (DSEC1): Food and Dairy Microbiology

By the end of this course, the student will be able to-

CO1. Signifies the importance of microorganisms in food & their stress responses. [2] *
CO2. Illustrate role of microorganisms in different fermented food products. [2] *
CO3. Appraise different methods of microbial detection & control. [5] *
CO4. Evaluate microbial quality of milk & milk products. [4] *
CO5. Compare & contrast different milk products. [4] *
CO6. Perform Sterility testing of sterile food products. [3] *
CO7. Prepare and study microbiology of fermented food like Dhokla and Idli. [5] *

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Mapping Matrix												
CO No	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	1	1	2	1	-	1	3	-	2	-	2
CO2	2	1	2	2	1	-	3	2	1	-	1	2
CO3	2	1	2	3	2	1	2	2	-	-	2	2
CO4	1	1	2	3	2	1	2	2	-	2	1	2
CO5	1	1	3	2	1	0	1	2	-	1	1	1
CO6	2	-	3	3	1	1	2	0	-	-	1	2
CO7	2	-	1	1	2	-	1	2	-	-	1	2

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course Code	Title	Credits
PGMB104.1A DSE-A	**Food and Dairy Microbiology**	**4**
Unit 1	**Microbes in Foods**	**15NH**
	1. Importance of microbes in food 2. Normal microflora of different foods a. Raw and ready-to-eat meat products b. Shelled egg and liquid egg c. Fish and shellfish d. Vegetables, fruit and nuts e. Cereal, starches, and gums f. Canned foods g. Sugars and confectioneries h. Soft drinks, fruit and vegetable drinks, juices and bottled water i. Mayonnaise and salad dressings j. Spices and condiments 3. Microbial stress response in food and its significance a. Microbial growth characteristics b. Stress adaptation c. Sub lethal stress and injury. d. Viable-but-non-culturable 4. Starter cultures a. Lactic starter culture b. Yeast and molds starter culture c. Other Starter Cultures 5. Fermented food Products a. Microbiology of fermented foods b. General Method of Production c. Meat Products d. Semidry Sausages e. Vegetable Products f. Idli, Dhokla, Pickles 6. Nutraceuticals 7. Probiotics and prebiotics	1
Unit II	**Microbial Detection and Food Safety**	**15NH**

	1. Conventional Methods a. Methods used, Sampling for microbial analysis b. Quantitative microbial enumeration in food c. Qualitative methods of microbial detection d. Detection of Bacterial Toxins e. Rapid methods f. Use of Biosensors 2. Controlling the Microbiological Quality of food a. Quality and Criteria b. Sampling Schemes c. QC using microbiological control d. Control at source e. Codes of GMP f. HACCP g. Laboratory Accreditation	
Unit-III	**Dairy Microbiology**	**15NH**
	3.1 Properties, Microorganisms and Analysis a. Physical and chemical properties of milk b. Microorganisms in milk c. Milk as a substrate for microorganisms d. Types of microorganisms in milk - bacteria, fungi and yeast e. Sources of microbial contamination of milk - milch animal, utensils and equipment, water, milking environment, personnel and packaging material 3.2 Microbiological analysis of milk: a. Rapid platform tests - organoleptic, Clot on boiling (COB), titratable acidity, alcohol test, DMC, sedimentation test and pH b. Standard plate count c. Dye reduction test - MBRT, Resazurin test d. Methods of preservation of milk and milk products.	**1**

Practicum: (1 Credit)

1. Determine microbiological load in foods like carrot and apple juice, salad, mayonnaise.
2. Assess quality and analysis of Dairy Products- Milk (Raw, Packed), Ice-cream and yoghurt, seafood and spices.
3. Determine microbial load in raw milk and pasteurized milk.

Reference Books:

1. Food processing Biotechnological application (2000) by S. S. Marwaha & K. Arora, Asiatech Publishers INC, New Delhi
2. Food science, Fifth Edition, Norman N. Potter 1996, CBS publishers and distributors
3. The technology of food preservation, Fourth Edition, Norman W. Desrosier BI Publisher and Distributors, Delhi (1987)
4. Food Microbiology - Adams & Moss
5. Dairy Microbiology by Robinson
6. Outlines of Dairy technology by Sukumar De
7. Milk and Milk Products – Willes Barnes Combs, Harold Macy
8. Milk and Milk Products- Yadav

DISCIPLINE SPECIFIC ELECTIVE (DSE-B)

PGMB104.1B (DSEC2): Food Licensing and Certification

By the end of this course, the student will be able to –

CO1. Interpret basic properties of food components [5*]
CO2. Convince the use of materials used in food packaging [5*]
CO3. Illustrate different regulatory and certification standards [4*]
CO4. Explain handling of food by assessment of risk [2*]
CO5. Understand the HACCP, TACCP, VACCP system flow of food [1*]
CO6. Create and maintain a safe and sanitary working environment in food industry [6*]

