Enclosure – II C

Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot
(An Autonomous College)
Affiliated to Saurashtra University, Rajkot

Department of Microbiology

M. Sc. MICROBIOLOGY

OBJECTIVES OF THE PROGRAMME

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their post graduation studies:

1. To impart in-depth knowledge, inculcate scientific thinking and develop practical skills to Microbiology students to pursue career in industry, academia or research.
2. To develop Microbiologists with ability to design, plan and implement research projects, scientific report writing skills and apply them to solve problems related to areas of Microbiology.
3. To work safely, independently and effectively in Microbiology laboratories along with understanding of microbes at molecular level.
4. To enable students to understand the applications of microbiology in healthcare, agriculture, food technology & environmental protection.

SCHEME OF INSTRUCTION AND EXAMINATIONS
For Students Admitted From A.Y. 2016-2017 & Onwards

Semester – I							
Course Code	**M.Sc. Micro Course**	**Hrs of Instruction /Week**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part- I							
16PMBCC01	**Core 1:** Cell Biology	4	3	30	70	100	4
16PMBCC02	**Core 2:** Microbial Genetics	4	3	30	70	100	4
16PMBCC03	**Core 3:** Microbial Diversity and Evolution	4	3	30	70	100	4
16PMBDC01/ 16PMBDC02	**Discipline Specific Elective-I** Research Methodology and Experimental Design/ Good Laboratory Practices	4	3	30	70	100	4
16PMBCC04	**Combined Practical - 1** Cell Biology, Microbial diversity and Microbial Genetics	10	9*	100	150	250	5
Part – II							
16PMBCE01	**Seminar Presentation**	1	-	50	-	50	1
16PMBCE02	**Technical Skill I :** Quantitative Biology (100% Internal Evaluation)	2	-	100	-	100	1
		29				**800**	**23**
PART- III							
16PVE01	Value Education	1	-	Remarks			1
Total		**30**				**800**	**24**
Career Skill Enhancement Training, 1 (one) hr/week compulsory to be taken by all students which will be evaluated at the end of second semester. It is compulsory to complete the course for all M.Sc. Microbiology students to get the degree.							

* 3hrs each on Day1, Day 2 and Day 3.

Semester – II							
Course Code	**Course**	**Hrs of Instruction /Week**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part –I							
16PMBCC05	**Core 4:** Bioprocess Technology	4	3	30	70	100	4
16PMBCC06	**Core 5**: Microbial Physiology and Energetics	4	3	30	70	100	4
16PMBCC07	**Core 6**: Mycology and Virology	4	3	30	70	100	4
16PMBDC03/ 16PMBDC04/ 16PMBDC05	**Discipline Specific Elective- II-** Soil and Agriculture Microbiology / Food and Dairy Technology/ Cell Culture Technology	4	3	30	70	100	4
16PMBCC08	**Core Practical – II** Bioprocess Technology, Microbial Physiology, Energetics, Mycology and Virology	8	6*	80	120	200	4
16PMBDC06/ 16PMBDC07/ 16PMBDC08	**Discipline Specific Elective- II- Practical** Soil and Agriculture Microbiology/ Food and Dairy Technology/ Cell Culture Technology	3	3	20	30	50	1
Part- II							
16PMBCE03	**Research Proposal Writing**	1	-	50	-	50	1
16PMBCE04	**Technical Skill II**: Career Competency Skill Development - I	2	-	100	-	100	2
Total		**30**				**800**	**24**
Career Skill Enhancement Training, 1 (one) hr/week in semester I & II compulsory to be taken by all students which will be evaluated at the end of second semester. It is compulsory to complete the course for all M.Sc. Microbiology students to get the degree.							

* 3hrs each on Day1 and Day 2.

Semester-III							
Course Code	Course	Hrs of Instruction /Week	Exam Duration (Hrs)	Max Marks			Credit Points
				CIE	SEE	Total	
Part-I							
16PMBCC09	**Core 7:** Genetic Manipulation Techniques	4	3	30	70	100	4
16PMBCC10	**Core 8**: Immunology and Medical Microbiology	4	3	30	70	100	4
16PMBCC11	**Core 9**: Basic Instrumentation and Biophysics	4	3	40	60	100	4
16PMBCC12	**Core 10: CBT**(All Papers of all three Semester)	-	-	100	-	100	1
16PMBDC09/ 16PMBDC10/ 16PMBDC11	**Discipline Specific Elective- III –** Advanced molecular techniques/ Pharmaceutical Technology / Nanobiotechnology	4	3	40	60	100	4
16PMBCC13	**Core Practical – III** Genetic Engineering, Immunology and Instrumentation	6	9	60	90	150	3
16PMBDC12/ 16PMBDC13/ 16PMBDC14	**Discipline Specific Elective- III – Practical** Advanced Molecular Techniques/ Pharmaceutical Technology / Nanobiotechnology	2	2	20	30	50	1
	Project	4	-	-	-	-	-
Part – II							
16PMBCE05	**Summer Training**	-	-	20	30	50	1
16PMBCE06	**Technical Skill III** : Career Competency Skill Development – II	2	-	100	-	100	2
		30				**850**	**24**