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Mapping Matrix												
CO No	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	2	-	1	2	-	-	1	2	-	-	-	-
CO2	-	-	3	1	-	-	1	3	-	-	-	2
CO3	2	1	2	1	-	1	-	3	-	-	-	1
CO4	1	-	1	2	-	1	2	3	-	-	-	1
CO5	3	1	1	2	-	2	-	2	-	-	-	2
CO6	1	1	1	3	-	-	-	2	-	-	-	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course Code	Title	Credits
PGMB104.1B	**Food Licensing and Certification**	**4**
Unit I	**Food Fundamentals and Chemistry**	**15NH**
	1.1 Food Analysis a. Sampling Techniques of Food Products b. Physical and Chemical Analysis of Food c. Instrumentation in Food Analysis d. Sensory Evaluation of Food Products 1.2 Food Processing and Preservation a. Food Additives b. Introduction to Food Preservation and Processing C. Waste Management in Food Processing Industry 1.3Food Packaging 1.4Fundamental of food Microbiology 1.5 Analytical techniques in Microbiology (Different IS methods) and cGMP Practices	1
Unit II	**Food Laws and Standards**	**15NH**
	1. India Food Regulator a. Food Safety and Standards Act, 2006 and Supplementary Material b. Essential Commodities act c. Legal Meteorological Act d. PFA Act and Rules e. Global Standards f. Codex Alimentarius Commission (CAC) g. CAC: Implications h. Other International Standards Setting Bodies i. USFDA / EU Regulation (an overview) 2. Export and Import Laws and Regulations Other Laws and Standards: BIS and AGMARK	1
Unit III	**Food Safety and Quality Management System**	**15 NH**

	3.1 Introduction to Food Safety 3.2 Food Safety System 3.3 TQM 3.4 Risk Analysis a. An Introduction to Risk Analysis b. Risk Management c. Risk Assessment d. Risk Communication 3.5 HACCP a. History, Background and Structure b. Pre- requisites c. Principles d. Case Studies 3.6 VACCP / TACCP (Food Fraud & Food Defense) 3.7 Other Food Safety Practices a. GMP b. GHP c. Nutritional Labelling 3. Traceability Study	1

Practicum: (1 Credit)

1. Design of Standard Operating Procedures (SOP) by different IS methods (Any one)
2. Microbial quality assessment of fruits and vegetables sold at local stores and supermarkets.
3. Case study on Food safety and Standard (Licensing and Registration of food Businesses)

Reference Books

1. Vickie A. Vaclavik, Elizabeth W. Christian. 2nd edition. Essentials of Food Science. Springer New York, NY. ISBN 0-306-47363-1.
2. Shakuntala Manay and M. Shadaksharaswamy. 4th edition. FOODS Facts and Principles. New age international publishers. ISBN 978-93-89802-40-5
3. Yeshajahu Pomeranz and Clifton Meloan. 4th edition. Food Analysis Theory and Practice. MedTech, Division of Scientific International.
4. S. Suzanne Nielsen. 4th Edition. Food Analysis. Springer. Ebook

SKILL ENHANCEMENT COURSE (SEC)

PGMBSEC101.1: Research Methodology

By the end of this course, the student will be able to -

CO1: Understand various study designs and hypothesis pertaining to research topic [2*]
CO2: Enlist different methods of data collection [1*]
CO3: Describe varied methods of sampling [2*]
CO4: Compare the role of different variables in research [4 *]
CO5: Understand steps involved in processing data [2*]
CO6: Elaborate in details Copyright and Neighboring Rights and Filing Patent Applications [2*]

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	2	1	3	1	2	3	2	3	1	2	1	1
CO2	2	-	2	2	1	2	2	1	1	1	-	1
CO3	1	1	1	1	1	2	2	1	2	1	-	-
CO4	1	1	1	1	-	1	2	2	2	1	-	-
CO5	2	-	3	2	-	3	3	2	1	1	1	1
CO6	2	-	3	2	-	2	2	2	-	1	1	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course Code	Title	Credits
PGMBSEC101.1	**Research Methodology and IPR**	**4**
Unit I	**Fundamentals of Research Methodology**	**15NH**
	1. Introduction to Research Methodology a. Meaning and objectives of research b. Terminology c. Features of a good research study d. Ethics in research 2. Study designs: basic, applied, historical, exploratory, experimental, ex-post-facto, case study, diagnostic research, crossover design, case control design, cohort study design, multifactorial design 3. Hypothesis a. Meaning, significance and characteristics of hypothesis b. Basic concepts concerning testing of hypotheses c. Hypothesis development d. Steps in formulation of hypothesis e. Statistical hypothesis testing – type 1, type 2 error, levels of significance	1
Unit-II	**Data Collection**	**15NH**
	1. Experimental data collection a. Types of data b. Methods of primary data collection (observation, experimentation, questionnaire, schedules, interviewing, case, pilot study) c. Methods of secondary data collection (internal, external) d. Selection of appropriate method for data collection 2. Sampling a. Terminology b. Need for sampling c. Types of Sampling (probability sampling and non-probability sampling) 3. Variable a. Dependent b. Independent c. Intervening d. Moderator e. Control variables f. Extraneous variables	1
Unit-III	**Data Analysis and Reporting**	**15 NH**