Semester – IV							
Course Code	**Course**	**Hrs of Instruction /Week**	**Exam Duration (Hrs)**	**Max Marks**			**Credit Points**
				CIE	**SEE**	**Total**	
Part – I							
16PMBCC14	**Core11**: Bioinformatics	4	3	30	70	100	4
16PMBDC15/ 16PMBDC16/ 16PMBDC17	**Discipline Specific Elective IV** : Bio-entrepreneurship / Bioethics and IPR / Environmental	5	3	30	70	100	5
16PMBCC15	**Core Practical – IV** Bioinformatics	3	6	30	70	100	2
16PMBCC15	**Project and Viva Voce**	18	3	80	120	200	12
Part –II							
16PMBCE07	**Educational Tour**	-	-	50	-	50	1
		30				**550**	**24**
	TOTAL					**3000**	**96**

- **TOTAL MARKS & CREDIT DISTRIBUTION**

S.NO	PART	Total Marks	Total Credits
1.	PART I: Core, DSE Allied, (Theory & Practical)	2500	86
2.	PART II : SEC, CC	500	09
3.	PART III: SEC	Remarks	01
	TOTAL	**3000**	**96**
It is compulsory to complete the Career Skill Enhancement Training course in Semester I and II for all the M. Sc Microbiology students to get the degree			

- **PART – I : CORE, DSE**

CORE COURSES [Theory]

S. No	Semester	Course code	Course
1	I	16PMBCC01	Core 1: Cell Biology
2		16PMBCC02	Core 2: Microbial Genetics
3		16PMBCC03	Core 3: Microbial Diversity and Evolution
4	II	16PMBCC05	Core 4: Bioprocess Technology
5		16PMBCC06	Core 5: Microbial Physiology and Energetic
6		16PMBCC07	Core 6: Mycology and Virology
7	III	16PMBCC09	Core 7: Genetic Manipulation techniques
8		16PMBCC10	Core 8: Immunology and Medical Microbiology
9		16PMBCC11	Core 9: Basic Instrumentation and Biophysics
10		16PMBCC12	Core 10: Computer Based Test
11	IV	16PMBCC14	Core 11: Bioinformatics

CORE COURSES [Practical]

S. No	Semester	Course code	Course
1	I	16PMBCC04	Cell Biology, Microbial diversity and Microbial Genetics
2	II	16PMBCC08	Bioprocess Technology, Mycology and Virology
3	III	16PMBCC13	Genetic Engineering, Immunology and Instrumentation
4	IV	16PMBCC15	Bioinformatics

OTHER CORE COURSES

S. No.	Semester	Course Code	Course
1	III-IV	16PMBCC15	Project and Viva Voce

DSE COURSES - [Theory & Practical]

Students are required to opt for any one of the courses offered in each Semesters respectively

S. No	Semester	Theory		Practical	
		Course code	Course	Course code	Course
1.	I	16PMBDC01/	Research Methodology and Biostatistics	-	-
		16PMBDC02/	Good Laboratory Practices	-	-
2.	II	16PMBDC03/	Soil and Agriculture Microbiology	16PMBDC06/	Soil and Agriculture Microbiology
		16PMBDC04/	Food and Dairy Microbiology	16PMBDC07/	Food and Dairy Microbiology
		16PMBDC05	Cell Culture Technology	16PMBDC08	Cell Culture Technology
3	III	16PMBDC09/	Advanced Molecular Techniques	16PMBDC12/	Advanced Molecular Techniques
		16PMBDC10/	Pharmaceutical Technology	16PMBDC13/	Pharmaceutical Technology
		16PMBDC11	Nanobiotechnology	16PMBDC14/	Nanobiotechnology
4	IV	16PMBDC15/	Bio-entrepreneurship	-	-
		16PMBDC16/	Bioethics and IPR	-	-
		16PMBDC17/	Environmental Biotechnology	-	-

- **PART – II : COMPETENCY ENHANCEMENT COURSES**

S. No	Semester	Course code	Course
1	I	16PMBCE01	Poster/ Seminar Presentation
2		16PMBCE02	Technical Skill I: Quantitative Biology (100 % Internal Evaluation)
3	II	16PMBCE03	Research Proposal writing
4		16PMBCE04	Technical Skill II: Career Competency Skill Development - I
5	III	16PMBCE05	Summer Training
6		16PMBCE06	Technical Skill III : Career Competency Skill Development - II
7	IV	16PMBCE07	Educational Tour

- **PART – III : COMPETENCY ENHANCEMENT COURSES**

S. No.	Semester	Course Code	Course
1	I	16PVE01	Value Education

M.Sc MICROBIOLOGY
SEMESTER – I

16PMBCC01	Core I: Cell Biology	4hrs/wk	4 Credits

Course Objectives:

Upon successful completion of this course, Students will be able to**:**

1. Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
2. Understand how these cellular components are used to generate and utilize energy in cells
3. Understand the cellular components underlying mitotic cell division.
4. Apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Unit 1: Cellular Ultrastructure (09hrs)