	1. Data processing and processing operations a. Problems in processing b. Elements of analysis in data processing c. Software for data processing e.g. SPSS & SAS 2. Scientific writing and publishing a. Report Writing b. Writing a Research Paper c. Writing a Review Article	1
Unit-IV	**Intellectual Property Rights**	**15NH**
	1. General Regime of Intellectual Property Rights a. Concept of Property vis-à-vis Intellectual Property b. Types of Intellectual Property- Origin and Development- An Overview. c. Intellectual Property Rights as Human Right. d. Role of International Institutions 2. Patent Law a. Introduction to Patent Law b. Paris Convention c. Patent Cooperation Treaty d. WTO- TRIPS e. Harmonization of CBD and TRIPs 3. Indian Patent Law a. Patentable Subject Matter, Patentability Criteria b. Procedure for Filing Patent Applications, Patent Granting Procedure c. Revocation, Patent Infringement and Remedies Relevant Provisions of the Biological Diversity Act, 2002 4. Copyright and Neighbouring Rights a. Introduction to Copyright b. Conceptual Basis c. International Protection of Copyright and Related rights- An Overview (International Convention/Treaties on Copyright) d. Indian Copyright Law 5. Trademarks a. Introduction to Trademarks b. Need for Protection of Trademarks c. Kinds of Trademarks d. International Legal Instruments on Trademarks e. Indian Trademarks Law	1

Reference Books

1. Research Methodology: C.R. Kothari Second edition
2. P. Narayanan (Eastern Law House), Intellectual Property Law
3. W. Cornish (Universal Publication), Intellectual Property Law
4. R.K. Nagarjan, Intellectual Property Law
5. Ganguli (Tata Megraw), Intellectual Property Rights
6. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow
7. Dr. B.L. Wadhera, Law Relating to Patent, Trademarks, Copyright
8. Patent: Jeffrey G. Sheldon, How to Write a Patent Application, Third Edition, Practicing Law Institute, 2016

SEMESTER II

CORE COURSE

PGMB201.1-CC: Molecular Genetics II

By the end of this course, the student will be able to -

CO1: Distinguish between different molecular mechanisms of regulation on gene expression in eukaryotes [5] *
CO2: Assess the effect of chromosomal rearrangement in the functioning of cell [5] *
CO3: Categorize/ classify different molecular tools used in Genetics [4] *
CO4: Correlate inheritance of cellular organelles with that of nucleus. [3] *
CO5: Explain various factors leading to changes in the genetic structure of populations. [2] *
CO6: Evaluate Epigenetic factors playing a role in genetic control [5] *

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	-	3	3	2	1	1	-	-	-	-	1
CO2	3	1	2	3	3	1	1	-	-	-	-	1
CO3	3	1	3	2	2	1	1	-	-	-	-	1
CO4	3	1	3	3	2	1	1	-	-	-	-	1
CO5	3	2	3	2	1	1	1	-	-	-	-	1
CO6	3	-	3	3	1	1	2	-	-	-	-	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course code	Title	Credits
PGMB201.1 CC	**PGMB201.1-CC: Molecular Genetics II**	**4**
Unit I	**Genetic Basis of Cancer**	**15NH**
	Genetic basis of cancer • Cancer: A Genetics Disease 1. The Many Forms of Cancer 2. Cancer and the Cell Cycle 3. A Genetics Basis for Cancer a. Oncogenes b. Tumor-Inducing Retroviruses c. Viral Oncogenes Cellular d. Homologs of Viral Oncogenes: The Proto-Oncogenes e. Mutant Cellular Oncogenes and Cancer f. Chromosome Rearrangement and Cancer g. Tumor Suppressor Genes 4. Inherited Cancers 5. Knudson's Two-Hit Hypothesis 6. Cellular Roles of Tumor Suppressor Proteins 7. Genetic Pathways to Cancer	1
Unit II	**Developmental Genetics**	**15 NH**
	1. Developmental genetics a. Cloning Experiments b. The Genetics of Pattern Formation in Drosophila c. Homeobox Genes in other Organisms d. The Genetics of Flower Development in Arabidopsis e. Programmed Cell Death in Development f. Evo-Devo: The Study of Evolution and Development 2. The genetic control of animal development a. The Process of Development in Animals 3. Oogenesis and fertilization • The Embryonic Cleavage Divisions and Blastula Formation • Gastrulation and Morphogenesis 4. Genetic Analysis of Development in Model Organisms a. Drosophila as a Model Organism b. *Caenorhabditis* as a model organism 5. Genetic Analysis of Development Pathways c. Sex Determination in Drosophila *d.* Sex Determination in *Caenorhabditis*	1

	6. Maternal Gene Activity in Development e. Maternal-Effect Genes f. Determination of the Dorsal-Ventral and Anterior-Posterior g. Axes in Drosophila Embryos 7. Zygotic Gene Activity in Development a. Body Segmentation b. Specification of Cell Types c. Organ Formation	
Unit III	**Epigenetics and CRISPR Cas9 Technology**	**15 NH**
	A] Epigenetics – Introduction 1. Heterochromatin Propagates from a Nucleation Event 2. Heterochromatin Depends on Interactions with Histone 3. Polycomb and Trithorax Are Antagonistic Repressors and Activators 4. X Chromosomes Undergo Global Changes 5. Chromosome Condensation Is Caused by Condensins 6. CpG Islands Are Subject to Methylation 7. DNA Methylation Is Responsible for Imprinting 8. Oppositely Imprinted Genes Can Be Controlled by a Single Centre 9. Epigenetic Effects Can Be Inherited B] CRISPR Cas9 Technology and its application	1

Practicum: (1 Credit)

1. Visit ATC lab (Demonstration of normal cells and Cancer cell lines)
2. Morgan experiment (problem-solving)
3. Chick embryonic stages – 18-hour, 24-hour, 36-hour, 48-hour and 72-hour embryo
4. Gene cloning in bacteria.
5. Demonstration of 2D Gel Electrophoresis
6. Demonstration of methylation pattern using bioinformatics software. (Epigenetic modification)

Reference Books:

1. Pierce, B.A., "Genetics- A Conceptual Approach", Second Edition, W. H. Freeman & Co
2. Lewin, B., "Genes-IX", Jones and Bartlett Publishers
3. Russell, P.J., "iGenetics- A Molecular Approach", Third Edition, Pearson International Edition
4. Snustad & Simmons, "Principles of Genetics", Third Edition, John Wiley & Sons Inc
5. Watson, Gilman, Witkowski, Zoller, "Recombinant DNA", Second Edition, Scientific American Books
6. Klug & Cummings, "Concepts of Genetics", Seventh Edition, Pearson Education (LPE)
7. Epigenetics in Human Disease- Trygve O. Tollefsbol

CORE COURSE

PGMB202.1- CC: Microbial Biochemistry

By the end of this course, the student will be able to -

CO1: Differentiate biomolecules on the basis of their properties [4*]
CO2: Understand basic concepts of biomolecules. [2*]
CO3: Compare & contrast between different levels of structure of proteins. [5*]
CO4: Evaluate activity of enzymes using enzyme kinetics. [5*]
CO5: Analyse biomolecules by various techniques. [4*]

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	-	-	-	-	-	-	2	-	-	-	3
CO2	1	-	-	-	-	-	-	2	-	-	-	3
CO3	1	1	3	2	1	3	3	2	-	2	-	1
CO4	1	1	2	3	2	1	2	2	-	2	1	2
CO5	-	-	-	1	-	2	-	2	-	-	-	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Core Course Code	Title	Credits (45 lectures)
PGMB202.1 -CC	**Microbial Biochemistry**	4
Unit I	**Amino acids & Proteins**	15 NH
	1. Amino acids a) Chemical structure and general properties, of amino acids, b) Acid base concepts. Henderson and Hasselbach equation. c) General metabolism scheme of amino acids and Urea cycle 2) Proteins: a) Classification- size, shape, degree of association, complexity. b) Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory) c) Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot. Peptides. d) Secondary structure - alpha helix and beta pleated structure, triple helix (collagen) and super secondary structures. e) Tertiary structure - Forces stabilising tertiary structure f) Unfolding/refolding experiment, prediction of secondary and tertiary structure. g) Quaternary structure - forces stabilising quaternary structure. Structure function relationship - myoglobin and haemoglobin.	**1**
Unit II	**Carbohydrates & Lipids**	**15NH**
	1. Carbohydrate: Definition,Types 2. Carbohydrate metabolism: Citric acid cycle- steps involved, amphibolic nature, anaplerotic reactions. 3. Autotrophy and heterotrophy- Concept, factors for, types of autotrophs, mechanisms 4. Pasteur and Crabtree effect 5. Definition and classification of lipids. 6. Fatty acids - general formula, nomenclature and chemical propertiesStructure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins. 7. Beta oxidation - pathway and regulation. Role of acyl carnitine in fatty acyl transport. 8. Synthesis of fatty acid - structure and composition of fatty acid synthetase complex, pathway and regulation	**1**