- Ultrastructure: Plasma Membrane and Cell Wall (Eukaryotic and Prokaryotic).
- Ultrastructure and functions of Lysosome, Peroxisomes & Glyoxisomes.
- Ultrastructure of Ventriole, Flagellum & Cilium, Vacuoles and their role in cell structure and function.
- Ultrastructure of Mitochondria and Chloroplast

Unit 2: Cell cycle and DNA packaging (10hrs)

- Cell Cycle, G_1/S Transition, Cyclines and cyclin dependent kinases. Regulation of CDK - cycline activity
- Ultrastructure of Nucleus and Nucleolus. Pore Complex of Nuclear envelop
- Ultrastructure of Chromosome & Chromosomal Models; Histone proteins: evolutionary trend and structure of nucleosomes; Histone like proteins in prokaryotes and genome organization in prokaryotes and archaea

Unit 3: Cytoskeleton (09hrs)

- Cytoskeleton: Ultrastructure and functions of Microtubules, microfilaments and associated proteins
- Ultrastructure and functions of Actin, Myosin, IF and associated proteins
- Intracellular Junctions and their functions. Ca^{++} dependent homophillic and non-homophillic cell-cell adhesion.

Unit 4: Cellular Transport (10hrs)

- Transport across cell membrane: diffusion, active transport and pumps, uniports, symports and antiports; Phenomenon of exocytosis and endocytosis
- Cell surface receptors and their mode of action;
- Secondary messenger system
- Overview of Apoptosis and Necrosis

Unit 5: Cancer Biology (10hrs)

- Cancer biology: Types of cancers; Cancer biology; Oncogenes versus Tumor suppressor genes
- Mutation: Mutagens/ carcinogens (chemical and physical agents); biological agents
- RAS signaling in cancer; Familial cancer syndromes and the discovery of tumor suppressors; Control over cell cycle; Apoptosis and the p53 tumor suppressor
- DNA repair mechanisms; DNA repair defects and their relationship to cancer
- Diagnosis and Treatment of Cancers: Chemotherapy, Immunotherapy, Newer targeted techniques

Reference Books:

1. Lodish, H., Berk, A., Kaiser, C.A. (2008). Molecular Cell Biology, 7th Edition. W.H. Freeman publication.
2. Cassimeris, L., Plopper, G., Lingappa, V.R. (2010). Lewin's Cell, 2nd Edition. Johns & Bartlett Publishers
3. Bolsover, S.R., Shephard, E.A., White, H.A., Hyam, J.A. (2011). Cell Biology, A Short Course, 3rd Edition. New York: Wiley publication

16PMBCC02	Core: 2 Microbial Genetics	4hrs/wk	4 Credits

Course Objectives:

Upon successful completion of this course, the student will be able to:

1. Understand the importance of microbial genetics;
2. Explain how microorganisms are used to understand the genetic mechanisms
3. Relate microbial genetics to Microbiology
4. Understand microbial genes, genomes, and gene expression and its importance for understanding the biology and evolution of microorganisms and their interactions with the environment.

Unit 1: Classical Genetics (09hrs)

- Principles of Mendelian genetics, Linkage & Pedigree Analysis
- Hardy-Weinberg genetic equilibrium, Natural selection, genetic drift
- Genetics of Speciation
- Extra-chromosomal inheritance

Unit 2: Gene and Gene expression (10hrs)

- Gene, Genome and Genomics
- DNA replication: Mechanism and regulation in prokaryotes
- Transcription in prokaryotes
- Translation in prokaryotes
- Post transcriptional and post translational modifications

Unit 3: Regulation of Gene expression (10hrs)

- Regulation of gene expression in prokaryotes: The Operon model of regulation
- Inducible and repressible operons with the examples of lac, trp and arabinose operons
- Genetic analysis and positive and negative control of lac operon; 3- Dimensional structure of lac repressor and mechanism of its binding to DNA
- Regulation of gene expression in bacteriophage λ

Unit 4: Mutation **(10hrs)**

- Mutational Theory of Evolution
- Molecular basis and Types of mutations
- Mutagenesis
- DNA damage and repair
- Chromosomal aberration

Unit 5: Gene Transfer **(09hrs)**

- Genetic exchange in Prokaryotes
- Molecular basis of conjugation among prokaryotes, Genetic exchange by conjugation involving prokaryotes and eukaryotes, Conjugation in *Paramecium*
- Molecular mechanism of transformation and transduction
- Plasmid Biology: Control of replication, Plasmid distribution and stability
- Transposable elements

Reference Books:

1. Snustad, D.P., Simmons, M.J. (2012) Principles of Genetics, 6th Edition. Wiley publications.
2. Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A. (2006). Concepts of Genetics, 10th Edition: Pearson publication
3. Hartl, D.L. (2014). Essential Genetics, A Genomics Perspective, 6th Edition: Jones & Bartlett publications.
4. Lewin, B. (2004). Gene-VIII. Pearson Prentice Hall publications.