	9. Synthesis of triacylglycerides.	
Unit III	**Enzymology**	**15NH**
	Introduction a) Discovery of Enzymes b) Enzyme Terminology 2) General methods of extraction: a) Salting out, Use of organic solvents, Purification of Enzymes 3) Enzyme Kinetics a) Basic concepts of Chemical Kinetics b) Kinetics of enzyme catalysed reactions, Enzyme inhibition (Reversible and irreversible), specific examples, effect of pH on enzyme activity. c) Kinetic parameters used to compare enzyme activities, enzymes which catalyse reactions with two or more substrates. 4) Enzyme inhibition – • Reversible inhibition • Competitive inhibition • Uncompetitive inhibition • Mixed inhibition • Irreversible inhibition and Suicide Inactivators of HIV enzyme 5) Enzyme regulation a) Phosphofructokinase an allosteric enzyme b) General properties of allosteric enzymes, c) Two themes of allosteric regulations, d) Regulation by covalent modification, e) Regulation by multienzyme complexes and multifunctional enzymes, specific example of the blood coagulation cascade	**1**

Practicum: (1 Credit)

1. Identification of sugars in fruit juices using thin layer chromatography.
2. Measurement of p*K* & pI values of glycine by titrimetric method.
3. Separation of fatty acids by Reverse-phase Paper Chromatography.
4. Enzyme production:
   a. Screening of amylase producing organisms
   b. Production & purification of amylase enzyme
   c. Determination of specific activity of crude and purified amylase
5. Enzyme kinetics-effect of enzyme concentration, substrate concentration, pH, temperature and inhibitors on enzyme activity.

Reference Books:

1. Principles of biochemistry 5th ed, by White, Handler, Smith
2. Text book of biochemistry 4th ed by West, Tood, Mason and Burgen
3. Lehniger's principles of biochemistry by Nelson kocs.
4. Biochemistry by Zubay
5. Elements of Biochemistry by O.P. Agrawal
6. Biochemistry - Garrett and Grisham 2nd Ed.
7. Harper's Illustrated Biochemistry-26th Ed.
8. Biochemistry 3rd edition, Mathew, Van Holde and Ahern, Pearson Education
9. Principles of Biochemistry, 4th edition, Zubey
10. Principles of Biochemistry, Horton and Moran, Scrimgeour Pears Rawn
11. Principles of Biochemistry, Lehninger A.L., Cox and Nelson, CBS publishers
12. Biochemistry by Conn and Stumph
13. Basic Concepts in Enzymology,Dr. P. Palanivelu

CORE COURSE

PGMB203.1-CC: Pharmaceutical Microbiology

By the end of this course, the student will be able to –

CO1: Understand Quality Assurance and Quality Management in pharmaceutical industries [2*]

CO2: Illustrate the guidelines of ISO certification & NABL accreditation [3*]

CO3: Distinguish between QA, QC, GMP and cGMP [5*]

CO4: Analyze various microbiological tests of pharmaceutical & cosmetic products [4*]

CO5: Explain the document maintenance in pharmaceutical industries [2*]

CO6: Apply the knowledge of calibration and validation of different laboratory instruments [3*]

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	1	2	2	1	-	2	3	-	3	1	2
CO2	2	1	2	1	1	2	-	3	1	3	-	1
CO3	1	1	3	2	1	3	3	2	-	2	-	1
CO4	2	1	3	3	2	2	2	2	-	2	-	2
CO5	2	2	1	-	1	1	1	2	-	3	1	2
CO6	1	-	1	2	1	3	1	2	-	1	-	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course Code	Title	Credits
PGMB203.1 -CC	**Pharmaceutical Microbiology**	6
Unit-I	**Quality Assurance and Quality Management concepts**	**15NH**
	1. Definition and concept of Quality control, Quality assurance and GMP 2. Total Quality Management (TQM): Definition, elements, philosophies, ICH Guidelines: purpose, participants, process of harmonization, Brief overview of QSEM, with special emphasis on Q- series guidelines, ICH stability testing guidelines 3. Quality by design (QbD): Definition, overview, elements of QbD program, tools ISO 9000 & ISO14000: Overview, Benefits, Elements. 4. Steps for registration NABL accreditation: Principles and procedure	1
Unit-II	**Quality Management and GMP in Pharmaceutical**	**15NH**
	1. Definitions and terminologies 2. QA, QC, GMP and cGMP **(**Comparison and Differences) 3. Premises and contamination control, location, design, structure, layout, services and cleaning 4. Personnel management, training, hygiene and health 5. Water for pharmaceutical use 6. Air conditioning system (HVAC) 7. Documentation 8. Validation 9. Quality control and GCLP 10. Sanitary practices in cosmetic manufacturing	1
Unit-III	**Analytical Aspects of Pharmaceutical and Cosmetic Products**	**15NH**
	1. Microbial test methods and general requirements 2. Sterility test 3. Microbial limit test 4. LAL test 5. Testing of water for pharmaceutical use 6. Antimicrobial preservation efficacy and microbial content testing 7. Evaluation of antimicrobial mechanism 8. Cosmetics microbiology- testing methods and preservation 9. Allergen screening testing for cosmetics 10. R & D aspects of pharmaceutical industry 11. Industrial safety	1
Unit-IV	**Organization and personnel safety**	**15 NH**