16PMBCC03	Core 3: Microbial Diversity and Evolution	4hrs/wk	4 Credits

Course Objectives:

The broader aims of the course are to provide:

1. In-depth knowledge about microbial evolution process, classification and phylogeny analysis
2. Understanding about vast diversity in various groups of bacteria
3. Understanding of the morphology, physiology and other features of Archaebacteria and Extremophiles
4. Understanding of uncultivable microorganisms.

Unit 1: Microbial Evolution (09hrs)

- Microbial evolution and phylogeny
- Chronometers and chronological distances, paradox in establishing evolutionary distances
- Phylogenetic trees and its types
- Molecular basis of microbial classification : Methods of 16S r-RNA analysis, (Signature Sequence), FAME Analysis, Density Gradient Gel Electrophoresis (DGGE), Thermal Gradient Gel Electrophoresis (TGGE), Amplified Ribosomal DNA Restriction Analysis (ARDRA).

Unit 2: Bacteriology (10hrs)

- Diversity of Gram positive bacteria
- Diversity of Gram negative bacteria
- Diversity of Actinobacteria
- Diversity of Cyanobacteria and Microalgae

Unit 3: Archaebacteria (09hrs)

- Archaebacteria - taxonomic position, distinguishing features and Phylogenetic groups
- Ecology and habitats of Archaebacteria
- Physiology and adaptive strategies of Archaebacteria
- Biotechnological potential of Archaebacteria

1 **Unit 4: Extremophiles (10hrs)**

- Introduction to extremophiles; Extreme Environments and distribution and types of
- Thermophiles: Types, adaptation mechanisms, biotechnological significance
- Halophiles: adaptation mechanisms, Industrial importance
- Methanogens: Classification, habitats and its applications

Unit 5: Uncutivable Microorganisms (10hrs)

- Concept of Metagenomics
- Methods of isolating Metagenomic DNA
- Application of Metagenomic DNA

Reference Books:

1. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition, New York: WCB Mc GrawHill publication.
2. Madigan, M.T., Martinko, J.M., Stahl, D.A., Clark, D.P. (2011). Brock Biology of Microorganisms, 13th ed.: Benjamin-Cummings publication
3. Stanier, R.Y. (1987). General Microbiology, 5th Edition: Macmillan publication.

16PMBDC02/ 16PBTDC02	Discipline Specific Elective I: Good Laboratory Practices	4hrs/wk	4 Credits

Course Objectives:

1. To bridge the gap between academics and industries
2. To inculcate skills of GLP as per regulatory authorities.
3. To equip students with instrumentation and validation studies.

Unit 1 **(10 hrs)**

- GMP/GLP Introduction
- Regulatory authorities in industry and their roles
- MHRA, USFDA, WHO,HACCP, EPA, OECD, ISO, FSSAI, NGCMA
- Introduction to good laboratory practices in a microbiology laboratory, aseptic technique, control of media, control of test strains, control of equipment, diligent recording and evaluation of data, and training of the laboratory stuff.

Unit 2 **(10 hrs)**

- Qualification and Validation of the Instruments in laboratory
- An overview of IQ, OQ,PQ of the instrumentation
- Calibration and preventive maintenance of equipments
- Validation, Approval of protocols, analysis test protocols
- Execution and Reporting skills

Unit 3 **(10 hrs)**

- Standard Operating Procedures and their importance in microbiology practices
- Various techniques in Good laboratory practices in microbiology internal
- Entry exit procedures and working practices of personnel's
- Change control, Quality management and Standards in quality control departments

Unit 4 **(9 hrs)**

- Method Validation and reporting documentation
- Media, Reagents Preparation, Storage & Qualification
- Reference standard maintenance and reports
- Accuracy, Precision, Repeatability, Robustness of methods in QC

Unit 5 **(9hrs)**

- Self-inspection & Quality audits
- Review of documents, Maintenance of Log book and review
- Record keeping, labeling files and folders, documentation in GMP
- Health Safety and Environment, Waste disposal management

References

1. World Health Organization. Handbook: good laboratory practice (GLP): quality practices for regulated non-clinical research and development. World Health Organization, 2010.
2. Selvakumar, R. (2010). Good Laboratory Practices. Indian Journal of Clinical Biochemistry. 25 (3): 221-224.
3. Weinberg, S. (2007). Good Laboratory Practice Regulations: CRC Press.

16PMBCC04	Combined Practical - 1 Cell Biology, Microbial Diversity and Microbial Genetics	10hrs/wk	5 Credits

Course Objectives:

The course is designed to impart

1. Skill related to study of intracellular and extracellular structures of Eukaryotic and Prokaryotic cells
2. Knowledge related to isolation and study of various cellular components
3. Hands-on training in Molecular Biology experiments
4. Familiarity with methods for measuring this diversity and monitoring changes due to both anthropogenic and natural factors
5. Hands-on training of latest techniques to the study of biodiversity, with an emphasis on genomics methods and digital tools for exploiting museum collections

Cell Biology

1. Mitosis and the Cell Cycle in Onion Root-Tip Cells
2. Cell Counting and viability
3. Mitochondria isolation
4. Buccal smear – Identification of Barr Body
5. Permeability assessment of the plasma membrane
6. Karyotyping
7. Isolation of DNA from microbial, plant and animal cells
8. Estimation of DNA by DPA method
9. Isolation of RNA from yeast cells
10. Estimation of RNA by orcinol method

Microbial Genetics

1. UV survival curve of bacteria
2. Chemical mutagenesis
3. Ames test
4. Isolation of Lac fermentor mutants by replica plating method
5. Enzyme induction
6. Bacterial Transformation
7. Bacterial conjugation
8. Genetic mapping by conjugation (Theoretical calculations)
9. Isolation of plasmid DNA

Microbial Diversity

1. Isolation of extremophilic bacteria and screening for their enzymes
2. Isolation of actinobacteria/ actinomycetes

3. Calculation of various diversity indices, such as Dominance Index, Shannon Index, Berger-Parker Dominance Index, Margalef richness Index, Menhinick Index, Ginni coefficient, Equitability Index
4. Isolation and identification of various fungi
5. Isolation of Yeast
6. Isolation of Plaques from sewage sample

Reference Books:

- Sambrook, J., Russell, D.W. (2001). Molecular Cloning – A Laboratory Manual: Cold spring Harbor Laboratory Press
- Chappuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications
- Brown, A.E. (2009). Benson's Microbiological Applications: Laboratory Manual in General Microbiology. New Delhi: McGraw Hill publication.
- Benson, H.J. (2001). Microbiological applications: a laboratory manual in general microbiology. New Delhi: McGraw Hill publication.

M. Sc. Microbiology Semester - II

16PMBCC05	Core: 4 Bioprocess Technology	4hrs/wk	4 Credits

Course Objectives:
On successful completion of this course students should have

1. An understanding of the variety of fermentation and subsequent processing approaches available for the manufacture of biological products
2. Knowledge about design and operation of these systems,
3. Appreciation of the regulatory framework under which the industry operates

Unit 1: Strain improvement and development (09hrs)

- Basic concept of fermentation
- Screening of industrially important microorganisms
- Strain improvement: Molecular approaches, Directed evolution & selection; Preservation of industrial microorganisms
- Substrates for microbial fermentations, antifoam agents

Unit 2: Bioreactor Design (09hrs)

- Design and construction of bioreactor
- Major types of bioreactors; Enzyme reactors
- Mass transfer of oxygen: Agitation and aeration, Determination of KLa, factors affecting KLa, fluid rheology
- Medium engineering by Response Surface Methodology (RSM)

Unit 3: Sterilization, control and Economics (10hrs)

- Sterilization of media and air; Scale up and Scale down
- Bioprocess kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems
- Control of process parameters
- Fermentation economics

Unit 4: Types of fermentation processes (10hrs)

- Antibiotic production: Penicillin
- Biomass: SCPs, Mushrooms and probiotics
- Alcohol fermentation
- Citric acid & Vitamin B12 fermentation
- Enzymes: Protease & Amylase
- Amino acids: Lysine & Glutamic acid
- Microbial production of polysaccharides: Xanthan & Dextran

Unit 5: Downstream Process **(10hrs)**

- Bioseparation- Filtration, Centrifugation, Sedimentation, Flocculation
- Cell disruption; Liquid-liquid extraction
- Purification by Chromatographic techniques : Reverse Osmosis and Ultra filtration
- Drying; Crystallization, Storage and Packaging
- Immobilization and applications of whole cells and enzymes

Reference Books:

1. Pepler H.J., Perlman, D. (1979). Microbial Technology. Volume-1 & 2. New York: Academic Press.
2. Casida, L.E. (1968). Industrial Microbiology. New Delhi: New Age International Pub. (P) Limited.
3. Stanbury, P.F., Whittaker, A. (1984). Principles of Fermentation Technology, 2nd Edition. Pergamon Press.
4. Waites, M.J., Morgan, N.L., Rockey, J.S., Higton, G. (2001). Industrial Microbiology: An Introduction: Wiley-Blackwell scientific publication.
5. Okafor, N. (2007). Modern Industrial Biotechnology & Microbiology. Edenbridge: Science Publishers.

16PMBCC06	Core: 5 Microbial Physiology And Energetic	4hrs/wk	4 Credits

Course Objective;

The overall aim of this course is to

1. Instill in students an appreciation for, and a working knowledge of, the diverse mechanisms that allow bacteria to survive and grow in ever-changing environments.
2. Understand the structure and function of the bacterial cell
3. Understand how bacterial growth is possible due to, and as an outcome of, the flow of genetic information (DNA to RNA to Protein).
4. Understand the range of bacterial metabolism (diverse metabolic capabilities) and energy production in the bacterial cell
5. Understand the ability of bacteria to sense and respond to environmental conditions

Unit . 1: Microbial Physiology (09hrs)

- Flagella, motility and process of chemotaxis- uptake and utilization of substrates
- Sporulation and germination
- Microbial biofilms; physiology and collective recalcitrance of microbial biofilm communities: Quorum sensing and quenching mechanisms
- Microbial stress responses: Heat, temperature, pH, Microbial energy stores, Microbial fuel cells and applications