	Personnel responsibilities, training, hygiene and personal records. Premises**:** Design, construction and plant layout, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, control of contamination. Equipment and raw materials: Equipment selection, purchase specifications, maintenance, purchase specifications and maintenance of stores for raw materials.	1

Practicum: (2 Credit)

1. Sterility testing and reporting (as per Pharmacopoeia)
2. Microbial load in cosmetic product
3. Efficacy testing of preservatives like parabens
4. Efficacy of preservation and shelf life study.
5. Preparation of cosmetic product and its preservation study
6. Report on LAL and other tests for QC

Reference Books:

1. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
2. Iyer S. (2003) Guidelines on cGMP and quality of Pharmaceutical products. D K Publishers Mumbai.
3. Philip A, Taylor and Francis (2006) Cosmetic Microbiology a practical approach.2nd Ed.
4. Denyer S p, Hodges N A and Gorman S P (2005) Hugo and Russell's Pharmaceutical Microbiology. Blackwell Publishing.
5. Bhatia R and Ichhapujani R L (1995) Quality Assurance in Microbiology. CBS publishers and distributors.
6. Hillisch A and Hilgenfeld R (2009) Modern Methods of drug discovery. Springer International Edition.
7. Kadam s s, Mahadik K R and Bothara K G (2009). Principles of medicinal Chemistry.Vol II NiraliPrakashan Pune.
8. Lemke T L and Williams D A (2008) Foye's Principles of Medicinal Chemistry. 6th Ed. WolterLuwer, Lippincott Williams and Wilkins. N Delhi.

DISCIPLINE SPECIFIC ELECTIVE (DSE-A)

PGMB204.1A (DSEC1): Quality Assurance and Quality Control in Pharmaceutical Industries

By the end of this course, the student will be able to –

CO:1- Understand Quality Management System in pharmaceutical industries [2*]
CO:2- Illustrate the Concept, evolution and scopes of quality control and quality assurance [3*]
CO:3- Distinguish between QA, QC. [5*]
CO:4- Analyze various microbiological tests of pharmaceutical & cosmetic products [4*]
CO:5- Explain the Biological Standardization & Quality Control **in** pharmaceutical industries [2*]
CO:6- Apply the knowledge of Audits and Regulatory Compliance

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	1	2	2	3	1	1	2	0	2	3	-	-
CO2	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	2	-	-	-	-	-	-	-	-
CO4	2	-	2	3	1	-	3	3	-	2	1	-
CO5	3	-	2	3	1	-	3	3	-	2	1	-
CO6	1	3	1	1	2	2	-	1	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course Code	Title	Credits (4)
PGMB204.1A	**Quality Assurance and Quality Control In Pharmaceutical Industries**	**(60 NH)**
Unit-I	**QUALITY MANAGEMENT SYSTEMS**	**(15 NH)**
	1. Introduction to quality: Definition, evolution and dimensions of quality. Quality as a strategic decision: Meaning of strategy and strategic quality management, mission and vision statements, quality policy, quality objectives, strategic planning and implementation, competitive analysis. 2. Pharmaceutical quality management: Basics of quality management, Pharmaceutical quality management-ICH Q10, knowledge management, quality metrics, operational excellence and quality management review. WHO-GMP requirements. 3. Six system inspection models: Quality management system, production system, facility and equipment system, laboratory control system, materials system, packaging and labeling system. Concept of self-inspection. 4. Quality systems: Change management/ change control, deviations, out of specifications (OOS), out of trend (OOT). Complaints: Evaluation and handling, investigation and determination of root cause, corrective and preventive actions (CAPA), returns and recalls, vendor qualification, annual product reviews, batch review and batch release. 5. Quality risk management: Introduction, risk assessment, risk control, risk review, risk management tools, HACCP, risk ranking and filtering according to ICH Q9 guidelines.	**1 credit**
Unit-II	**QUALITY CONTROL AND QUALITY ASSURANCE**	**(15NH)**
	1. Introduction: Concept,evolution and scopes of quality control and quality assurance 2. Good laboratory practice: Introduction, scope and overview of ICH guidelines QSEM, with special emphasis on Q-series guidelines, quality assurance unit, protocol for conduct of non-clinical testing, control on animal house, report preparation and documentation. CPCSEA guidelines. 3. cGMP guidelines according to schedule M, USFDA (inclusive of CDER and CBER) and WHO covering: Organization and personnel responsibilities, training, hygiene and personal records, drug industry location, design, 4. construction and plant layout, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, control of contamination and good warehousing practice.	**1 credit**