Unit . 2: Carbohydrate Metabolism (10hrs)

- Carbohydrates: Classification, chemical structure, functions
- Carbohydrate Metabolism: Aerobic and anaerobic pathways: Glycolysis and its regulation, Gluconeogenesis and its regulation.TCA cycle, anaplerotic reactions.
- Electron Transport chain, Oxidative phosphorylation, & production of ATP, balance sheet of glucose oxidation, Pentose phosphate pathway

Unit . 3: Lipid Metabolism (10hrs)

- Lipid: Classification, chemical structure, functions
- β-oxidations of saturated even chain fatty acids.
- Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex
- Regulation of fatty acid biosynthesis
- Biosynthesis of cholesterol, regulation

Unit . 4: Protein metabolism (10hrs)

- Amino acids & Proteins: Classification, chemical structure, functions
- Biodegradation of amino acids–deamination, transamination, decarboxylation
- Urea cycle including its regulation
- Biosynthesis of amino acids, Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, Biologically active amines

Unit . 5: Bioenergetics (09hrs)

- Bioenergetics: Gibbs free energy, endergonic & exergonic reactions, Standard state free energy changes, Feasibility of reactions
- ATP Structure, properties and energy currency of the cell, Importance of Coupled reactions, High energy compounds
- Bioenergetics of glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducer, aerobic and anaerobic respiration, fermentation,
- Photosynthesis bacteria and algae

Reference Books:

1. Nelson, D.L., Cox, M.M. (2013). Lehninger Principles of Biochemistry. W.H. Freeman publication.
2. Voet, D., Voet, J.G., Pratt, C.W. (2012). Fundamentals of Biochemistry, 4th Edition: Wiley publications
3. Moat, A.G., Foster. J.W., Spector, M.P. (2009). Microbial Physiology, 4th Ed: Wiley India Pvt Ltd.
4. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.

16PMBCC07	Core: 6 Mycology and Virology	4hrs/wk	4 Credits

Course Objectives:

This course is aimed at providing students:

1. To understand general features and properties of fungi
2. To provide awareness about different classes of fungi
3. To understand basics of viruses
4. To acquire knowledge regarding economic aspects of Fungi and virus

Unit . 1: Fungi – General Characters (09hrs)

- Morphological features of fungi; Fungal nutrition and growth; Fungal associations
- Fungal classification: Natural and Artificial
- Four Class Classification of Fungi; Nine class Classification of Fungi; Five Class
- Classification of Fungi
- Sexuality in fungi: Asexual reproduction; Sexual reproduction; Parasexual cycle
- Fungal nutrition: Mode of fungal nutrition; Omnivorous nature of fungi

Unit . 2: General features of different classes of Fungi (10hrs)

- Zygomycotina
- Ascomycotina
- Basidiomycotina
- Deuteromycotina
- Slime molds

Unit . 3: General Characteristics of Virus (09hrs)

- Morphology, Ultra structure, Chemical composition and classification of virus
- Physical, chemical and structural components of viruses.
- Isolation and purification of viruses, Detection of viruses: physical, biological,
- Immunological and molecular methods
- Sub-viral Particles – Viroid, Satellite Virus, Prions

Unit . 4: General features of different classes of Virus (10hrs)

- Viruses of Anima
- Viruses of Plants
- Bacterial viruses
- Viruses of Eukaryotic Microorganisms
- Viruses and Cancer

Unit . 5: Economic importance of Fungi and Virus (10hrs)

- Role of Fungi in agricultural sector: biofertilizers, biopesticides, fungal diseases of plants
- Fungi as foe: Fungi in food spoilage and toxication; Fungi as deteriorating agent; Fungal diseases
- Industrial Applications of fungi
- Viral diseases of plants and animals
- Use of Viral as therapeutic agents, Gene transfer tool in plant biotechnology

Reference Books:

1. Deacon, J. (2006). Fungal Biology, 4th ed: Wiley publication.
2. Gow, N.A., Gadd, G.M. (1995). The Growing Fungus. Springer publication.
3. Kendrick, B. (2001). The Fifth Kingdom, 3rd edition: Focus Publishing.
4. Carlile, M.J., Watkinson, S.C., Gooday, G.W. (2001). The Fungi, 2nd edition: Academic Press.
5. Collier, L., Balows, A., Sussmann, M. (1998). Topley & Wilson's Microbiology and Microbial Infections, Volume 4: Hodder Education Publishers.
6. Alexopoulos, C.J., Mims, C.W., Blackwell, M.M. (1996). Introductory Mycology: Wiley publication.
7. Wanger, E.K., Hewlett, M.J. (2004). Basic Virology: Blackwell Science.
8. Matthew, R., Hull, R. (2002). Matthew's Plant virology: Elsevier Academic press.
9. Acheson, N.H. (2011). Fundamentals of molecular virology, 2nd Edition: Wiley publication.