	5. Analysis of raw materials, finished products, packaging materials, in process quality control (IPQC), developing specification (ICH Q6 and Q3), purchase specifications and maintenance of stores for raw materials. In process quality control and finished products quality control for following dosage forms in pharma industry according to Indian and US Pharmacopeia: Tablets, capsules, ointments, suppositories, creams, parenteral, ophthalmic and surgical products. 6. Documentation in pharmaceutical industry: Three tier documentation, policy, procedures and work instructions, and records (Formats), basic principles- How to maintain, retention and retrieval etc. Standard operating procedures (How to write), master batch record, batch manufacturing record, quality audit plan and reports. Specification and test procedures, protocols and reports. Distribution records and electronic data handling. Concepts of controlled and uncontrolled documents. Submission documents for regulators DMFs, as common technical document and electronic common technical documentation (CTD, eCTD). Concept of regulated and non-regulated markets	
Unit III	**BIOLOGICAL STANDARDIZATION & QUALITY CONTROL**	**(15 NH)**
	1. Good clinical practice: Provisions, prerequisites and protocol for a clinical trial, protection of trial subjects, responsibilities of the investigator, sponsor and monitor, monitoring of safety, record keeping and handling of data, handling and accountability for pharmaceutical products, role of the drug regulatory authority, quality assurance for the conduct of a clinical trial, consideration for multi centre trials. 2. In Process quality control: In process quality control for tablets, capsules, parenterals, ophthalmic preparations, ointments and liquid orals. 3. Pyrogens-Production and properties of bacterial pyrogens and endotoxins, mechanism of action of pyrogens. Analytical testing of pyrogens as per IP, BP and USP. Interpretation of data in comparison with other officials. pyrogen tests. Determination methods of microbial counts and bio-burden. 4. Biological standardization: Detailed study of principles and procedures involved in the biological assays of the following: Adsorbed diphtheria vaccine, adsorbed tetanus vaccine, heparin sodium, oxytocin, pertussis vaccine, plague vaccine, rabies antiserum, rabies vaccine, streptokinase, tetanus antitoxin, tuberculin purified protein derivative, typhus vaccine.	**1 credit**

	5. Quality assurance of herbal products: Determination of physical constants and chemical constants such as extractive values, moisture content, alcohol content, volatile oil content, ash value, bitterness values, foaming index, filth, insoluble matter, swelling factor. 6. Significance of UV, IR, HPLC**,** HPTLC and mass spectroscopy in analysis of herbal products	

Practicum: (1 Credit)

1. Quality Control of culture medium (as per Pharmacopoeia)
2. Sterility testing and reporting (as per Indian Pharmacopeia)
3. Standardisation of instruments as per SOP (pH meter, Analytical Balance & Autoclave)
4. Assignment on Production of vaccines, bacterial pyrogens or endotoxins as per IP
5. *Hands-on* training on UV and HPLC

Reference Books:

1. Sharp John (2000) Quality in the manufacture of medicines and other healthcare products. Pharmaceutical Press.
2. Iyer S. (2003) Guidelines on cGMP and quality of Pharmaceutical products. D K Publishers Mumbai.
3. Philip A, Taylor and Francis (2006) Cosmetic Microbiology a practical approach.2nd Ed.
4. Denyer S p, Hodges N A and Gorman S P (2005) Hugo and Russell's Pharmaceutical Microbiology. Blackwell Publishing.
5. Bhatia R and Ichhapujani R L (1995) Quality Assurance in Microbiology. CBS publishers and distributors.
6. Hillisch A and Hilgenfeld R (2009) Modern Methods of drug discovery. Springer International Edition.
7. Kadam s s, Mahadik K R and Bothara K G (2009). Principles of medicinal Chemistry.Vol II NiraliPrakashan Pune.
8. Lemke T L and Williams D A (2008) Foye's Principles of Medicinal Chemistry. 6th Ed. Wolter Luwer, Lippincott Williams and Wilkins. N Delhi

DISCIPLINE SPECIFIC ELECTIVE (DSE-B)

PGMB204.1B (DSEC2): Advances in Biotechnology

By the end of this course, the student will be able to –

CO 1: Describe marine environmental conditions, marine life forms and understand role of microorganisms in ocean processes with respect to Biofouling, biodeterioration [2]*
CO 2: Illustrate products from marine microbes,Biomimetic materials, New class of pharmaceuticals & Understand various marine derived compounds and bioactive compounds and biomaterials in marine environment[3]*
CO 3: Differentiate between physical, chemical, and biological, microbiological methods and summarize applications of nanoparticles in different fields [4]*
CO 4: Compare and contrast in between procedures involved in bioenergy production [4]*
CO 5: Prepare, Characterize silver nanoparticles for its antimicrobial effect on different bacteria [3]*
CO 6: Produce PHB, Biodiesel from marine bacterial species [3]*