16PMBDC03/ 16PBTDC03	Discipline Specific Elective -II: Soil and Agricultural Microbiology	4hrs/wk	4 Credits

Course Objectives:

The course is designed to make student aware about:

1. Soil and its characteristics
2. Microorganisms in soil and their role in agriculture
3. Sustainable agriculture and its impact
4. Plant Microbe interaction and Molecular Plant Pathology

Unit 1 : Microbes and Soil Fertility (10hrs)

- Physical and Chemical properties of soil
- Role of Microbes in soil fertility
- Soil fertility Evaluation and Improvement
- Interactions among soil microorganisms
- Organic Farmimg

Unit 2:Plant Microbe Interaction (09hrs)

- Rhizosphere Microorganisms : Phyllosphere, Spermosphere and Rhizoplane
- Methods of Enumeration, Rhizosphere Effect,
- Factors affecting Rhizosphere Microorganisms
- PGPR, Siderophore, Mycorrhiza and VAM

Unit 3: Biological Nitrogen Fixation (10hrs)

- Nitrification, Dinitrification
- Symbiotic Nitrogen Fixation *(Rhizobium, Frankia)*
- Asymbiotic Nitrogen Fixation *(Azotobacter, Azospirillum)*
- Nitrogenase enzyme, *nif* genes and Molecular mechanism of Nitrogen fixation
- Role of nodulin genes in nodule development and symbiosis
- Genetic engineering of BNF

Unit 4: Biofertilizers and Biopestisides (10hrs)

- **Biofertilizers** – Types, Production and Quality control
- Cultivation and mass production of Bioinoculants – Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, Azolla and Phospahte Solubilizing Microorgansms – Production and applications
- Carrier based inoculants
- **Biopesticides –** Types and applications (*Psedomonas Fluoroscence, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma viridae, Nuclear Polyhedrosis Virus)*

Unit 5 : Molecular Plant Pathology (09 hrs)

- Recognition and entry of pathogens into host Cell, Alteration of host behavior by pathogen
- Molecular mechanism of Disease establishment; enzymes, phytotoxins, growth regulators, involvement of elicitors; role of R and r genes in disease development
- Molecular mechanism of disease diagnosis.
- Resistance Mechanism in Plants, Systemic Resistance, Resistance genes, Phytoalexins. PR Proteins, Signalling Mechanisms.

Reference Books:

- Atlas, R.M., Bertha, R. (1997). Microbial Ecology, 4th Edition: Benjamin Cummings publication
- Pelczar, M.J., Chan, E.C.S. and N.R. Kreig (1993). Microbiology, 5th Edition. New Delhi: Tata Mc Graw Hill Publishing co. Ltd.
- Alexander, M. (1977). Introduction to soil microbiology, 2nd edition. Wiley publication.
- Purohit, S.S. (2007). Microbiology-Fundamentals and Applications, 6th Edition. New Delhi: Agrobios Publications.
- Rangaswami, G., Mahadevan, A. (2004). Diseases of Crop plants in India: PHI publication.
- Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.

16PMBDC04/ 16PBTDC04	Discipline Specific Elective - II: Food And Dairy Technology	4hrs/wk	4 Credits

Course Objectives:

The course will impart the students with the knowledge about:

1. The interactions between microorganisms and the food and milk environment, and factors influencing their growth and survival.
2. Explain the significance and activities of microorganisms in food and milk.
3. Describe the characteristics of food borne, diseases and spoilage microorganisms, and methods for food and milk preservation.
4. Fermented food and milk products

Unit . 1: Food Microbiology (9 hrs)

- Introduction to Food Microbiology
- Factors affecting interactions of microorganisms with food: intrinsic and extrinsic factors
- Objectives, Importance and functions of quality control.
- Food quality standards and control system. Food industries and QA in production, ISO certifications
- Food standard and safety regulations: BIS, ISI, FSSAI, FDA, CODEX, HACCP

Unit . 2: Food Processing and Packaging Technology

(9 hrs)

- Microbial flora associated with fresh foods.
- Scope, importance and principles of food processing.
- Application of enzymes in food processing
- Processing of fruits, vegetables, cereals, pulses, meat and fishes.
- Introduction to packaging, principles of development of protective packaging

Unit . 3: Food spoilage and Preservation

(10 hrs)

- Microbial spoilage of food: fresh food and canned food.
- Physical and chemical factors ionfluencing microbial spoilage of food.
- Types of microbes normally associated with spoilage and biochemical change.
- Preservation of foods: General principles & methods of food preservation
- Physical methods: Low temperature, high tem,perature, osmotic dehydration, blanching, canning, dielectric heating, microwave processing, membrane technology, irradiation.
- Chemical Methods: preservatives, salts, sugars, antioxidants and spices.
- Food additives and adulterants

Unit . 4: Dairy technology (10 hrs)

- Composituion of Milk, types of microbes in milk
- Microbial analysis of milk: SPC, Direct count, MBRT, Resazurin test
- Types of spoilage of milk and milk products, Milk borne infections affecting human and milking animal.

- Processing of milk products: Cheese, yoghurt, dahi, shrikhand, paneer, skimmed milk
- Preservation of milk and its products

Unit . 5: Advancement in Food technology (10 hrs)

- Introduction to neutraceuticals and functional foods.
- GM Foods and issues concerning GM foods.
- Bioactive foods: prebiotics, probiotics and synbiotics.
- Interaction between food and genes.