***Note: According to Blooms taxonomy – 1: Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating**

CO-PO Matrix Mapping												
CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO1	3	-	2	1	2	1	1	-	-	-	3	-
CO2	3	1	2	2	3	1	1	-	-	-	-	-
CO3	3	-	3	2	2	1	2	-	-	-	-	-
CO4	3	-	2	2	2	1	2	-	-	-	-	-
CO5	3	-	2	2	2	1	2	-	-	-	3	-
CO6	3	-	2	2	2	1	2	-	-	-	3	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated).

Course code	Title	Credits
PGMB204.1B	**Advances in Biotechnology**	**4**
Unit 1	**Marine Biotechnology**	**15NH**
	1. Extreme environmental conditions, Marine life forms, Biomimetic materials, new class of pharmaceuticals, industrial products and processes, vaccines, diagnostics and analytical reagents, Environmental research in marine environment, Methods in Marine Microbiology – Detection of microorganisms and microbial activity, Metabolic diversity, Extreme Environment conditions, Marine bacteria, marine archaea, Biofouling and biodeterioration, Degradation of pollutants, Bioremediation, Role of microorganisms in ocean processes, Marine Genomics and Proteomics. 2. Marine bioprospecting – Isolation of Marine Natural Products 3. Diversity of marine derived compounds - Alkaloid, Terpenoids and steroids, nucleoside, amino acids, peptides, depsipeptide, polyketide, Macrolide; Marine Enzymes- protease, lipase, chitinase, glucanase; Marine biominerals; Biomineralized structures; Biocomposites; Biopolymers - polysaccharides, chitin, marine collagen 4. Bioactive Compounds and Biomaterials from Marine Environment.	**1**
Unit II	**Nanotechnology**	**15NH**
	1. Nanoscale systems, nanoparticles, nanowires, thin films and multilayers, Properties of nanomaterials 2. Synthesis of nanostructures: physical, chemical, and biological, microbiological methods- 3. Biomolecules and nanostructures 4. Nanoparticular carrier systems 5. Micro and nanofluidics 6. Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging, Nanomedicine and cancer diagnostics and treatment	**1**
Unit III	**Bioenergy and Bioplastics**	**15NH**
	1. Biomass- A renewable source of energy 2. Biomass conversion a) Non biological process b) Biological process	**1**

	3. Bioenergy- a) Biomethanation b) Hydrogen- a new fuel c) Biofuel d) Biodiesel 4. Bioplastics- a) Preparation b) Properties c) Practical applications d) Production economics 5. Microbial Composting	

Practicum: (1 Credit)

1. Preparation of Nanosilver By Wet reduction method (Chemical) using Neem Extract (plants) & Bacteria (Microbiological)
2. Characterisation of Nanosilver by UV spectrometry and microscopic methods
3. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.
4. Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria
5. Construction of biogas plant using cow dung on laboratory scale
6. Preparation of Bioplastic [Poly β Hydroxybutyric acid] and study its physico- chemical properties

Reference Books:

1. Nanobiotechnology by David Goodsell. John Wiley
2. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology by Nalwa HS 2005. American scientific publishers
3. Nanobiotechnology by Niemeyer CM &Mirkin CA 2005. Wiley Interscience
4. Biodiversity, Biotechnology & Traditional Knowledge- Understanding Intellectual Property Rights, Aravind Kumar, Govind Das, Narosa
5. A textbook of Biotechnology, R.C. Dubey, S. Chand publications.
6. RSK Barners& R.N Huges: Introduction to Marine Ecology, Blackwell
7. David H. Attway & Oskar R. Zabosky: Marine Biotechnology: Volume 1,2,3, Plenum Press, (1993).
8. P.J. Scheuer: Marine. Natural Products, Volume 1 & 2 (1978). Volume (1980-81) Academic Press.
9. O. Kinne: Marine Ecology, Vol. V. , Ocean Management 3 & 4, John Wiley & Sons, (1984).
10. Rita Colwell (Ed.): Biotechnology in Marine Sciences, Academic Press, (1981).
11. R.R. Colwell (ed), Biotechnology of Marine Science, (1982).

12. R.R. Colwell et. al (eds) Biotechnology of Marine polysaccharides, (1985).
13. David H. Attway & Oskar R. Zabosky: Marine Biotechnology, Volume 1,2,3, plenum press (1993).
14. P.J. Scheuer: Marine Natural Products, Volume 1&2 (1978) Volume (1980, 81), Academic Press