Reference Books:

1. Frobisher, M. (1974). Fundamentals of Microbiology 9th edition. Philadephia. Sanders Company.
2. Pelczar, M.J., Chan, E.C.S. and N.R. Kreig (1993). Microbiology, 5th Edition. New Delhi: Tata Mc Graw Hill Publishing co. Ltd.
3. Presscott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCB Mc GrawHill publication.
4. Frazier, W.C., Westhoff, D.C. (1978). Food Microbiology. Tata McGraw-Hill Publishing Company.
5. Swaminathan, M. (1990). Food Science, Chemistry and Experimental Foods. Mysore: Bappco Book Publishing Company.
6. Jay, J.J., Loessener, M.J., Golden, D.A. (2005). Modern Food Microbiology: Springer publication.
7. Prajapati, J.B. (1995). Fundamentals of Dairy Microbiology: Ekta Publication.

16PMBCC08	Combined Practicals Core Papers II Bioprocess Technology, Mycology and Virology	8hrs/wk	4 Credits

Course Objectives:

1. Skill related to operation of fermentation process and its various control aspects
2. Knowledge related to isolation and preservation of industrially important microbial strains
3. Hands-on training in analysis of various biomolecules
4. Hands-on training in handling fungal culture and its microscopic observation
5. Ability to identify various fungal culture on the basis of its morphology

Bioprocess Technology

1. Primary and Secondary screening for various extracellular enzymes by microorganisms
2. Single cell protein production
3. Ethanol fermentation and yield assessment by *S. cerevisiae*
4. Citric acid production and recovery by *A. niger*
5. Glutamic acid production and purification
6. Purification and Immobilization of enzyme

Physiology and Energetics

1. To study Km, Vmax, Kcat of some selected enzymes viz, Amaylase
2. To derive Line Weaver Burk Plot of selected Enzymes

Mycology and Virology

1. Isolation and Identification of various fungi
2. Isolation and Identification of various yeasts
3. Germ tube detection in *Candida albicans*
4. Isolation of plaques from the sewage sample

Reference Books:

1. Thimmaiah, S.K. (2006). Standard Methods of Biochemical Analysis: Kalyani publishers.
2. Sawhney S.K., Singh, R. (2005). Introductory Practical Biochemistry: Alpha Science International.
3. Rehm, H.J., Reed, G. (1983). Biotechnology: A Comprehensive Treatise in 8 Volumes. Vol. 3: Biomass, Microorganisms for Special Applications, Microbial Products I, Energy from Renewable Resources. Verlag Chemie, Weinheim –Deerfield Beach–Basel.

16PMBDC05/ 16PBTDC05	Discipline Specific Elective Practical –I Soil and Agricultural Microbiology	3hrs/wk	1 Credits

Course Objectives:

This laboratory course will make student understand the principle and the procedure of:

1. Isolation of nitrogen fixing bacteria
2. Cultivation of cellulose decomposing microorganisms from soil(Demo)
3. Demonstration of oozing , and isolation of pathogen from diseased specimen of lemon leaf showing citrus canker and isolation of *Xanthomonas spp.*
4. Isolation of Phosphate solubilizing microorganisms
5. Isolation and Study of PGPR attributes of soil microorganisms
6. Isolation of symbiotic and non-symbiotic Nitrogen fixers
7. Isolation of phosphate solubilizers
8. Production of liquid biofertilizers
9. Cultivation of nitrifying and denitrifying bacteria (Demo)

Reference Book:

1. Cappucino, T.G. and Sherman, N. (1996). Microbiology; A Laboratory Manual. The Benjamin-Cummings Publishing Co.

16PMBDC06/ 16PBTDC06	Discipline Specific Elective Practical- I: Food And Dairy Technology	3hrs/week	1 Credits

Course Objectives:

The student shall be able to:

1. Acquire skills to examine food and milk for its microbial load.
2. Understand the role of microbes in milk and food
3. Identify different microbes associated with food, enumerate them and understand their role
4. Evaluate different parameters affecting food quality and methods of preparation of different dairy products.

List of Experiments:

1. Detection and enumeration of various microbes in processed and unprocessed foods.
2. Efficiency of pasteurization and sterilization of milk by Phosphatase Test.
3. Preparation of Cheese, sauerkraut by microbial fermentation process.
4. Determination of common adulterants in different food sample.
5. Determination of antimicrobial activity of various spices.
6. Isolation of *Aspergillus flavus* and detection of aflatoxin from infected peanuts.
7. Determination of antioxidant activity of citric fruits.

Reference Books:

1. Baker, F.J., Breach, M.R. (1967). Handbook of Bacteriological Technique: Butterworth & Co Publishers Ltd.
2. Smith, S (2010) Food Biotechnology Practical Manual, Deakin University.
3. Dietrich, W. K. (2004) Food Science and technology by Taylor and Fransis.
4. Cappuccino, J. G. and Sherman, N., (1983) Microbiology: A Laboratory Manual.